Safe Operation and Airspace Integration of Airborne Wind Energy Systems

White Paper of the Airborne Wind Energy Industry

Version 2.0

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Content

Executive Summary

This White Paper outlines the needs and requirements of the Airborne Wind Energy (AWE) industry with regards to safe operation and airspace integration of AWE Systems. It lays out a number of recommendations for policy makers and regulators on national and EU level.

Integration of high-altitude wind energy into the airspace

Since AWE systems produce renewable electricity, **they should be given at least equal access to airspace in the "overriding public interest".**

The great advantage of AWE systems in terms of airspace integration is that the systems can automatically and quickly lower their flight altitude or land if necessary. For this reason, **AWE systems can be considered both obstacles and unmanned aerial vehicles (drones).** This varies depending on the country, location and technology used, e.g. soft kites or fixed-wing aircraft. **In general, both approaches or a combination of them should be made possible:**

Air risk mitigation

In general, other air space users should regard an AWE system as an obstacle which – like conventional wind farms – should be circumnavigated. AWE should therefore be marked with a special symbol on aeronautical maps. In addition, a special marking and firing of the kite and the ground station should be defined for all systems at all stages of development.

To reduce air risk, AWE systems can also dive down or land to avoid other airspace users. The prerequisite, however, is that they "cooperate" via transponders and are identifiable. Similar to Aircraft Detection Lighting Systems (ADLS), AWE systems would automatically initiate these tactical manoeuvres. A special marking of the tether, which would significantly impair the functioning of the AWE systems, is therefore not necessary.

A general transponder obligation for all air space users in the entire airspace – or at least around AWE locations – should be mandated. Due to the increasing use of drones, this development is already progressing in various countries (e.g. Netherlands). In Germany, too, 100% of all aircraft certified for night flying and a large proportion of all air traffic users have already installed transponder systems. The AWE sector supports the development of creating a more cooperative airspace by means of novel transponder technologies such as UAT/ADS-R.

For about 10 test and demonstration sites, flight restriction areas (ED-R) in Germany should be established for a limited time to enable the trouble-free development of AWE systems with 24/7 operation. For commercial operation, the designation as **hazardous areas should** be sufficient.

Ground risk mitigation

From a ground risk point of view, a AWE system can be treated as an unmanned aerial vehicle and – over controlled areas – also as an obstacle. The relatively new European regulations for drones are already being used by some AWE companies to carry out *Specific Operations Risk Assessment (SORA)* and obtain operating licenses, e.g. in the Netherlands and Ireland. In general, drone regulation is helpful for the AWE sector, as it applies throughout Europe.

AWE installations should be approved for operation over unpopulated areas if it is ensured that third parties on the ground are not endangered**.** This enables rapid testing and commissioning of AWE systems. Some AWE systems are already approved for use in areas where farmers, for example, are temporarily present. Areas that can be used for AWE operation should be made available to the plant developers.

1 Introduction and Objectives

This White Paper outlines the needs and requirements of the Airborne Wind Energy (AWE) industry with regards to safe operation and airspace integration of AWE Systems and lays out a number of recommendations related to policies and regulation.

The paper addresses policy makers and regulators from both the energy and the aviation sector, including ministries of energy, ministries of transport/aviation, national and regional civil aviation authorities, EASA, and the European Commission. Its intention is to provide the context and framework of how the AWE sector plans to secure safe operation and airspace integration. Hence, while the recommendations are mainly directed to authorities dealing with airspace related permitting, it will also help authorities that are in charge of energy-related installations to understand the specific requirements for “flying wind energy systems”.

This paper aims to trigger – and where possible contribute to – the development of international standards and guidelines for AWE. It does not intend to provide specific guidance for a particular system at a particular site, instead it is providing general guidelines for the AWE sector. The final goal is to ensure that AWE systems can and will be operated in a safe and economically viable way so that the AWE sector can contribute to reaching the renewable energy and climate targets. The uptake of AWE installations has been described in the AWE-White Paper developed by BVG Associates.[1]

At this stage, the main focus is on Europe as the majority of AWE technology developers are based in Europe. However, the recommendations will ideally be applied world-wide to facilitate the global deployment of AWE. Therefore, consultations with e.g. FAA or other Aviation Authorities are advisable.

The AWE industry is fully committed to safe operations. This has been already underlined by the joint statement of the AWE developers on “Key Safety Principles for operation of experimental and developmental Airborne Wind Energy Systems”[2]. The sector has also been working on the regulation for UAS and the Specific Operational Risk Assessment (SORA) over the last years including the definition of guidelines.[3] Moreover, the sector seeks full compliance with health and safety regulation.

[1] AWE White Paper 2022. Getting airborne – the need to realise the benefits of airborne wind energy for net zero. BVG Associates on behalf of Airborne Wind Europe, September 2022 https://airbornewindeurope.org/wp-content/uploads/2023/03/BVGA-Getting-Airborne-White-Paper-220929.pdf

[2] https://new.airbornewindeurope.org/wp-content/uploads/2023/03/AWEurope_Key-Safety-Principles.pdf

[3] Houle, C. 2021, An introduction to the Specific Operations Risk Assessment (SORA) for Airborne Wind Energy; Houle, C. 2021, Safe AWE Testing CONOPS Guidelines.

2 Background – AWE systems at the intersection of the aviation and energy sectors

Airborne Wind Energy Systems (AWES) will have to comply with standards from both the energy and the aviation sector. For instance, topics like grid compliance, power performance, electrical components, etc. will fall under the IEC-61400 (or still to-be-defined AWE-specific additions or annexes). This paper focuses on the aviation related standards.[4]

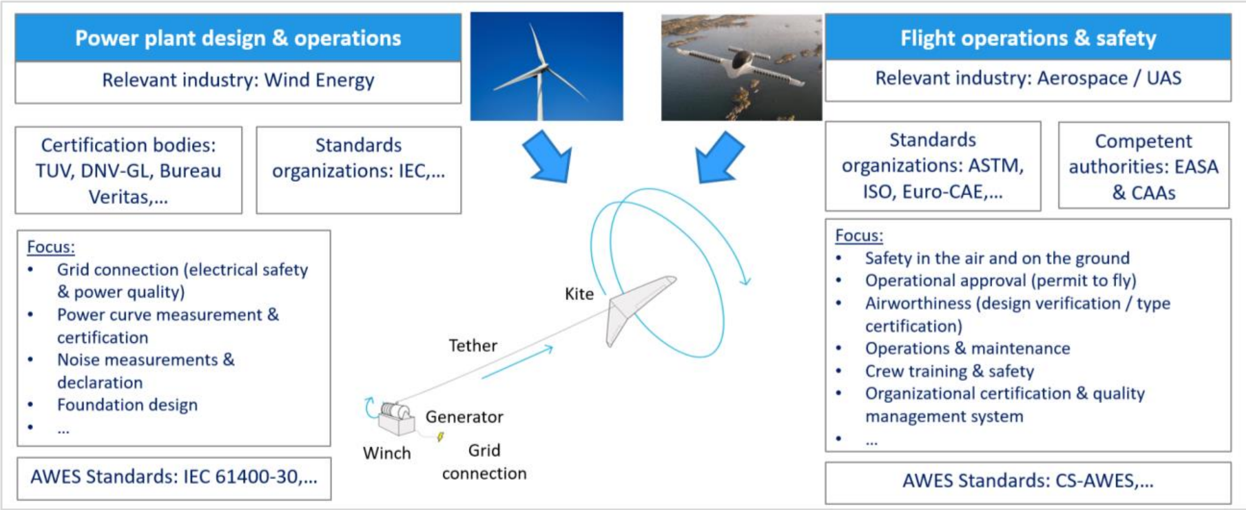

Figure 1: AWE systems at the intersection of aviation and energy section

Depending on the jurisdiction, the type of AWE and the type of risk, AWES can be considered unmanned aircraft systems (UAS) or obstacles or even both:

- **In several jurisdictions[5], AWES fall under the regulation for unmanned aircraft systems (UAS).** Probably most fixed-wing AWE systems are subject to EU Delegated Regulation 2019/945 on unmanned aircraft systems and EU Implementing Regulation 2019/947 on the rules and procedures for the operation of unmanned aircraft.
    - **AWES are within the “specific category” of UAS.** At their current size and when operated over secured locations, AWES do not require a full certification. In future, when AWES become larger and can potentially operate closer to or above roads and railways, a type certification may be needed[6].
    - **AWES have to carry out a Specific Operations Risk Assessment (SORA).** Under EU Regulation 2019/947, SORA provides a methodology to help both the operator and the competent authority determine whether UAS operation can be carried out in a safe manner.[7]
- **Other jurisdictions consider AWES as obstacles** based on general rules for obstacles according to ICAO Annex 14. The main reason is that AWES are limited in their movements by the tether. For instance, in Germany at least soft-kites are currently considered obstacles like balloons, masts, etc. This implies that they have to be made visible towards other airspace users, e.g. through

[4] Another White Paper on the approach and standards related to the energy sector related topics is planned in the course of 2023. The main focus will be put on grid connection as this topic has highest priority.

[5] From current permitting processes and discussions these are The Netherlands, Ireland, Spain. Apart from jurisdictions, also EASA seems to consider AWES as UAS, however, EASA has not issued an AWE-specific statement as of today.

[6] This may be the case under SAIL V or VI operations (see the Specific Assurance and Integrity Level (SAIL) under SORA)

[7] See EASA UAS rules: https://www.easa.europa.eu/downloads/110913/en

lighting and marking. It is, however, important that making AWES visible is not only achieved through purely visual means but includes other technologies like transponders (see also below).[8]

Ideally, national or regional regulation should not impede permitting neither under UAS-nor under obstacle regulation, see recommendations below in section 4.

3 AWE Developer Survey

3.1 Methodology

In February/March 2023 the AWE sector carried out a survey among its developers.[9] The survey contained five main sections and aimed to develop a clear understanding of where the AWES industry stands today as well as a vision of where it is heading in terms of operational safety and airspace integration.

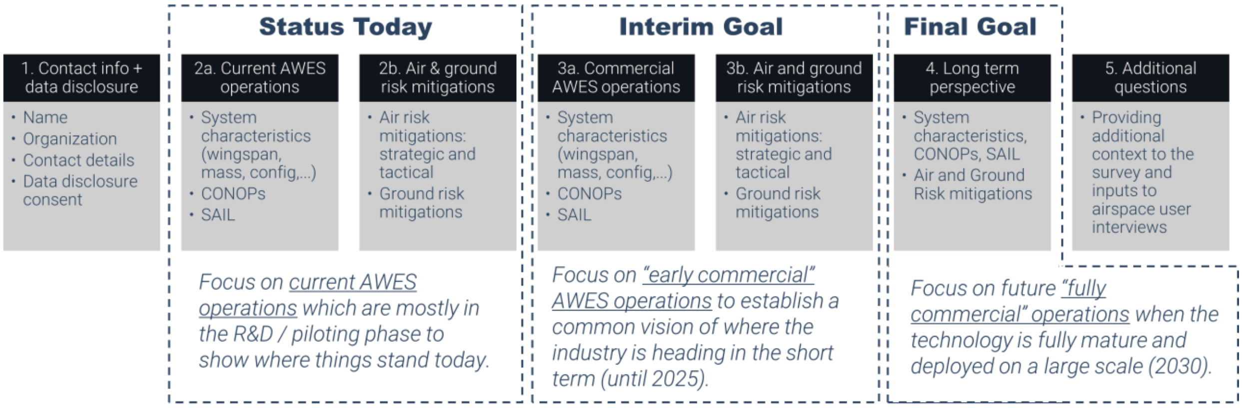

Figure 22: Survey structure

A total of eleven AWE system developers participated in the survey. They represent the major developers world-wide and are all members of Airborne Wind Europe.

[8] ICAO Annex 14 may have to be potentially adapted to AWES – mainly lighting and marking –by national representatives hrough ICAO working groups.

[9] The Survey was developed and carried out by TwingTec in close collaboration with Airborne Wind Europe and UASolutions. The activities are being co-funded by the Swiss Federal Office of Civil Aviation.

Figure 33: Survey participants

Nine of the companies develop ground-based generation systems, thereof three soft-kites, four fixed-wing and two other systems (rotary/semi-rigid). One developer preferred to stay anonymous.

The detailed results have been shared with the participants of the IEA Wind Task 48 “Working Group 3 on Safety and Technical Guidelines”.

3.2 General findings

There was a high degree of consensus between developers in terms of system evolution, CONOPs and classification. Over 70% of the participants ranked the challenges indicated in the questions as highest or high priority / criticality in their development and commercialization plans. There was clear consensus on current and future mitigations, especially from an air risk perspective. Safety on the ground and regulatory uncertainty were seen as main challenges.

As a general guiding principle, AWES should be classified

- **as an obstacle from the air risk perspective and**
- **as UAS and/or obstacle (depending on the circumstance) from the ground risk perspective**

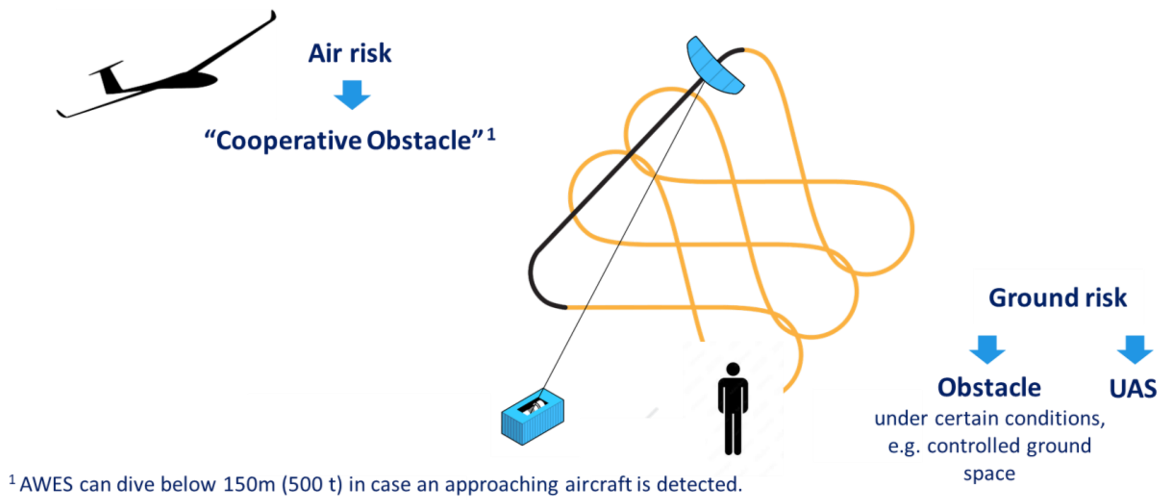

Figure 4: AWES being both obstacle and UAS

60% of the responds agree to this approach; 18% proposed to just be "tethered UAS" while another 18% opted to be only "obstacles".[10] This means that individual companies may not follow the "mixed" classification. Therefore, given that the effects of this approach have not been fully assessed yet, it should be considered as "working assumption". Further details are discussed under 3.6 and 3.6

AWES need to be designed and approved to operate over sparsely populated ground area in order to achieve significant market uptake as indicated in the BVG White Paper. Already today, soft-kite systems have been approved to operate in ground areas which are not fully `controlled` and from time to time may have third parties (like farmers) within them.

3.3 System evolution

At this stage the majority of companies fly small systems with wingspans below 8m and mass below 25kg. The first commercial systems are being installed based on soft kite systems with a power output of 100-150kW. Most companies consider 50-100kW systems to become the first commercial products. Fully commercial systems are planned to be in the 100-200 kW range, and then later also in the 1-2 MW range.

Table 1: System evolution

Most common AWES attributes

	Current[1]	Early Commercial	Fully commercial
Wingspan	3-8 m	8-20 m	20-40 m [3]
Mass	<25 kg	25 – 600 kg	600 – 5670 kg
Airspeed	25 - 50 m/s	25 – 75 m/s	25 – 75 m/s
Config	Soft[1]/rigid, GBG[2], single tether	Soft/rigid, GBG, single tether	Soft/rigid, GBG, single tether
Power	<50 kW	50 – 100 kW	100 – 2000 kW

[1] First commercial operations are already underway based on soft kites with larger dimensions. [2] Ground Based Generation. [3] >40m for soft kites.

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[10] In this context a recently published position by the FAA is of interest: It considers AWES as an obstacle under part 77. https://www.federalregister.gov/documents/2022/12/23/2022-27993/airborne-wind-energy-systems-awes-policy-statement However, AWES operations in the US are also being considered under part 107 (~'Open' category in the EU). Further exchange with FAA on this topic is planned.

3.4 Concept of Operations (CONOPs)

The general Concept of Operations (CONOPs) foresees for the early commercial systems a Level of Automation of 4 (“fully automated”) where the systems flies onshore Beyond Visual Line of Sight (BVLOS). Full commercial systems would have a Level of automation of 5 (system only) at on- and offshore sites.

Table 2: Most common AWES operations

	Current		Early Commercial	Fully commercial
LOA[1]	2: Partially Automated		4: Fully Automated	5: System Only
Observer	VLOS[2]		BVLOS[3]	BVLOS[3]
Duration[4]	< 1 hour	Where?	On-shore	On and off-shore
Number[4]	< 100	When?	2024 / 2025	

[1] Level of Automation. [2] Visual Line of Sight. [3] Beyond Visual Line of Sight. [4] Typical duration / number of flights with current systems. Note that much longer and more frequent flights are already being conducted by soft kite developers.

3.5 UAS category and SAIL classification

Current operations are either under the Open or Specific category for those considered as unmanned aerial systems by the competent authority. As mentioned previously, some operations (e.g. soft-kites operated in Germany) are permitted as obstacles. However, several developers indicated that they are now being asked to comply with SORA for future operations even if they are currently not required to. Due to the higher degree of intrinsic risk posed by the larger systems in the early and fully commercial phases, these operations will rather be considered as Specific or eventually Certified.

There was not a full consensus on the final Specific Assurance and Integrity Level (SAIL) assessment for fully commercial operations, but it is likely that these will be SAIL V operations for which a type certification of the system will be required.[11]

[11] SAIL V is especially likely large rigid wings operating over sparsely populated areas. There may be the chance that with some partial controlling of ground area and parachutes to reduce critical area this could start at SAIL IV. The requirements for a type certificate and the process to obtain it would need to be defined once this type of operation is closer to implementation.

Table 3: Category and SAIL classification most commonly indicated by participants.

	Current	Early Commercial	Fully commercial
Category	Specific / Open / Other[1]	Specific	Specific / Certified
SAIL[2]	II	II-III[3]	III – V[4]

[1] Permitted in another way: i.e. as a kite / obstruction -> not considered as a UAS. [2] Specific Assurance and Integrity Level, only relevant for Specific operations. [3] Early commercial OPS are mostly SAIL III, which would require controlled ground area for rigid wings but could be sparsely populated for soft kites. Under certain conditions SAIL II may be possible, see https://repository.tudelft.nl/islandora/object/uuid%3A2904d449-a183-4d30-b6f5-f290c28ed0aa [4] SAIL III is also the most common category for fully commercial OPS which makes sense for soft kites but it is our view that rigid wings operating over rural (<25 ppl / km^2) or sparsely populated (<250 ppl / km^2) environments will be classified as SAIL IV or V respectively. No credible counter arguments to this conclusions were given by participants.

3.6 Air risk mitigation

AWE systems should – in general – be regarded as obstacles from the air risk perspective. This means that other manned or unmanned aircraft must avoid airspace in which AWE systems are operated. As obstacles, AWE systems also would not be required to be operated by a pilot, allowing full autonomous operation in the long term (as of today, UAS still require a pilot, there is no regulation on fully autonomous operation yet). BVLOS (Beyond Visual Line of Sight) operation above 150m will be crucial for viable operation.

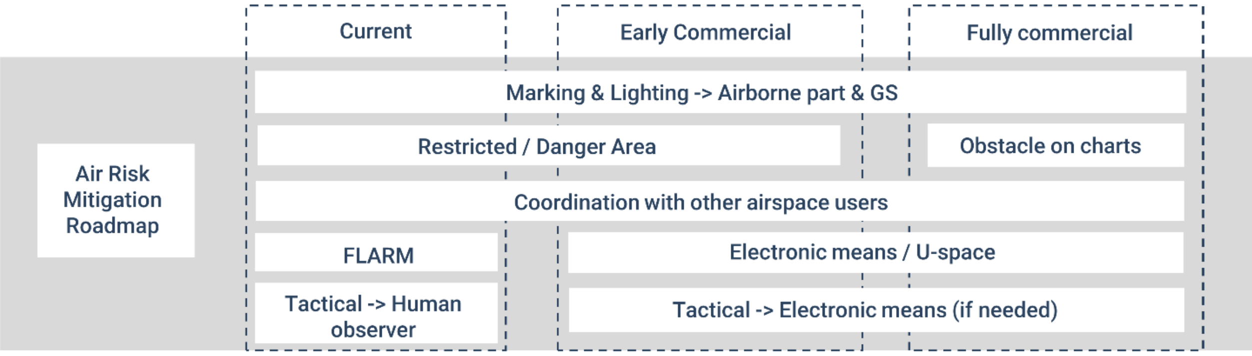
AWE systems should be clearly indicated in airspace charts. This would include a new, AWE-specific symbol. In the beginning restricted and danger areas should be set up.

However, even if regarded as obstacle, AWE systems can be cooperative through electronic means, i.e. they can apply tactical mitigation by detecting and avoiding air traffic. Similar to Aircraft Detection Lighting Systems (ADLS) which are current rolled out in Germany for wind turbines, other aircraft would be detected and the kites would dive down to below 150m (500ft). Being cooperative is important for AWES outside of restricted airspace because the tether cannot be marked and therefore may not be sufficiently visible for other airspace users. Nevertheless, tactical mitigations should be reduced to a minimum because if applied on a regular basis it could result in a significant reduction in energetic output of an AWE system, which would negatively impact the economics.

Coordination with other airspace users requires transponders: Aircraft can only be detected if they use a transponder, not only during night flights but also during the day. Airspace users without transponders must avoid AWE systems as they would have for any other fixed obstacle. Ideally modern ADS-B transponders will become mandatory that allow communication between transponders, allowing to transmit and receive detailed data on position, altitude, travel speed direction, etc. and which could also include information on the type of aircraft, i.e. in the case of an AWE users would know that there is a tether. **Transponder mandatory zones** could be established around AWE systems, like what is already implemented around airports.

Marking and lighting of the airborne part and the ground station will be required for all systems throughout all development stages. Synchronized flashing lights on the kite and the ground station could help pilots who have entered AWE airspace by mistake to identify the tether or at least imagine its position.

In summary, ensuring safe operation and airspace integration is the top priority for AWE developers who actively seek to coordinate and cooperate with other airspace users through the use of electronic means and integration in future U-Spaces or other cooperation agreements. The different air risk mitigation measures as proposed by AWE developers are shown in Figure 55



Air Risk Mitigations[1]	Current	Early commercial	Fully commercial
M&L -> Airborne part & GS	50%	91%	91%
Restricted / danger area	36%	64%	27%
Obstacle on charts	0%	45%	73%
Coordination	36%	55%	36%
Electronic means / Uspace	18%	95%	91%
Tactical mitigations	91%	55%	36%

[1] % of participants who indicated that they are using or intend to use these mitigations.

Figure 55: Air Risk Mitigation Roadmap

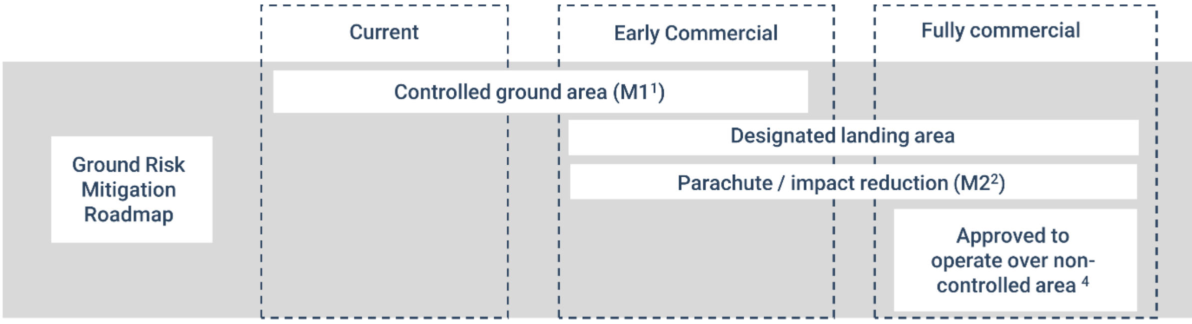
3.7 Ground risk mitigation

From the ground risk perspective AWES are either UAS and/or obstacles, depending on the site specifics, the type of AWES and the jurisdiction.

For current and early commercial systems, developers require controlled ground areas in order to fully mitigate the ground risk, irrespective of the system reliability. This allows for fast testing and deployment of AWES without putting any third parties on the ground at risk of harm.

The use of a designated landing area or some form of parachute or other means to reduce the kinetic energy of an impact in case of a hard landing were both indicated by developers.

In order to allow for a wide-spread deployment of AWE systems, companies aim to operate over non-controlled ground area in the future. This will require an appropriate certification basis and means of compliance that should be developed in the coming years. The risk of the tether sweeping over the ground in case of crash or loss of control needs to be addressed.



Ground Risk Mitigations[3]	Current Operations	Early Commercial	Fully Commercial
Controlled Ground Area	50%	55%	41%
Designated landing area	18%	45%	55%
Parachute / impact reduction	27%	36%	45%
Approved to operate over non-controlled areas	18% [5]	18%	64%

[1] Mitigations that reduce population density. [2] Mitigations that reduce effects of impact. [3] % of participants who indicated that they are using or intend to use these mitigations. [4] Appropriate certification bases and means of compliance to be determined. [5] Claims were not substantiated.

Figure 46: Ground Risk Mitigation Roadmap

4 Policy and regulatory recommendations

Based on the discussion within the AWE sector, consultations with regulatory experts and the survey results, the following policy and regulation-related recommendations have been developed as a basis for discussion with public and private stakeholders.

4.1 Test and demonstration phase / R&D sites – to be put into operation as soon as possible

In the next years, AWES will still require sites in Europe where safe operation of test and demonstration systems can be ensured 24/7. These sites are crucial to demonstrate the feasibility and reliability of AWE operations.

1. **Concede restricted airspace for R&D sites:** For the financial viability of research & development, time-unlimited flight restriction areas (ED-R) are necessary. The AWE sector therefore calls for the establishment of such areas to be facilitated in limited numbers until alternative solutions are implemented safely and reliably.
2. **Provide sites with controlled ground area:** To mitigate ground risk, AWE require test and demonstration sites where access of people can be restricted or controlled. This will also help reducing operations costs as systems may be allowed to fly 24/7 without monitoring of a pilot crew.
3. **Implement "regulatory sandboxes":** To facilitate R&D operations, AWE should be exempt from certain standards and regulations, e.g. with regards to grid connections or conformity declarations. Furthermore, any streamlining or simplification of permitting processes, e.g. building permit, noise restrictions, environmental impact assessments, etc., would be helpful to minimize deployment costs and speed up time to market.

4.2 Commercial sites – preparation for deployment needs to commence

1. **Acknowledge that AWES require AWE-specific regulation in the mid-term.** While the AWE sector can, should and will build largely on existing standards and regulation for obstacles, UAS and wind energy systems, they need to be treated in a special way. As mentioned above, AWES might – in general – be classified as obstacle from the air risk perspective and UAS from the ground risk perspective. But in the end, AWES will have to be regulated as "AWES" – even though the majority provisions would stem from UAS and obstacle regulation.

2. **Give AWES fair or even preferential access to the airspace:** The EU has recognized **r**enewable energy as an overriding public interest.[12] In order to tap into the wind resources at higher altitudes, AWE should not be considered "nice-to-have" renewable technology but a technology which can substantially contribute to reach the climate goals. Access to airspace for AWES should be weighed appropriately in terms of the public cost / benefit ratio compared to other airspace users.
3. **Include AWE with own symbol in aeronautical maps**: AWE facilities or AWE farms should be marked in aeronautical maps with their **own symbol**. That way airspace users are aware of this new type of energy infrastructure which represents an obstacle. It is not the goal of the AWE sector that complete airspace closures are carried out around AWE systems but rather to have an integrated approach where AWES and other airspace users can share the airspace in a safe and efficient manner.
4. **Other airspace users should avoid AWE sites:** At those sites where AWE systems are permitted to operate, other airspace users should – in general – be obliged to evade AWES or the Operational flight volume. Where appropriate, danger areas should be defined. Renewable power generation should ideally not be interrupted or made commercially unviable.
5. **Make use of AWES' ability to dive down or land in exceptional cases:** To clear the airspace for emergency or rescue aircraft or other aircraft that have lost orientation, AWE systems could temporarily fly below a certain altitude or land. Such manoeuvres require automated procedures and use of technology like transponders. However, it needs to be further investigated how AWES can carry out an active evasion that is sufficiently fast and secure to fully rely on it for any kind of encounter with other airspace users.
6. **Make mandatory use of transponders for all airspace users.** The AWE sector supports the development of using novel transponder technologies (such as UAT/ADS-R) to ensure a more cooperative use of airspace. In the medium term a transponder obligation for all air traffic participants will increase safety.[13] Due to the increasing use of drones, this development is already progressing in various countries (e.g. Netherlands). In Germany, 100% of all aircraft certified for night flying and a large proportion of all air traffic users have already installed transponder systems. Ideally transponder signals would include information that it is emitted by an AWE system, so users would know that there is a tether.
7. **Agree internationally on lighting and marking of airborne devices and ground stations.** ICAO Annex 14 on lighting and marking for obstacles can be used as basis. In addition to safety aspects, the learnings regarding social acceptance on the visibility of wind farms should be taken into consideration, e.g. Aircraft Detection Lighting Systems (ADLS). Country-specific lighting and marking requirements should be avoided.[14]
8. **Tethers should not have to be marked.** It has been shown that in practice e.g. colours on tethers wear off and that no added value of a colour marking could be determined.[15] Markings must be technically and economically feasible, i.e. the efficiency of the overall system must not be reduced to such an extent that commercial operation is no longer possible. This would happen for instance with flags attached to the tether as they would impede the reeling of the tether. Potential collision of aircraft with tethers needs to be further investigated in order to determine if the risk is catastrophic or hazardous.

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[12] https://ec.europa.eu/commission/presscorner/detail/en/IP_23_2061

[13] See also recommendations of Droniq GmbH and DFS Deutsche Flugsicherung 2021 "Erkenntnisse & Handlungsempfehlungen des Fördervorhabens „Einrichtung eines U-Space Reallabors in Hamburg"

[14] Marking and lighting certification standard for tethered gas balloons could be useful, at least for some AWES architectures. https://www.easa.europa.eu/en/certification-specifications/cs-31tgb-tethered-gas-balloons

[15] SkySails Power has used a red-white coulored tether and has come to the conclusion that the contrast does not significantly improve visibility.

9. **Integrate AWE into U-Spaces:** The AWE sector sees significant potential in the U-Space concept if extended to rural areas where awes would operate. AWES should therefore be considered in on-going and future U-Space related discussions and developments. In the first phase of U-Space integration – which will last for a few years – manned and unmanned traffic should be segregated due to safety concerns, even if the final U-Space concept may allow a shared air space.[16]

10. **AWE installations should be approved for operation over unpopulated areas** if it is ensured that third parties on the ground are not at risk**.** Some AWE systems are already approved for use in areas where farmers, for example, are temporarily present. Areas that can be used for AWE operation should be made available to the plant developers.

4.3 Governance and Support

1. **Allow transfer of permits-to-fly under comparable conditions.** For the commercial deployment of AWE permits-to-fly issued in one country or jurisdiction should be transferrable to other jurisdictions provided that the conditions of the sites are comparable. The criteria and rules applied should be based on common, international guidelines and standards to be developed together with the AWE sector.

2. **Set-up AWE-specific communication channels with stakeholders:** There should be defined contact persons with AWE expertise in the relevant authorities in order to build up expertise and facilitate collaboration across entities on an international level.

3. **Support definition of AWE-specific guidelines, standards and regulation.** AWE will build on existing rules and regulations. However, the elaboration of internationally agreed upon adjustments, additions or new AWE-specific rules and regulations will require time and resources from various stakeholders. For instance, there is the need for a Pre-defined Risk Assessment for the operation of AWES in the specific category and dedicated means of compliance for the design verification and certification of AWES. Adequate capacities and funding should be made available at the relevant authorities and standardisation committees.

4. **Fund R&D activities into AWES safety.** Public funding should be made available for research into safety relevant topics such as airspace integration, operation and maintenance procedures, standard development and harmonization for AWE systems. For instance, the Swiss Federal Office of Civil Aviation (FOCA) provides funding through its BV87 program for "Research into safe operation and integration of Airborne Wind Energy Systems".[17]

5 Conclusions

If the above-mentioned recommendations are implemented, the aviation-related conditions will give the AWE industry a realistic chance to prosper in Europe and globally. Otherwise, the deployment of AWE will be restricted without being able to reach its full potential of about 1 GW installed capacity by the early 2030s and up to 270 GW by 2050 as outlined in the AWE White Paper by BVG Associates.

The sector thus calls on public authorities and policy makers to support the development of regulations and standards based on the above-mentioned recommendations. The years 2023-2025 are the crucial ones to provide a good basis and long-term roadmap for the AWE sector.

This Paper is considered to be a "living document" which will be continuously updated with the results of discussions with stakeholders like EASA and CAAs. Additional aspects, e.g. in terms of permitting, certification basis and roadmap, learnings from actual system deployment, etc. will be used to periodically update and reinforce the recommendations made here.

[16] http://www.smll.fi/wp-content/uploads/2021/04/IAOPA-position-paper_segregation-of-U-space-airspace.pdf

[17] https://www.bazl.admin.ch/bazl/de/home/themen/finanzhilfen-luftverkehr/spezialfinanzierung.html

6 Outlook

The AWE industry plans to coordinate their continued activities in this area over the IEA Wind 48 Task WP3: Safety and Regulation. A graphical overview of the planned activities has been included in the figure below.

Figure 7: Coordinated activities on Safe Operation and Airspace Integration

The development of a certification basis and the stakeholder engagement to validate the guidelines serve as cross-cutting activities (horizontal). The development of guidelines on specific topics which will eventually lead to standardized means of compliance (vertical).

These activities are harmonized with the scope of the aforementioned R&D project funded by the Swiss FOCA. It is anticipated that sub-working groups within WP3 will be formed in order to elaborate on the various topics and progress towards draft technical guidelines. After consultation with competent authorities and a broader set of industry stakeholders, the guidelines will be refined into a harmonized set of AWES specific standards that provide a means of compliance towards the agreed upon certification basis.

Apart from that the sector will continue to work on other permitting related best-practices and guidelines, e.g. with regards to sound emissions, birds & bats, building/infrastructure, etc.

7 References

Airborne Wind Europe 2020, Key Safety Principles, https://airbornewindeurope.org/wp-content/uploads/2020/09/AWEurope_Key-Safety-Principles.pdf

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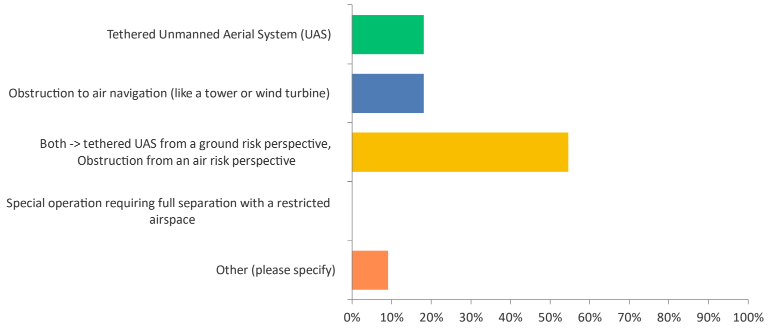
8 Annex: Selected results from survey

OUTLOOK

Q79: How do you think commercial AWES should be classified?



Comment to 'Other': Unmanned tethered gas balloon for lighter-than-air systems. Both tethered UAS for ground risk and obstruction for air risk for heavier-than-air systems.

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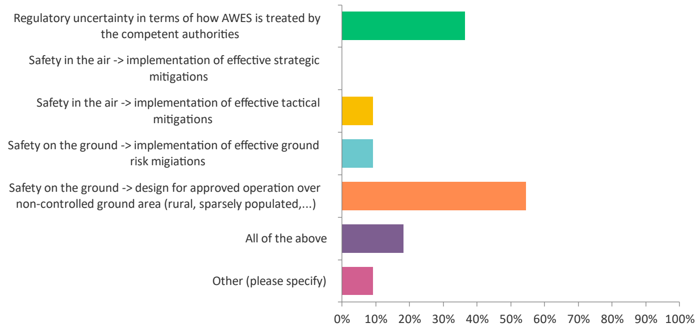
OUTLOOK

Q80: What do you see as the largest challenges facing the safe operation of commercial AWES?



Comment to 'Other': The biggest challenge is to allow us to fly in order to mature technologies and systems. Either we get that or the AWES industry collapses.

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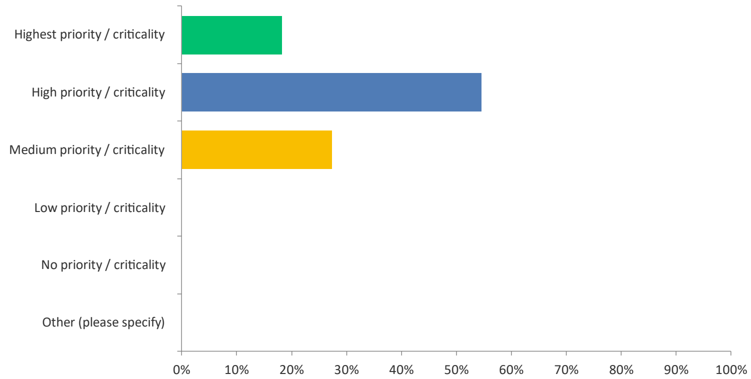
OUTLOOK

Q81: How do you rank addressing the challenges indicated in the previous question in terms of priority / criticality in your development / commercialization plans?



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