IEA Wind Task 48 on Airborne Wind Energy

Kick-off Meeting – DRAFT Agenda

Online meeting, 27-28 October 2021

Organising Committee:

Kristian Petrick, Stefanie Thoms, Udo Zillmann – Airborne Wind Europe (Operating Agent)
Chris Vermillion – NC State University, USA
Roland Schmehl – TU Delft, Netherlands
Jochem Weber – NREL, USA
Andy Clifton – WindForS, Germany (advisor)

Objectives:

- Gather the international Airborne Wind Energy (AWE) community to officially kick-off the new IEA WindTask 48
- Give an overview of the current state-of-play of the five Working Group themes defined in the Technical Expert Meeting in fall 2020
- Define actionable next steps with clear responsibilities for the Working Package leaders and participants (see WP details below)
- Attract additional participants and supporting organisations

Agenda 27-28 October 2021

Time	Topic	Presenter
Wednesday, October 27, 2021		
Introduction Session		
14:15 CET	Check-in	All
14:30	Welcome and short meeting overview	Kristian Petrick, *AWEurope*
14:35	Introduction about IEA Wind and Tasks	Tbd, *IEA Wind ExCo member*
14:45	Speed-Dating - online meeting ice-breaker *3 min. break-outs with 3 people randomly chosen*	
14:50	News from the AWE sector: Short presentation for AWE newcomers	Udo Zillmann, *Airborne Wind Europe*
Session 1		
15:00	**WP1 Resource potential and markets** *Presentation plus Q&A 15 min.* *Support by Philip Bechtle*	Roland Schmehl, TU Delft
15:15	**WP2 Reference models, tools and metrics** *Presentation plus Q&A 15 min.* *Support from TU Delft*	Chris Vermillion, NC State University (US)

Time	Topic	Presenter
15:30	**Moderated Break-out sessions on the two presented topics (45 min.)** *Goals:* • *Collect updates, provide feedback on topics* • *Define participants in WPs* • *Define action items, next meetings, collaboration with other IEA Wind tasks*	
16:15	Plenary with main results of break-out groups *Short discussion / Q&A (15 min.)*	
16:30	Break (10 min.)	
Sessions 2		
16:40	**How to become a Task member** Explanation of structure, plans, formalities.	Kristian Petrick, *AWEurope*
16:50	Short summary of the day	Udo Zillmann, *AWEurope*
17:00	Close of day	
Thursday, October 28, 2021		
14:15 CET	Check-in	All
14.30	Welcome and Recap of Day 1	Kristian Petrick, *AWEurope*
14:35	Speed-Dating *3 min. break-outs with 3 people randomly chosen*	
Session 3		
14:40	**WP3 Safety and regulation** *Presentation plus Q&A*	Dieter Moormann, *RWTH Aachen*
15:00	**WP4 Social Acceptance** *Presentation plus Q&A*	Kristian Petrick, *AWEurope*, Helena Schmidt, *TU Delft*
15:15	**WP5 AWES Architectures** *Presentation plus Q&A*	Jochem Weber, *NREL* Christof Beaupoil, *someAWE*
15:30	Break (10 min.)	
15:40	**Moderated Break-out sessions on the two presented topics (45 min.)** *Goals:* • *Collect updates, provide feedback on topics* • *Define participants in WPs* *Define action items: Next meetings, collaboration with other IEA Wind tasks*	
16:25	Plenary with main results of break-out groups *Short discussion / Q&A (15 min.)*	
Final Session		
16:35	**Organisational topics:** website, how to log-in, etc.	Stefanie Thoms, *AWEurope*
16:45	Discussion and consensus among all participants • Review of all actions to be taken • Timelines and Next steps	Udo Zillmann, *AWEurope*
17:00	Event close	

Work Packages (WPs) and WP Leaders

WP0: Task coordination	WP1: Resource potential and markets	WP2: Reference models, tools and metrics	WP3: Safety and regulation	WP4: Social acceptance	WP5: AWES architectures
• Organisation & management of Task • Communication • Website • Dissemination Operating Agent: Airborne Wind Europe	• AEP prediction for selected sites & toolchain documentation • Global high-altitude wind resource atlas • Recommendation on AWE entry-markets	• Common definition of metrics and KPIs • Joint reference model(s) • Centralized design tool • Simulation vs. test flights comparison	• Concept of operations and risk assessment • Airspace integration concept • Benchmarking concepts for safe automatic operation	• Life-Cycle Analysis • Repository of survey and studies • Guidelines for site selection, noise measurement and impact mitigation • Circular Economy	• Design space representation • Market specific deployment recommendations • AWES R&D state, trends and needs • Portal for AWES engagement and development potential
• Task reporting • Communication outputs	• AEP prediction toolchain • Economic metrics	• Definitions • Centralized design tool database	• Whitepaper on AWES safety	• LCA of AWE • Repository of surveys & studies	• Guidelines

No.	Work Package Name	Lead Organisation
WP0	Management and dissemination	Airborne Wind Europe (BE)
WP1	Resource potential and markets	TU Delft (NL), University of Bonn (DE)
WP2	Reference models, tools and metrics	NC State University (US), TU Delft (NL)
WP3	Safety and regulation	RWTH Aachen University (DE)
WP4	Social Acceptance	Airborne Wind Europe (BE)
WP5	AWES Architectures	someAWE Labs (ES), Airborne Wind Europe (BE)

WP1: Resource potential and markets

Coordinator: TU Delft, University of Bonn

Topics and objectives

This work package will assess the high-altitude wind resource, the related generation performance of deployed AWE technologies, both on system and on wind park level, as well as the economics and potential contribution of AWE to the future energy system. Several potential scenarios for the global deployment of AWE will be developed to facilitate the formulation of a roadmap for the AWE sector. The following tasks will be covered:

- Assessment of the wind resource (up to ~1 km) using available reanalysis data (e.g. ERA5), regional refinements using appropriate mesoscale model data (e.g. DOWA/new US wind atlas by NREL/GWA3/NEWA) and measurement data (e.g. Lidar data).
- Techniques to simplify the use of the wind resource data and improve its usability (e.g. clustering methods for wind profile shapes) and explore compatible system performance characterizations (e.g. a set of power curves for a variety of wind conditions).
- Performance prediction methods distinguishing different AWES architectures, using low to medium fidelity models to generate power curves, which will then be validated by test data from operational AWES in close collaboration with WP2. The impact of short timescale wind variations and turbulences not covered in the reanalysis data shall be assessed.
- Assessment of the electricity generation potential at selected sites, first for Europe and US, then for other sites, using the derived wind resource data and AWES power curves.
- Combine performance prediction methods with cost models for specific AWES architectures to explore the system/wind farm design space.
- Embed AWES performance and cost models in an energy system model and investigate the deployment in potential markets, such as on- and off-grid or on- and offshore, considering different penetration scenarios.
- Determine economic metrics, such as levelized costs/profit/revenue of energy (LCOE, LPOE, LROE) etc.

This framework will allow developers to assess how expensive a system is expected to be and how expensive it can be to be economically viable, based on the market. The different stages of model development are systematically interleaved with validation steps, linking also to the reference models of WP2. An optional outcome of the work package is a joint technology assessment approach.

Deliverables

D1.1 AEP (Annual Energy Production) predictions for selected sites in Europe and US
D1.2 AEP prediction toolchain documentation
D1.3 Global high-altitude wind resource atlas
D1.4 Recommendation on AWE entry-markets

WP2: Reference models, tools and metrics

Coordinator: NC State University, TU Delft

Topics and objectives

This work package will develop key capabilities, tools and reference cases that support the research and technology development of airborne wind energy systems. It will span from the formulation of the fundamental problem statement of airborne wind energy conversion, through the definition of metrics and performance indicators, specification and development of simulation and assessment tools to the specification of reference models serving as application and educational examples. The following specific tasks will be targeted:

- Collaborative conduct of a holistic systems engineering approach to identify stakeholder requirements and extract system functional requirements for airborne wind energy systems well considering the different use cases associated with the different markets.
- Identification of commonly used metrics and key performance indicators and determination of gaps between available metrics and the quantification need of functional requirements.
- Development of technology assessment methodologies and tools for the holistic, absolute and relative assessment of the techno-economic performance of airborne wind energy systems applicable at different technology development stages from concept to high TRL. these methods will be built on the identification and suitable combination of metrics and key performance indicators to reflect detailed specific as well as trade-off influenced holistic system capabilities.
- Determination of the state of the art of globally available simulation approaches, tools and platforms. Identification of gaps in the simulation tool landscape and initiation of simulation tool development activities ranging from collaborative development to simulation competitions with embedded use of the developed reference models as test cases.
- Development of key airborne wind energy technology concept reference model(s) representing distinctly different fundamental airborne wind energy technology archetypes.
- Development of validation approaches for the comparison between the simulation tools and prototype test data, and for the upscaling from prototype to commercial system.

Deliverables

D2.1 Report and Common definitions of metrics and KPIs and gap analysis

D2.2 Online dissemination platform for reference model(s) including, system definition, overall design, Concept of Operations and applications examples metrics and simulation tools

D2.3 Centralized design tool database

D2.4 Comparison of simulation and test flight data, validation of simulations and upscaling assumptions

WP3: Safety and regulation

Coordinator: RWTH Aachen University, Airborne Wind Europe

Topics and objectives

Question to be answered: How to deploy AWE safely in a technological feasible and affordable way?

The Task will review existing siting, grid connection procedures and permitting regulations in selected countries and develop guidelines for their adaption to AWE technology where necessary or appropriate for a smooth AWE deployment in Europe and worldwide. We will also elaborate regulatory guidelines on how AWE should be treated regarding ground safety, airspace integration (e.g. lighting & marking interference with air traffic). To that end, we will seek collaboration with the European Union Aviation Safety Agency (EASA) and the Federal Aviation Authority of the US (FAA), national, and regional aviation and permitting authorities and other experts in the field (e.g. operators of unmanned aerial systems (UAS)).

With respect to different AWE operational approaches (offshore .vs. onshore; soft kite .vs. hard kite) we will elaborate adequate safety guidelines, keeping in mind technological feasibility and affordability. We aim to trigger and where possible contribute to the development of international standards and guidelines for AWE (e.g. within the IEC-61400 for wind generators and aviation related standards).

- Concept of operations (CONOPS) guidelines for different AWE concepts
- Power generation systems regulation on ground safety (on ground):
    - How does AWE change existing regulations?
    - Electrical system safety: How to deal with all ground station and grid connection related components and related safety expected.
- Aviation regulation:
    - How does AWE fit into the current and future aviation regulation including ground safety of 3rd parties and airspace integration?
    - Which laws and regulations apply (e.g. European Commission Implementing Regulation (EU) *2019/947* of 24 May 2019; FAA regulation; other national regulations) and how do they need to be adjusted to accommodate for AWE?
    - How to apply Specific Operations Risk Assessments (SORA) assessments comparable among AWE concepts (e.g. Benchmark) required health monitoring and recovery systems to ensure the safety of 3rd parties.
    - Airspace integration: How can AWE become a player in the shared concept?
- Health, safety and environment (HSE): Practical aspects of protecting environment, maintaining health and safety at occupation
- Operations: How can design concepts and approaches, standardization be benchmarked for different AWE operation approaches including aviation, ground operation; HSE)?

This WP will work closely with aviation authorities (EASA, FAA, CAAs, ...) and other technical standardization entities (FGW, IEC, …).

Deliverables: D3.1 Whitepaper on AWES safety, D3.2 Concept of operations (CONOPS) and guidelines on risk assessments (e.g. SORA); D3.3 Airspace integration concept; D3.4 Benchmarking concepts for safe automatic operation

WP4: Social Acceptance

Coordinator: Airborne Wind Europe, TU Delft

Topics and objectives

Question to be answered: What are AWE benefits for and impacts on society and environment?

This WP will ideally also involve non-technical expertise like social sciences in order to investigate how neighbors and society perceive AWE. The following topics will be potentially covered:

(1) Site selection: What are key features that AWE sites should fulfil? Which sites already developed for conventional wind could be used for AWE?
(2) Local perceptions regarding visual impacts and safety aspects: How will neighbouring communities perceive AWE?
(3) Noise emissions: How should noise emissions be measured? How can noise be reduced?
(4) Impacts on birds, bats, other fauna including marine habitats in case of offshore
(5) Participation of local communities in AWE projects: How can it be ensured that local communities can participate and benefit also financially from AWE projects? What differences may there exist to other renewable energy projects?
(6) Life-Cycle Analysis (LCA): What is the carbon and environmental footprint of AWE compared to other energy technologies? How can it be further reduced? Which components and materials have the highest impact?
(7) Circular Economy: How can AWE systems be designed to reduce material consumption through repairability, re-use, recycling?

Synergies with Tasks 28 (Social Acceptance) and Task 34 (Working Together to Resolve Environmental Effects of Wind Energy) will be sought. It will be discussed if it is preferential to include AWE-aspects in these Tasks instead of taking up all social and environmental issues in the AWE Task.

Deliverables

D4.1 LCA for AWE and conclusions
D4.2 Repository of surveys and studies on social acceptance and impacts on birds/bats
D4.3 Guidelines for site selection, noise measurement and environmental impact mitigation measures
D4.4 Circular economy / cradle-to-cradle aspects for AWE, incl. design process

WP5: AWES Architectures

Coordinators: someAWE Labs, Airborne Wind Europe

Topics and objectives

The main question to be answered in this Work Package is: Which AWES Architectures exist and how do they compare?

There is a plethora of necessary design choices to be made when designing an AWES - ranging from the choice of method for power transfer, the type of rotor/wing, the lift source, the launch/land method etc. Design decisions need to be based on a systematic exploration process. However, the exploration process is complex because of a variety of ways in which the same functionality can be implemented. This WP aims to provide the basis for a tradeoff analysis between each of the implementation option based on parameters of interest.

The work package will conclude with the R&D needs and gaps being identified and will also highlight as yet untapped design spaces.

This WP will include

- AWE Design space exploration –
- Identify Reference models
- Tradeoff analysis between implementation options
- Project Evolution / Development history / Reasoning
- Categorizing working and proposed AWES architectures
- Evaluating applicability, performance and impact metrics across AWES architectures
- Highlighting resources linked to defined AWES architectures
- Highlighting potential for further investigation

This WP will produce a broad-spectrum AWES technology assessment.

Deliverables

D5.1 Design space representation
D5.2 Application / market specific recommendations on AWES deployment
D5.3 Oversight on AWES R&D state, trends and needs
D5.4 Definition and specification of a portal for identifying AWES engagement and development potential

The deliverables in this work packages will be elaborated in three steps: i) structure for consultation to the working group, ii), draft for consultation with the working group, and iii) final version for the public. The respective phases are shown in the Gantt chart as sub-milestones.