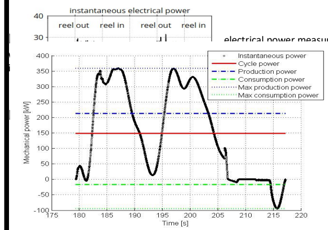
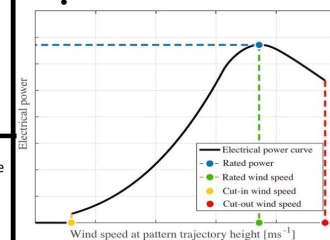
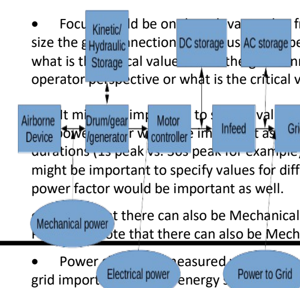
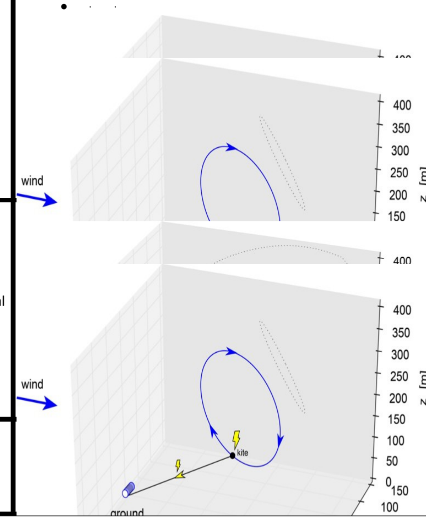
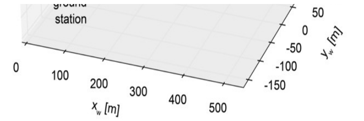
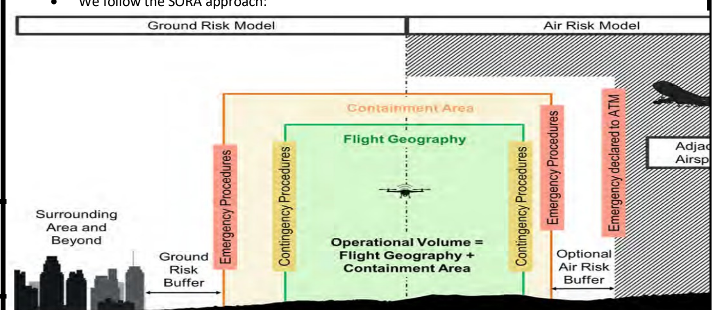
Identifyer	Symbol	Term	Definition	Notes / comments: Please state your initials in front of comments
		Power [Filter: Theme]		
P1	$P_{e,avg}$	Average Cycle Power / Electrical Average Power	Net energy over one Power Cycle divided by the Cycle time. [kW]	• Most important is the electrical power.  electrical power measured at the generator/motor of the AWES for a ground wind speed of 6 m/s (normally a areas indicate the reel out phase of the cycles (positive power) while the red areas r is indicated in the figure by the horizontal dashed line. n arbitrary 150 kW system during one pumping cycle. idual AWE system, i.e. before the transformer. (Definition for low voltage side of the transformer, i.e. it is measured on eration systems. TBD: • How to define for off-grid systems that are only connected to a battery pack. • Losses in the battery should be excluded because flattening with batteries is not mandatory, especially in parks and arrays
P2	P_n	Rated Power / Nominal Power	Maximum Average Cycle Power. [kW]	•  Power Curve ystem or the generator gure above. pared with a conventional wind turbine (e.g. "2 MW-turbine).
P3	$P_{e,o,peak}$	Electrical Peak Power during reel-out	Maximum power that a system can sustain over a certain time before failures are very likely. [kW]	before feeding it from a single system into the park) ○ measured at the system side of the transformer (park towards grid) – this is important for the grid operator. Some measures may be applied so that peaks are avoided. • It depends on the rated power of the electrical machine. • If this value is exceeded for extended period of times, the generator may get hot or something may break. • The Peak Power at the transformer could be lowered through heat elements (resistor banks) or storage devices. Graph with the different system components and measurement points:  • Focu ld be on va from a grid operator perspective or what is the critical value to size the g nection us be on the relevant value from a grid operator perspective or what is t cal value the nnection.· Focus should be on the relevant value from a grid operator perspective or what is the critical value to size the grid connection. • It mi imp to val different durations (1s peak vs. 30s peak for example), also powe r w im t as It might be important to specify values for different durations (1s peak vs. 30s peak for example), also the power factor would be important as well. · It might be important to specify values for different durations (1s peak vs. 30s peak for example), also the power factor would be important as well. • t there can also be Mechanical Peak Power· Note that there can also be Mechanical Peak ote that there can also be Mechanical Peak Power
P4	$P_{e,i,peakPe,i,peakPe,i,peak}$	Electrical Peak Power during reel-in	Maximum power measured during reel-in. [kW]	• Power easured ant to capacity that needs to be provided (either contracted as grid import energy m).· Power should be measured where relevant to capacity that needs to be provided (either contracted as grid imports or through energy storage system).· Power should be measured where relevant to capacity that needs to be provided (either contracted as grid imports or through energy storage system).
P5	$E_{e,oEe,oEe,o}$	Produced energy during reel-out	Energy generated by the system during reel-out phase [kWh]	• "Internal" term, not so relevant for AWE clients.· "Internal" term, not so relevant for AWE clients.· "Internal" term, not so relevant for AWE clients. • Relevant mainly for ground-gen systems.· Relevant mainly for ground-gen systems.· Relevant mainly for ground-gen systems. • The produced energy is always equal or larger than zero.· The produced energy is always equal or larger than zero.· The produced energy is always equal or larger than zero.
P6	$E_{e,iEe,iEe,i}$	Consumed energy during reel-in	Energy consumed by the system during reel-in phase [kWh]	• "Internal" term, not so relevant for AWE clients.· "Internal" term, not so relevant for AWE clients.· "Internal" term, not so relevant for AWE clients. • Relevant mainly for ground-gen systems.· Relevant mainly for ground-gen systems.· Relevant mainly for ground-gen systems. • Important to determine efficiency of the system and size of the generator.· Important to determine efficiency of the system and size of the generator.· Important to determine efficiency of the system and size of the generator. • Consider that with a battery there would be no power needed from the grid.· Consider that with a battery there would be no power needed from the grid.· Consider that with a battery there would be no power needed from the grid.

				• Tbd if instantaneous or average· Tbd if instantaneous or average· Tbd if instantaneous or average
		KPIs: Performance indicators / metrics		
KPI1		Availability factor	Factor obtained by the hours that the full AWES is available during periods with operational wind conditions divided by the total (cumulative) amount of hours in those periods. [%]	• Important is the energetic availability, not the time-related availability.· Important is the energetic availability, not the time-related availability.· Important is the energetic availability, not the time-related availability.
KP2		Annual Electricity Production (AEP)	The annual electrical net energy production of a facility. Calculated as produced energy minus the consumed energy. [MWh/a]	• Measured AEP vs. Calculated AEP.· Measured AEP vs. Calculated AEP.· Measured AEP vs. Calculated AEP. • We may have to define a standard site to allow comparison between systems or versions of systems. Also difference between single systems and parks (wake effects, etc.)· We may have to define a standard site to allow comparison between systems or versions of systems. Also difference between single systems and parks (wake effects, etc.)· We may have to define a standard site to allow comparison between systems or versions of systems. Also difference between single systems and parks (wake effects, etc.) • Make distinction between gross-energy & net-energy-production. AEPnet=AEPgros* energetic availability· Make distinction between gross-energy & net-energy-production. AEPnet=AEPgros* energetic availability
KP3		Capacity factor	Energy generated by a facility divided by the maximum amount of energy that could have been generated by that same facility when operating continuously at rated power as defined above (P2) during a specific time period (default: 1 year). [%]	• If it is measured over the period of one year, the numerator is the Annual Electricity Production (AEP)· If it is measured over the period of one year, the numerator is the Annual Electricity Production (AEP) • The Capacity Factor is site-dependent. · The Capacity Factor is site-dependent. • Important when comparing technologies from a system or market perspective.· Important when comparing technologies from a system or market perspective.
KP4		Power density	Power capacity installed above one square kilometer of land/sea (area) [MW/km2]	• This is asked frequently by policy makers and others; they want to know if you need more or less space for AWE compared to a conventional wind farm.· This is asked frequently by policy makers and others; they want to know if you need more or less space for AWE compared to a conventional wind farm. • Tbd: Need to specify/define how to account the occupied area: circle with radius=cable? Include safety margins? And is it computed for a farm with possibly overlapping circles?· Tbd: Need to specify/define how to account the occupied area: circle with radius=cable? Include safety margins? And is it computed for a farm with possibly overlapping circles? • It depends on the park configuration.· It depends on the park configuration. • Overlapping circles should be possible.· Overlapping circles should be possible. • Rated power over outer limits of the ground stations (so the area that has to be owned – like an airport: the land over starting and landing corridors is not owned by the airport operators.).· Rated power over outer limits of the ground stations (so the area that has to be owned – like an airport: the land over starting and landing corridors is not owned by the airport operators.). • Important for comparison with other technologies.· Important for comparison with other technologies. • 35 MW/km2 may be possible.· 35 MW/km2 may be possible. • Principles for conventional turbines: Neighbour must be able to put wind turbine up. Different for AWE because they point in the same direction.· Principles for conventional turbines: Neighbour must be able to put wind turbine up. Different for AWE because they point in the same direction. • “Energy density” may be better in comparison, because of the higher capacity factor / lower rated power.· “Energy density” may be better in comparison, because of the higher capacity factor / lower rated power. • ·
KP5		Yearly weighted energy average	Power obtained by summation of the power contribution over all wind speeds, by weighting each power contribution at a wind speed by its probability of occurrence, according to a wind speed bin using a Weibull distribution, during a year. [MWh/a]	• Simplified approach to the AEP, gives customer an idea of energy output by site (low, medium, high wind site)· Simplified approach to the AEP, gives customer an idea of energy output by site (low, medium, high wind site) • It needs to be defined how this is done exactly. In the end its’ a sort of weighted power curve· It needs to be defined how this is done exactly. In the end its’ a sort of weighted power curve • Probably a long way to a standardized calculation – ongoing discussions in other WGs •
KP6		Production Predictability	Ratio of the actual parameter value (energy produced) divided by the simulated parameter value, i. e. it provides the simulation error (1-predictability). [%]	• “Strategic” KPI: Potentially an advantage for AWE because there may be less wake problems. Once companies sell systems, this will become important. • This is a challenge even for conventional wind turbines due to difficulty in assessing the wind field. more easily done on other variables than energy, but then it becomes a bit too technical. • Distinction between "wind resource does not match wind forecast" and "electricity generation does not match calculation/simulation”. Probably years away from meaningful values/data
KP7		Uptime / Annual Flight Hours	Time that Airborne component is Airborne [h]	• Similar to the availability factor. • There will be times when the kite is flying but not producing or even consuming energy.
		Operational phases		
		Launch	Take-off phase of the kite	• Close to the ground
		Reel-out	Phase in which the kite pulls out the tether from the winch	• There may be times of reel-out where the system produces very little power or even consumes onboard-power in case of propellor-driven aircraft. • Depending on the system, also during reel-out there may be phases where the system needs to be reeled-in to keep the tether tension and maneuver (technically we are aiming to remove this).
		Reel-in	Phase in which the kite is being retracted	

		Park in air / hover / idle	Phase in which the kite is flying but not generating, either steady or carrying out flight paths with almost constant tether length	• State where the kite is meant to stay airborne· State where the kite is meant to stay airborne· State where the kite is meant to stay airborne· State where the kite is meant to stay airborne • This usually applies mainly to systems with light flexible kites.· This usually applies mainly to systems with light flexible kites.· This usually applies mainly to systems with light flexible kites.· This usually applies mainly to systems with light flexible kites. • For fixed wing kites with onboard vertical axis propellers, it may be called “hovering” phase.· For fixed wing kites with onboard vertical axis propellers, it may be called “hovering” phase.· For fixed wing kites with onboard vertical axis propellers, it may be called “hovering” phase.· For fixed wing kites with onboard vertical axis propellers, it may be called “hovering” phase. • For systems with horizontal axis propellers (e.g. Ampyx), it may be called “idling” phase.· For systems with horizontal axis propellers (e.g. Ampyx), it may be called “idling” phase.· For systems with horizontal axis propellers (e.g. Ampyx), it may be called “idling” phase.· For systems with horizontal axis propellers (e.g. Ampyx), it may be called “idling” phase.
		Trans-in	Transition from hovering to any other operational phase	• Term is also used in the Makani videos· Term is also used in the Makani videos· Term is also used in the Makani videos· Term is also used in the Makani videos
		Top Transition	Transitioning from reel-out to reel-in phase	• Only relevant for Yo-Yo systems· Only relevant for Yo-Yo systems· Only relevant for Yo-Yo systems· Only relevant for Yo-Yo systems
		Bottom Transition	Transitioning from reel-in to reel-out phase	• Only relevant for Yo-Yo systems· Only relevant for Yo-Yo systems· Only relevant for Yo-Yo systems· Only relevant for Yo-Yo systems
		Approach	Phase before landing	
		Land	Phase during which the kite lands	
		Operation	Phase which includes all airborne flight phases excluding Emergency Operation	• Depending on the system, it could include launch, reel-out, hover/parking in the air, reel-in, land.· Depending on the system, it could include launch, reel-out, hover/parking in the air, reel-in, land.· Depending on the system, it could include launch, reel-out, hover/parking in the air, reel-in, land.· Depending on the system, it could include launch, reel-out, hover/parking in the air, reel-in, land.
		Emergency Operation	Phase that includes all maneuvers under emergency conditions	• There may be different Emergency Landings, e.g. with or without reel-in, landing close or further away from ground station, etc.· There may be different Emergency Landings, e.g. with or without reel-in, landing close or further away from ground station, etc.· There may be different Emergency Landings, e.g. with or without reel-in, landing close or further away from ground station, etc.· There may be different Emergency Landings, e.g. with or without reel-in, landing close or further away from ground station, etc.
		Parked on ground	Kite not aloft; systems functions turned off	• Different parking status are possible.· Different parking status are possible.· Different parking status are possible.· Different parking status are possible. • “Parkposition”, IEC· “Parkposition”, IEC· “Parkposition”, IEC· “Parkposition”, IEC
		Stowed on ground	Kite secured when not in operation	• This include stowing for extended periods of time· This include stowing for extended periods of time· This include stowing for extended periods of time· This include stowing for extended periods of time • Stowed on ground under extreme conditions includes e.g. additional fixation, moving to a hangar or other shelter to withstand extreme weather conditions.· Stowed on ground under extreme conditions includes e.g. additional fixation, moving to a hangar or other shelter to withstand extreme weather conditions.· Stowed on ground under extreme conditions includes e.g. additional fixation, moving to a hangar or other shelter to withstand extreme weather conditions.· Stowed on ground under extreme conditions includes e.g. additional fixation, moving to a hangar or other shelter to withstand extreme weather conditions.
		Yo-Yo Mode / Pumping Mode	Mode of ground-generation AWE systems which operate in two phases (reel-out and reel-in)	
		Trajectories		
		Pattern	A figure the tethered aircraft follows during power production (figure of eight or circle).	
		Pattern Trajectory	A pattern the tethered aircraft follows during power production	• · ·  le figures of eight in a cone shapeo Multiple ures of circles, i.e. spiralo Multiple figures of ani)o Single circle (e.g. Makani)
		Cycle trajectory	The unique trajectory of a single cycle running through all operational phases once (without launch and land).	nds on the wind conditions, tether length.· se where applicable.· This includes the the first pattern starting from initial tether ultiple patterns. In such a case, the first tern.
		Pattern Trajectory Height	Expected or logged altitudes time-averaged height over the pattern trajectory	e· For a fly-gen system this would be the nt of the trajectory during reel-out· For a ajectory during reel-out

		Rated Trajectory Height	Pattern Trajectory Height at which Rated Power is achieved	
		Wind speeds		
S1		Reference / Rated Wind Speed	Minimum wind speed at pattern trajectory height at which an AWES' rated power is achieved in the case of steady wind without turbulence.	ch a wind turbine's rated power is achieved in l: "minimum wind speed at hub height at steady wind without turbulence." • Default: When not explicitly stated when referring to wind speeds, one can assume it refers to the rated wind speed.· Default: When not explicitly stated when referring to wind speeds, one can assume it refers to the rated wind speed. • One point on the power curve (see graph in Power Curve)· One point on the power curve (see graph in Power Curve) • Basic parameter for wind speed used for defining AWES classes· Basic parameter for wind speed used for defining AWES classes • Can be measured with LIDAR and is standard. ERA5 provides wind speed at 100m as a standard output. Good data availability and comparable to conventional WTG hub heights.· Can be measured with LIDAR and is standard. ERA5 provides wind speed at 100m as a standard output. Good data availability and comparable to conventional WTG hub heights.
S3		Cut-in wind speed	Lowest 10 min average wind speed at pattern trajectory height] at which the AWES starts to produce power in the case of steady wind without turbulence	• According to IEC61400-1: "lowest wind speed at hub height at which the wind turbine starts to produce power in the case of steady wind without turbulence."· According to IEC61400-1: "lowest wind speed at hub height at which the wind turbine starts to produce power in the case of steady wind without turbulence." • Still, cut-in wind speed depends on system and operation strategy such as adapting operational altitude.· Still, cut-in wind speed depends on system and operation strategy such as adapting operational altitude. • The kite may be launched at wind speeds lower than the cut-in wind speed, this depends on the company and operational/economic optimization.· The kite may be launched at wind speeds lower than the cut-in wind speed, this depends on the company and operational/economic optimization. • ·
S4		Cut-out wind speed	Wind speed at pattern trajectory height at which wind speed above which the facility can no longer be operated without risking damage to the system and at which power production ends	• Measured at pattern trajectory height.· Measured at pattern trajectory height. • Term should be used consistent with definition applied for conventional wind: IEC 61400:2020: "highest 10 min average wind speed at hub height at which the wind turbine is designed to produce power in the case of steady wind without turbulence" • This doesn't mean that the kite must land, it could be put in an airborne parking position, or fly to another altitude or out of the wind window. •
S5		Launching minimum wind speed / Launching Limit Low	Minimum wind speed at which system can be launched (at 10m)	
S6		Launching maximum wind speed	Maximum wind speed at which system can be launched (at 10m)	
S7		Forced Landing minimum wind speed / Drop-out wind speed / Flying Limit Low	Minimum wind speed (pattern trajectory height) at which system must land	• Wind speed below the Cut-in speed at which an operational system can no longer be operated or will be ordered to halt operation in order to reduce wear and power consumption. • The AWES can "search" suitable wind conditions in its operational range and not land immediately if a certain threshold is reached. •
S8		Forced Landing maximum wind speed / Blow-out wind speed	Wind speed at pattern trajectory height above which the facility can no longer be operated without risking damage to the system during landing.	• Maximum wind speed at which system must land. • Time period tbd • If the wind speed is above that threshold, the system must land to avoid risking damage and cannot stay in parking position for example.
S9		Maximum (survival) wind speed in the air	Wind speed above which the AWES will take damage in the air.	• In the range between "blow-out" and "survival" it might be impossible to land the AWES in a regular way.
S10		Survival wind speed on the ground in storage position	Wind speed above which the AWES will take damage when stored or parked on the ground.	• Conventional wind: Range 216 km/h normal survival wind speed, AWE could go up to 300 km/h
		Flight Volumes and Areas		
		Flight Geography / Flight Volume	Volume the kite can fly through during normal operation.	• We follow the SORA approach:  *Figure 2 - Graphical Representation of SORA Semantic Model*
		Current Flight Geography / Current Flight Volume	Volume in which the kite is flying under current wind conditions.	
		Sector	A Flight Geography that is deliberately limited.	above certain structures, • power generation sector downwind • power generation sector downwind • reel-in sector• reel-in sector

		Containment Volume	Volume that the kite must not leave, even in emergency situations	• Staying within the Containment Volume must be secured through Contingency Procedures or (Emergency Procedures?).· Staying within the Containment Volume must be secured through Contingency Procedures or (Emergency Procedures?). • Includes instances when they system is malfunctioning)· Includes instances when they system is malfunctioning)
		Operational Volume	Volume that includes Flight Geography and Containment Volume, i.e. where the kite can potentially fly through while continuing normal operation.	
		Operational Area	Area where the kite can potentially fly over under normal conditions.	
		Landing Area	The area where kite is supposed to land under normal conditions.	
		Emergency Landing Area	The area where kite is supposed to land under emergency conditions.	• In most cases of failure, mitigating measures can prevent the AWES from crashing outside the emergency landing area (see “contingency volume”).· In most cases of failure, mitigating measures can prevent the AWES from crashing outside the emergency landing area (see “contingency volume”). • This includes situations where the kite can “land” (or crash) in case of tether failure during flight· This includes situations where the kite can “land” (or crash) in case of tether failure during flight
		Launching Area	The area where kite is launched.	• For certain systems the Launching Area may be the same as the Landing Area.
		Hazardous Area	Operational Area plus the Ground Risk Buffer Area	• This could imply no residential areas
		Restricted Area	Area where only authorized personnel is allowed.	• This could imply e.g. a fence or wall.
		Kites / aircraft		
		Fixed-wing Aircrafts	Kites that are designed like conventional aircraft, but take into account the higher wing loading.	• They are used with single tether without any bridle lines (e.g. Ampyx Power) or with bridle lines (e.g. Makani). • The term “rigid” is not useful because the larger the wing span, the more flexible the wings actually get.
		Soft Kites	Kites that use inflatable membrane wings and are generally of the type leading edge inflatable (LEI) tube kite or ram air wing.	• LEI kites (e.g. Kitepower) for high wing loading, such as customary for AWE applications, often use rigid reinforcement elements for the inflated tubular frame or the textile canopy. • Ram air wings (e.g. Skysails) typically achieve higher wing loading by increasing the number of bridle lines and reinforcing the textile material used for ribs and wing surface
		Hybrid Kites	Kites that combines a rigid support structure with a textile membrane canopy.	• These can be delta kites (e.g. UC3M, or EnerKite's trainer kite) or the EnerKite swept wing.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