Schedule 1 – Service Description

This document is part of the Turbit General Terms and Conditions and describes the offered services of Turbit. These services are bookable in the Order Form.

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Definitions and Explanations

1. **User:** An authorized user, including a non-human program that uses the Turbit App, Turbit API or Turbit Realtime MQTT.
2. **Turbine**: A machine that converts wind energy into electric energy.
3. **Solar Plant**: A facility that converts sunlight into electricity using photovoltaic panels. A Solar Plant usually contains many solar panel arrays that are connected to several electric converters and a datalogger. A solar park may contain several Solar Plants each with one datalogger.
4. **BESS**: Any system that stores electrical energy in batteries (typically lithium-ion) for later use. A BESS usually includes battery modules, power converters, a battery management system (BMS), and a datalogger.
5. **Plant**: A Turbine, Solar Plant, or BESS.
6. **Park**: A group of several Plants (min. 1 Plant).
7. **Assets Under Contract**: All Plants that are under contract.
8. **Data**: Any of the following type of data:
   a. **Machine Meta Data:** Any information about the Plant or Park (e.g., the machine type, location, components, contracts)
   b. **Sensor Data:** Any time series data of the Plant or Park, (e.g. a time series data of the temperature of the gearboxoil, power or windspeed or others).
   c. **Original Status Data:** Any time-related datapoint of the Plant or Park that describes the operational state of the Plant.
   d. **Customer Status Data:** A time-related datapoint that is manually or programmatically set by the Users to describe a single Original Status Data entry, many Original Status Data entries as a group or any other time-related datapoint interval.
9. **Event:** A noteworthy time-related datapoint or other anomaly detected by Turbit.

10. **Case**: A ticket that may summarize and link to several Events and has additional information from Users.
11. **Label**: Any of the following type of labels:
    a. **Customer Label:** Any label that gives Data a description and is manually set by a User within the Turbit App.
    b. **Turbit Label:** A label that describes Data and is calculated by Turbit.
12. **Pool Data:** anonymized Data, Events and Labels from the Customer and other customers of Turbit.
    a. **Pool Sensor Data:** anonymized Sensor Data of the Customer and other customers of Turbit.
13. **Machine Learning:**
    a. **ML Algorithm:** Any supervised or unsupervised machine learning algorithm.
    b. **ML Model:** Any machine learning model, that is not yet trained with data.
    c. **ML Instance:** Any trained ML Model.
    d. **ML Instance In Production:** A ML Instance that is active and in production.
    e. **Simulated Sensor Data:** Sensor Data that is simulated by a ML Instance in Production.
14. **Monitoring Module**: An algorithm incorporating an ML Instance In Production that detects Events and Cases for a given set of Sensor Data.
15. **KPI:** A key performance indicator that summarizes or describes Data.
16. **All Filter:** Filters give the User the ability to filter the analyzed Data by one or many of the following conditions connected with a logical “and” or “or”. All Filters means that all the following filters are possible to use:
    a. Filter by Plant.
    b. Filter by Time Range.
    c. Filter by Sensor Data.
    d. Filter by Label.
    e. Filter by ML Instance.
17. **Enrollment Process (for new Authorized Users):** The Customer writes Turbit an Email with the request to create a new Authorized User. Turbit then generates the Authorized User and sends the login information to the Customer via Email. User credentials are never sent via email and need to be accessed only via a one-time link on https://secrets.turbit.com or a similar service.

Turbit Products

Basic features and functionalities

The following basic features and functionalities are included in every Turbit product.

The **Turbit App** is a web app that is accessible at https://app.turbit.com (Turbit App Domain).

Dashboard

The Dashboard displays important KPI or other relevant high-level information about the Assets Under Contract or the usage of the Turbit App by the Authorized Users.

XY Plotter

The XY Plotter is a scatter plotter, that displays any Sensor Data in 2 dimensions.

Filter possibilities: All Filter except Filter by ML Instance.

Angular Plotter

The Angular Plotter is a radial plotter that can plot average value histograms of Sensor Data. If more than one Plant is selected, the average of the selected Plants is displayed.

Filter possibilities: All Filter except Filter by ML Instance.

Power Comparison

Compare the power output of selected Plants with each other.

Filter possibilities: All Filter except Filter by ML Instance.

Sensor Comparison

Compare Sensor Data of selected Plants with each other in a scatter plot. The x axis of the plot displays the average of the Sensor Data of the selected Plants. The y axis of the plot displays the the individual Sensor Data of the selected Plants.

Filter possibilities: All Filter except Filter by ML Instance.

Turbine Comparison

Like Sensor Comparison but the User can choose freely any Sensor Data to be displayed on the x and y axis of the scatter plot.

Benchmarking

Like XY Plotter but additionally plot data from the Pool Sensor Data of the selected Plants of the same machine type.

Filter possibilities: All Filter except Filter by ML Instance.

Histogram Plotter

Create a histogram plot of Sensor Data.

Filter possibilities: All Filter except Filter by ML Instance.

Status Table

Display Original Status Data and Customer Status Data in a table.

Filter possibilities: Filter by Turbine, Filter by Time Range.

CMS Plotting

Like XY Plotting but additionally plot Simulated Sensor Data generated by the selected ML Instance.

Event Table

Like Status Table but displays Events instead.

Event Card

The Event Card is an automated analysis report and displays an Event within the Turbit Web App. Each Event Card has its unique ID, deep link and is accessible via the Turbit API. The deep link can be sent via E-Mail to customers’ and users' inboxes or third-party software.

Case Table

Like Status Table but displays Cases instead.

Case Card

The Case Card is connecting multiple Events from different Plants or ML Modules if they are technically connected. E.g. a gearbox failure resulting in high temperatures but also a throttling in power will be connected in one Case. The Case Card then helps you manage the status of that Case by adding a comment, set labels of priority and root cause and whether or not the Case is unconfirmed, open or closed and communicated to the OEM/service team. From the Case Card you have access to all relevant information that is related to that particular Case.

Labeling

An Event and a Case can be labelled by the User. Labels are used to enhance the Data and can be used as input for the training of a ML Instance or the Event Detection. Labeling improves the performance of the ML Instances as well as the performance of Label Prediction.

Settings

Edit settings of the Turbit App per Authorized User.

API

An API where Users can pull Data, Simulated Sensor Data as well as Events and Cases is accessible here at https://api.turbit.com.

Data Science Pipeline

1. Data Gathering: The Data is gathered periodically from the Customer. If the availability of the Data from the Customer is unusual or generally broken, Turbit informs the Customer.
2. A Data Availability Check as described above is performed.
3. Data Cleaning: Turbit generates a training dataset from the Data to have a dataset that represents the normal behaviour of the Plant. Additionally, Pool Data is used to compare.
4. Training of ML Instances: After the Data Cleaning the training dataset is used to train an ML Instance. If the ML Instance is deemed of sufficient quality, it transitions into an ML Instance in production.
5. Data Simulation: For every Output Sensor that has been available to Turbit, Turbit is immediately generating Simulated Sensor Data with the ML Instance in production.
6. Event Detection: If Simulated Sensor Data is abnormal and not in accordance with the Data, Turbit automatically generates Events.
7. Case Inclusion: Events are combined into Cases based on underlying turbine issues. Customers are informed about Cases.

Transfer Learning

With transfer learning, Turbit can quickly monitor newly commissioned wind parks. Turbit uses a similarity score for Plants to choose turbines from the Anonymized Customer Data to train ML Instances and finetunes them with new data from the specific Plant.

Training Schedule

Turbit constantly retrains ML Instances to improve prediction quality. The retraining schedule is structured as follows:

1. Main ML Modules are trained once a year.
2. Label Prediction and Relevance Prediction models are trained every 8-10 weeks.

Document Manager

In the Document Manager you can upload any type of PDF (we currently only support PDFs). The documents are then stored and extracted with AI (OCR) or other methods. The Documents are then summarized and key content is extracted by Large Language Models, e.g. the criticality and serial numbers or wind parks are extracted automatically.

Case Manager

The Case Manager is a tool to manage and document Cases.

Depending on the type of Case (e.g. from Power Module, Blade Monitoring etc.) there might be different flows of stages that a Case can go through. In general a Case goes through these stages:

1. Unconfirmed
2. Confirmed
3. Review
4. Closed

Turbit Monitoring

Every Monitoring Module can be optionally booked as stated in the Order Form. Turbit can only provide the services of a Monitoring Module if at least one of the described Input Sensors and one of the described Output Sensors is sufficiently available and if at least three months of recent historical data is available.

For each new Monitoring Module and a retraining of a ML Module Turbit is performing the Data Science Pipeline.

Available Monitoring Modules:

Power

Surveillance of the power output of a Plant.

Input Sensors	Output Sensors
"windspeed.val"	"power.val"
"windspeed.min"	
"windspeed.max"	
"windspeed.stddev"	
"windspeed_1.val"	
"windspeed_1.min"	
"windspeed_1.max"	
"windspeed_1.stddev"	
"windspeed_2.val"	

"windspeed_2.min"	
"windspeed_2.max"	
"windspeed_2.stddev"	
"temperature_nacelleambient.val"	
"temperature_ambient.val"	
"orientation_windvane.val"	
"orientation_wind.val"	
"orientation_nacelle.val"	
"curtailment_mode.val"	
"setpoint_max_power.val"	
"utctime_stop"	

Rotor

Surveillance of the main rotor bearings of a Turbine.

Input Sensors	**Output Sensors**
"temperature_nacelleambient.val"	"temperature_bearing_1.val"
"temperature_ambient.val"	"temperature_bearing_2.val"
"power.val"	"temperature_bearing_inner.val"
"temperature_nacelle.val"	"temperature_bearing_outer.val"
"rpm_rotor.val"	"temperature_rotorbearing.val"
	"temperature_rotorbearing_1.val"
	"temperature_rotorbearing_2.val"

Gearbox

Surveillance of the gearbox of a Turbine.

Input Sensors	**Output Sensors**

"temperature_nacelleambient.val"	"temperature_gearbox.val"
"temperature_ambient.val"	"temperature_gearboxoil.val"
"power.val"	"temperature_gearboxoilpan.val"
"temperature_nacelle.val"	"temperature_gearboxoil_inlet.val"
	"temperature_gearboxbearing.val"
	"temperature_gearboxbearing_1.val"
	"temperature_gearboxbearing_2.val"
	"temperature_gearboxbearing_3.val"
	"temperature_gearboxbearing_4.val"
	"temperature_gearboxbearing_5.val"
	"temperature_gearboxbearing_6.val"
	"temperature_gearboxbearing_7.val"
	"temperature_gearboxbearing_8.val"
	"temperature_gearboxbearing_9.val"
	"pressure_gearboxoil.val"
	"pressure_gearboxoilpan.val"
	"temperature_gearbox_cooling.val"
	"temperature_transmissionbearing_1.val"
	"temperature_transmissionbearing_2.val"

	"temperature_transmissionbearing_3.val"

Generator

Surveillance of the generator of a Turbine.

Input Sensors	Output Sensors
"temperature_nacelleambient.val"	"temperature_generator.val"
"temperature_ambient.val"	"temperature_generator_1.val"
"power.val"	"temperature_generator_2.val"
"temperature_nacelle.val"	"temperature_generatorbearing.val"
	"temperature_generatorbearing_1.val"
	"temperature_generatorbearing_2.val"
	"temperature_generatorbearing_de.val"
	"temperature_generatorbearing_nde.val"
	"temperature_generatorcooling.val"
	"temperature_generatorcoolingair.val"
	"temperature_generatorcoolingwater.val"
	"temperature_generatorphase_1.val"
	"temperature_generatorphase_2.val"
	"temperature_generatorphase_3.val"
	"temperature_statorwindings.val"

	"temperature_statorwindings_1.val"
	"temperature_statorwindings_2.val"
	"temperature_statorwindings_3.val"
	"temperature_statorwindings_4.val"
	"temperature_statorwindings_5.val"
	"temperature_statorwindings_6.val"
	"temperature_statorwindings_7.val"
	"temperature_statorwindings_8.val"
	"temperature_statorwindings_9.val"
	"temperature_statorwindings_10.val"
	"temperature_statorwindings_11.val"
	"temperature_statorwindings_12.val"
	"temperature_transformer.val"
	"temperature_transformerphase_1.val"
	"temperature_transformerphase_2.val"
	"temperature_transformerphase_3.val"

Label Prediction

Each Authorized User can give feedback to the Events and Cases that are generated by Turbit. The feedback is given in terms of labels that include:

- The location of the root cause.
- A description of the anomaly (Data Description), which describes how the detected anomaly is evolving, e.g. steadily wihout steps or suddenly with a stepwise increase in temperatue.

For each Event Turbit predicts the possible root cause.

Relevance Prediction

Authorized Users can rate Events for relevance, e.g., an Event that is not yet known to the Authorized User and indicates a potential breakdown of the gearbox can be labeled with a high relevance, whereas a direct marketer power curtailment can be labeled with low relevance since this information is already known.

For each Event Turbit then predicts the possible relevance with AI. The predicted relevance ratings are used to filter events such that only likely relevant events are included in cases and visible to users.

Blade Monitoring

Turbit Blade Monitoring is a system designed to monitor the health of Turbine blades, which are critical components subject to extreme conditions and potential failures.

1. Data Collection: The system uses high frequency vibration sensor data (e.g. from third party sensor providers) to measure acceleration, strain, or acoustic emissions on the blades. These sensors capture frequency spectra over defined time periods, which are then visualized as spectrograms to analyze vibration patterns.
2. Similar to all other Monitoring Modules Turbit is performing the Data Science Pipeline to detect Events and Cases.
3. Independence and Integration: Turbit Blade Monitoring is designed to be independent of any hardware vendor. It can utilize existing data and sensors or data from retrofitted sensors with next-generation hardware.

Document Monitoring

If documents uploaded in the Document Manager contain values that are abnormal or critical, Cases are automatically generated.

Turbit Assistant

The Turbit Assistant enables you to chat with the documents you uploaded in the Document Manager. Turbit is using a technology called Retrival Augmented Generation (RAG) for this.

The Turbit Assistant consists of 3 main functionalities:

1. Document Manager: You can upload your documents (PDFs) via Drag and Drop. The information inside the documents is extracted and summarized. Severety and priority is extracted and we can set up automatic Case generation (see Document Monitoring as part of AI Monitoring), if a documents needs further attention (e.g. if an oil report shows high iron levels).

2. Chat: The Turbit chat works like any other LLM chat and enables you to ask a variety of questions. The answers are augmented by your real data, e.g. when you ask about what needs to be done in windpark x, the information is gathered from multiple service inspection reports and summarized in the chat. The total number of chats (Token Limit) per Customer per month may be limited.
3. Workflows: With the Turbit Assistant you can set-up workflows, that enable you to automate busy work. E.g. you can automate defect tracking for your windpark: With each newly uploaded document a list of defects is updated and prioritized. This way you always have everything in one place you need to know and you need to focus on. Turbit may charge for each workflow in a pay-as-you-go pricing model.

Turbit Blue

Turbit Blue enables the Customer to combine Turbit's SaaS service with traditional insurance. For this purpose, Turbit cooperates with one or several insurance providers who offer better insurance conditions if the Customer is working with Turbit. For the purpose of transparency and ease of claim management, Turbit provides the following data to the insurance provider:

- Cases of Plants under Turbit Blue

Turbit does not share any Data as defined in this service description.

With regard to the insurance conditions, including the conditions for an insurance cost reduction, the terms of the insurance provider apply, which the customer agrees to directly with the insurance provider. For the sake of clarity, Turbit is not an insurance and is not liable for any damage to the Plants whatsoever.

Turbit Datahub

The **Turbit Datahub** offers a streamlined solution for connecting and storing all Data from the Parks and Plants in one central repository, making it easily accessible through the Turbit API or in real-time via the Turbit MQTT Broker Turbit Datahub API - Swagger UI. The Turbit Datahub allows the User to fetch all Data centralized for convenience and efficiency in a raw format in a data lake (Data Lake) or in a mapped/orderly format (Data Warehouse) with Turbit sensor mappings.

The **Turbit MQTT Broker** is a managed MQTT broker (MQTT - The Standard for IoT Messaging) by Turbit where Users can push and pull Data. Users can directly subscribe to specific topics of the MQTT broker and get the Data of the Plants.

Customer Success and Support

The Customer Success is intended to support the Customer in achieving maximum value from the services and products, facilitate adoption, and ensure customer satisfaction throughout the term of the Agreement.

Scope of Customer Success

Main tasks and activities throughout the Customer Journey (Onboarding, Adoption and Expansion):

- Onboarding and training of users
- Assistance in setting up and configuring the platform
- Discovery session with customers to align on goals to be achieved and set a plan of action through the collaboration
- Regular check-ins and performance reviews
- Identification of opportunities for further value and adoption
- Support in issue resolution in collaboration with technical support
- Documentation and guidance for best practices
- Identification of further needs or customer pain points that could be bridged with additional Turbit products.
- Provide assistance and guidance during product usage, along with expert advice on decision-making processes related to Turbit insights and recommended actions in the wind portfolio.

Customer Responsibilities

To ensure a smooth collaboration and successful implementation, customers are expected to actively participate in the following areas:

Onboarding process

- Grant access to the required data and fill out the onboarding form
- Align on the main points of contact and collaboration partners

Regular tasks

- Attend scheduled meetings
- Set a weekly time slot for working with the Turbit App
- Collaborate on adoption goals