BUSINESSPLAN

AWINGEN GmbH

Frankfurt, 23.10.2020

Inhaltsverzeichnis

1. Executive Summary

AWINGEN GmbH (http://awingen.com/ws/de/) is an innovative company from the field of renewable energies, which follows the purpose of a proactive participation in climate protection. The company's main focus is the design and manufacture of a multi-turbine wind power system for utilizing the airstream of motor vehicles, which is called "METU-WAK". METUWAK's technology is completely "Made in Germany". The name “METU-WAK” is an abbreviation for the German translation of multi-turbine wind power system Kolesnikov; Kolesnikov is the surname of the founder. METUWAK is a wind power system located in the central reservation between two lanes of traffic driving in opposite directions and thus positioned in such a way that the airstreams triggered by passing vehicles can be absorbed, diverted and converted into energy. METUWAK is based on the idea of building a wind power system to use airstream from motor vehicles, which can be operated reliably and safely with a simple and inexpensive structure by enabling a high energy yield. It is also possible to install the multi-turbine wind drive (METUWAK) on railroad lines and on flat roofs. The utilization of the airstream of motor vehicles is carried out by a number of wind turbines, each with a vertical axis of rotation, which are arranged in a row one behind the other in a supporting structure. The wind turbines are operated by a rotation transmission mechanism with a common drive shaft. Implementation of this project might require a state authorization or a change in national/federal legislation/introduction of a new law or by-law, allowing the installation of METUWAK system on the highways in each EU country of operation. All Images of the project can be found at:

https://onedrive.live.com/?authkey=%21AD-CAVD0lw44aDKM&id=1E1C41F341FC23CE%21194430&cid=1E1C41F341FC23CE

AWINGEN GmbH acts in accordance with the Paris Climate Convention and pursues the goal of combating global warming. METUWAK are to be installed on or in the central separation of freeways and contain stationary wind turbines which rotate counter-clockwise around the standing axis. These wind turbines are driven by the air(wind)steam of passing cars and transfer the torque to corresponding generators that generate energy. The resulting energy is conducted through the connection line to storage devices, charging stations or the regional power system. The headquarters of

AWINGEN GmbH is in Frankfurt am Main. The managing director of the company is Mr. Anton Kolesnikov. The technology of the AWINGEN GmbH is specially developed and patented. The present business plan is intended to present the present business model in a qualitative and quantitative way in order to highlight its profitability.

One METUWAK is six meters long and 1.61 meters high. AWINGEN GmbH calculates 150 METUWAK panels (cassettes) per kilometer. AWINGEN GmbH will generate its income through feed-in tariffs. The company will create at least five jobs on the German labor market. It is assumed that the purchase price of a METUWAK panel is 15 000 EUR. Detailed cost and profit planning is provided in the financial section of this chapter. A simple example calculation for power generation without stress is follows:

Exemplary calculation for power generation without stress:
One METUWAK 20kwt (kilowatt)x 45% = 9Kwt/h(hour)
One METUWAK x 16 hours = 145 Kwt/h (kilowatt hour) per day
10 Kilometers = 1500 METUWAK x 145 Kwt = 217.500 Kwt/h/day x 360 days =
78 300 000 Kwt/year

Furthermore, it should also be taken into account that METUWAK can be installed on almost every freeway in Germany (or anywhere else; as AWINGEN GmbH is a German company this business plan refers to german sources). This would mean that with 13,000 km of freeways in the Federal Republic of Germany and approx. 58,000 km of freeways in the European Union, a large part of the required power demand could be generated and covered by METUWAK. An exemplary installation of METUWAK on 1,000km of German freeways, could generate energy of 7,830,000,000 kilowatt per year. This possible energy production could be achieved by investment costs of 22.475.000.000 €.

Using and constructing METUWAK comes with numerous advantages. For example, energy production does not require the felling of trees and can be carried out in a very space-saving environment. The construction and assembly of the METUWAK panel can be finished very fast; the power generation is local. METUWAKs are easy to repair, and in case of a defect, the whole cassette can be replaced. The electricity generated by METUWAK is also to be used for charging points for electric cars and for cars with fuel cells. The corresponding charging stations are to be located at rest areas where no conventional gas stations are located. Compared to conventional wind power and solar power plants, METUWAK can be operated on any day of the year, with the same price per kilowatt hour as a horizontal wind power plant. The electricity generated by METUWAK can also be used to generate hydrogen. The generation of hydrogen is supported by the German government within the framework of the national hydrogen strategy.

On December 12, 2015, history was made in Paris: At the international climate conference, also known as "COP 21", the Paris Agreement was adopted. After many years of intensive negotiations, all states have thus committed themselves to changing the global economy in a climate-friendly way. This is a historic step - under the previous arrangement in the so-called Kyoto Protocol, only a few industrialized countries were obliged to reduce emissions. Important decisions were also made at the climate conference on the issue of financing. Global warming can only be limited to well below two degrees Celsius or even to 1.5 degrees if global financial flows are redirected: both public and private investments must support the implementation of the agreed climate targets. The Paris Accord formulates precisely this as one of its core objectives: the consistency of financial flows with development paths towards a climate-friendly world that is also resilient to the negative effects of climate change. Public climate financing is of crucial importance here. The Convention recognizes that non-party stakeholders have an important role to play in combating climate change. These include cities, regional and local authorities, civil society and the private sector.[1]

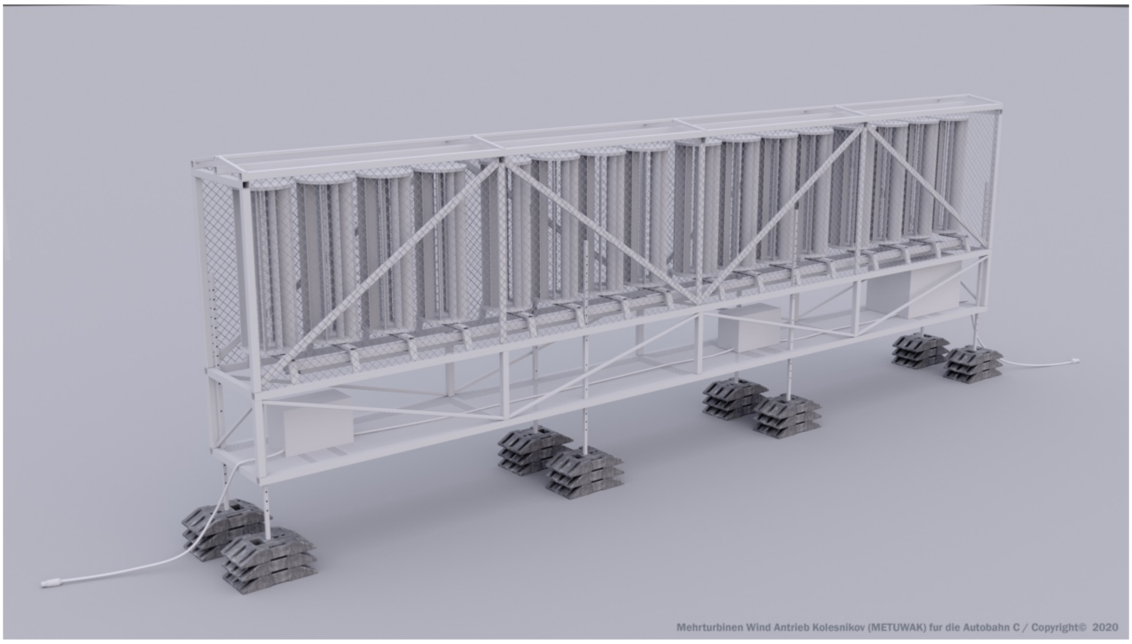
2. Description of the multi-turbine wind power system METUWAK

2.1 Construction of METUWAK: An overview

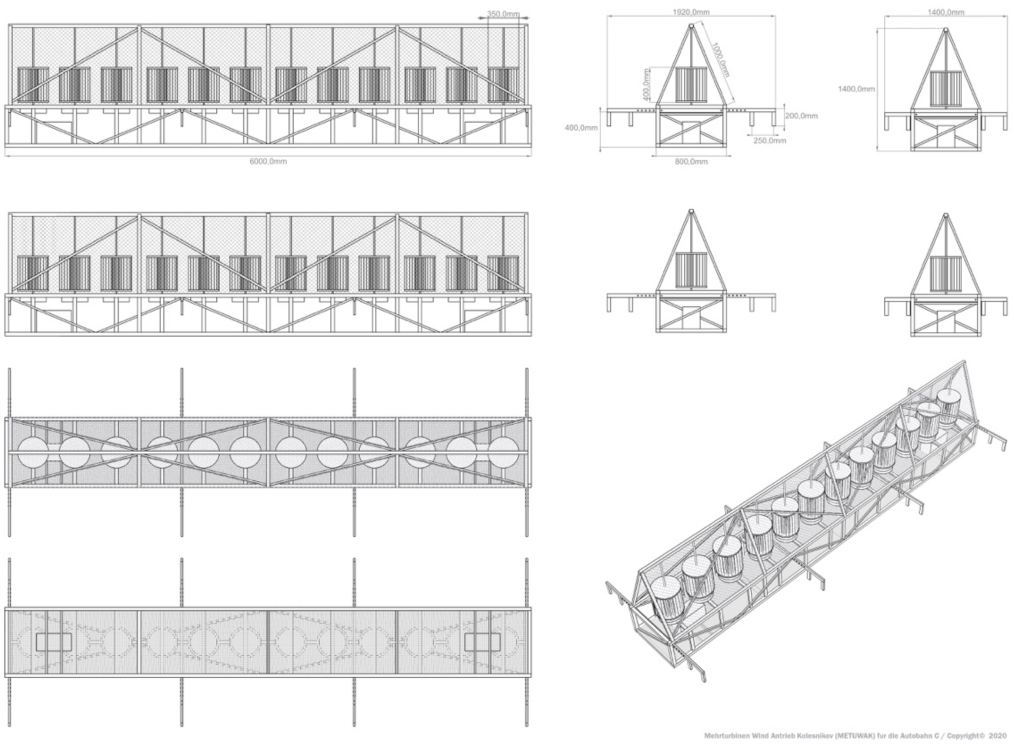
The multi-turbine wind power system (METUWAK) consists among other things of the hard triangular or square support structure (hereinafter referred to as cassette) with a preferred length of 6000 mm, which is installed on or in the concrete crash barrier of the central separation of a freeway or federal road. Inside the cassette, there are some (depending on the size) standing wind turbines installed, which can rotate counterclockwise (or clockwise for left-hand traffic) around the vertical axis of rotation. These

[1] https://ec.europa.eu/clima/policies/international/negotiations/paris_de

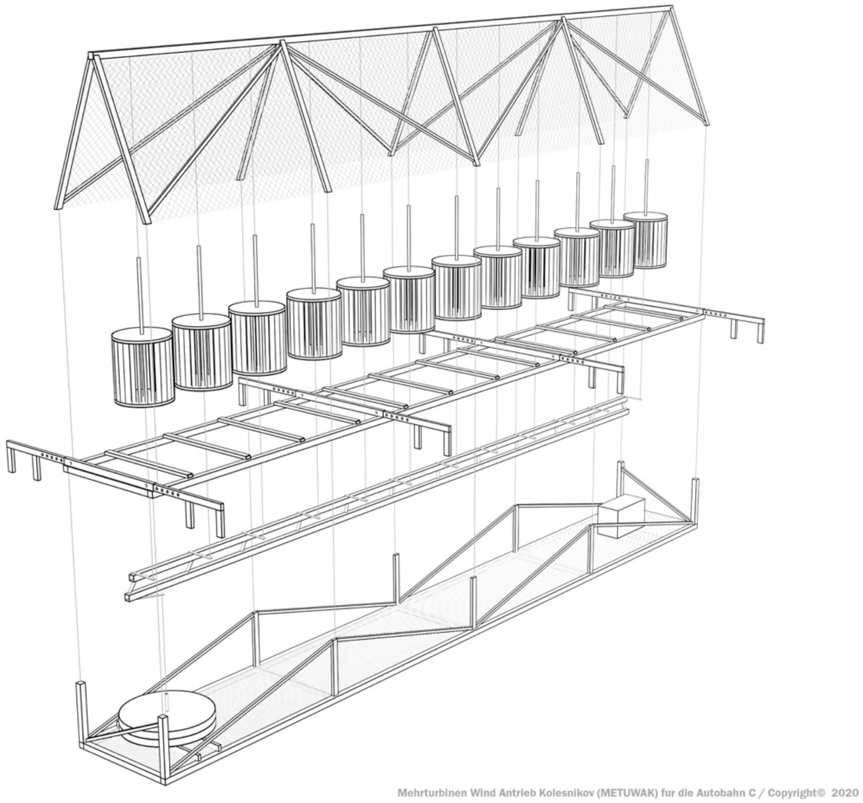
wind turbines are turned up or driven by the air currents of passing cars. This cassette forms the base, which is installed on or in the concrete crash barrier of the central separation of freeways. The METUWAK contains stationary wind turbines that rotate counterclockwise around the stationary axis and transfer the torque to corresponding generators that produce energy. These wind turbines are driven by the air streams of passing cars. The Multi-Turbine Wind Turbine Drive System (METUWAK) consists among other things of the hard triangular or square support structure (hereinafter referred to as cassette) with a preferred length of 6000 mm, which is installed on or in the concrete crash barrier of the central separation of a freeway or federal road etc. Inside the cassette are some (depending on the size) standing wind turbines, which can rotate counterclockwise (or clockwise for left-hand traffic) around the vertical axis of rotation. These wind turbines are turned up or driven by the air currents of passing cars. This cassette forms the base, which is installed on or in the concrete crash barrier of the central separation of freeways. One METUWAK contains stationary wind turbines that rotate counterclockwise around the stationary axis and transfer the torque to corresponding generators that produce energy. These wind turbines are driven by the air streams of passing cars. METUWAK cassettes are installed piece by piece on (or in) the crash barriers of the freeway and simultaneously connected to the control line or connecting line. The energy produced at the output of the receptors is conducted through the connecting line to the storage stations (the electricity can be stored), charging stations or into the power system (power system). The colloquial term power grid in electrical power engineering refers to a network for the transmission and distribution of electrical energy. Lighting devices (street lamps), which are used for street lighting, are also embedded in the cassettes. The geometrical dimensions of the cassette are selected according to the requirements for efficient transport to the installation site and according to the width of the concrete (or metal) baffle plates of the lane separation strip. The width of the cassette (outer dimension) is preferably a multiple (meaning a divider) of the width of the standard truck body (2400 mm) and is 600 mm, 800 mm or 1200 mm. In this way, 4, 3 or 2 cassettes can be placed next to each other. The length of the cassette is a multiple of the standard length of the profile tube and is 3000 mm or 6000 mm. The height of the cassette is selected as a multiple (meaning a divider) of 6000 mm, thus minimizing metal waste and rejects.



(One panel of multi-turbine wind power system - METUWAK)



(Inne life of METUWAK)



(Inner life of METUWAK)

(METUWAK on the motorway)

The rotating wind turbines transmit the total (sum) torque of all (preferably 5 to 30) wind turbines to the torque receiver via a rotation transmission mechanism (hereinafter referred to as RÜM). In this example, the RÜM consists of two balance beams, which are connected to the turbines and the axis of the receiver via hinges.

Torque receivers are:

a) either a cassette electro generator, which generates electricity immediately;

b) or a compressor, which produces compressed air as "working body“;

c) a flywheel or super flywheel that stores kinetic energy (e.g. the Chakratec storage device or Mr. Nurbei Guliy's flywheels). Today, the flywheel is the most energy efficient mechanical energy storage device known.

d) or a reduction gear that provides the operating speed of the receiving device;

e) every other RÜM;

f) a combiation of the above mentioned possibilities.

The mechanism for absorbing rotary motion produces "power" (as a physical quantity); the generator immediately produces electricity. A compressor or air cylinder produces compressed air for further storage and use in various devices (e.g. air motors). "Power" as a product of METUWAK (or as a physical unit) can be used to lift water up into the air and store it in tanks, then discharge it into the blades of hydraulic turbines to produce electricity (principle of a pumped storage power plant). The flywheel stores kinetic energy, which can be quickly converted into electrical energy by a generator. The flywheels can be used to balance voltage peaks in the grid.

The electrical energy received at the output is transferred via connecting cables to a cassette battery (hereinafter referred to as KAB) to power the generator and supply the control units or to supply external consumers, such as network storage devices; or to the charging stations for electric cars in parking lots located along the freeways (especially those without petrol stations, but only with toilets and rest areas); or to the regional power grid; or to the immediate production of environmentally friendly (green) hydrogen (H_2) in parking lots through mini-water hydrolysis stations that can refuel hydrogen vehicles immediately or send them to industry; or to operate the rigidly attached headlights that illuminate the roadway at night, thus increasing comfort and traffic safety.

One METUWAK (panel) consists of the following components:

- a cassette (hard supporting structure): strictly necessary
- stationary turbines: strictly necessary
- components of the bearing suspension: strictly necessary
- rotation transmission mechanism (RÜM) - the heart of the METUWAK: strictly necessary
- control and measuring instruments unit: not necessary
- individual generators/motors; wheels for each turbine: not necessary
- connection cable: not necessary
- control cable: not necessary
- adjustable fixing systems (mounted above the guard rail or between guard rail and height-adjustable fixing system with lower weighting devices): strictly necessary
- cassette generator: not necessary
- illuminators for street lighting: not necessary
- additional metal shielding net (protection against turbine fragments in case of breakage): strictly necessary
- cassette accumulator battery: not necessary
- system cover plate as protection against rain and snow: not necessary
- external system control panel, which is intended for controlling the system segments and the system itself. The console is located outside the METUWAK cassettes, i.e. outside the cassette setting zone.
- receiving devices: Those devices, such as an electric generator or flywheel or reduction gear or compressor, which are designed to receive the power generated by the METUWAK (i.e., energy or torque for the production of the "working body")

2.2 METUWAK: Components

2.2.1 Casette (hard supporting structure)

The cassette is constructed of highly secure metal tubes, which ensure the stability and durability of the system in all weather conditions. If necessary, the cassettes and turbines are painted with rust-proof, light-absorbing materials to eliminate any dazzling spots that disturb drivers. The cassette has a central transverse beam in which the bearing suspension components of the standing turbines are mounted, thus ensuring that the turbines can be freely rotated. If necessary, the steel supports of the individual generators are mounted on the central crossbars. If necessary, the steel supports of the individual generators are mounted on the central cross beams. The side surface of the cassette is covered with metal or net plastic coating, which protects the road against fragments of the turbine in case of mechanical damage or faulty manufacture. If necessary, the upper side can be equipped with a cover plate against wind and rain so that no objects can enter the turbine.

2.2.2 METUWAK turbine

The METUWAK turbine is a cylindrical structure with a diameter of 30 to 120 centimetres (cm), consisting of a metallic central rotation axis hard attached by the bearing suspension components to the central guard rail of the cassette. The lower and upper aluminum turbine wheel discs (or made of plastic or metal) are hard attached to the metallic standing axle. Turbine blades (8 to 72 pieces depending on the diameter of the turbine blade) are hard fixed between them. The turbine blades have a curved shape and are made of recycled plastic or aluminum. Due to the high height of the turbine, an additional turbine blade or wheel disc can be attached for intermediate support to make the construction harder.

2.2.3 Component of the bearing suspension of METUWAK

The structural element of the bearing suspension of METUWAK is the upper and lower pivot bearing, the inner part of which is rigidly fixed to the turbine axis and the outer part of the central crossbars.

2.2.4 Rotation transmission mechanism (RÜM)

The rotation transmission mechanism (RÜM) - as the main element of the system - consists of a set (of two or more) connecting compensating devices made of metal (or carbon fiber), one of which is connected by a joint on the axis of each turbine or to the outer diameter of the disk of each turbine. These elements move inside the technical compartment of the cassette along elliptical curves parallel to the horizon, performing a reciprocating motion that is transformed by the pivots into a rotary motion that is transmitted to the axis (shaft) of the receiving device. This means that the RÜM converts the total rotation (i.e. the sum torque) of all cassette wind turbines into the rotation of the receiving shaft (generator, compressor, flywheel or gearbox). If necessary, the RÜM is equipped with a reduction gear for speed-adapted transmission to the receiver.

2.2.5 Control and measuring instruments Unit

The control and measuring unit is a metal container with a cover plate that allows access to all components of the unit. All the devices that control the work of the generator (which lead the electricity for the forced untwisting up to working cycle and receive the electricity produced by the generator), DC changers, super capacitors, voltage indicators, current meters, Wi-Fi modules, storage devices are located here. These devices adjust the values of the energy received from the generator according to the system requirements and transmit them through the connecting cables to the storage device or to the users. This unit is responsible for switching the street lamp on and off and transfers the parameters of the system work to the data collection station via Wi-Fi module.

2.2.6 Generator

The generator is a ready-to-use power tool that is mounted inside the cassette and generates electricity by turning the generator impeller. Only one generator can be installed in a cassette, but it has a high performance. Alternatively, a single generator with lower performance can be connected to each turbine. Generators are motors with different diameters and different capacities.

2.2.7 Connection cable

The connecting cables are electrical, multi-core cables with an individual cut-out, which are responsible for connecting the cassettes to each other or for transferring the contained electricity

2.2.8 Control cable

Control cables are electric, multi-core cables that transmit control signals to the equipment in the cassette. Through these cables technical information can be transferred to the outside of the system console.

2.2.9 Adjustable fixing systems

Adjustable fixing devices are steel structures made of metal tubes of square, circular or rectangular cross section. The adjustable fixing devices are hard and strong enough to fix the METUWAK cassettes robustly to the concrete crash barrier. For the stability of the cassette further weighting devices can be optionally implemented.

2.2.10 Casette generator

The complete cassette generator is a ready-to-use wall power tool with high performance, which meets all system requirements regarding performance, quality of the extendable electricity and breakaway torque. A breakaway torque is the force that must be applied to overcome the effective frictional forces and/or forces that result from the tilting of two components towards each other. Thereby static friction changes into sliding friction. The circular shaft of the METUWAK rotates with the help of the rotating movement of the turbines.

2.2.11 Illuminator devices for the illumination of the street

Street lighting devices are ready-made lighting systems with sufficient power to illuminate the street. These devices are hard attached to the cassette at a certain angle so that drivers are not dazzled. The installation angle is calculated on the basis of all safety regulations. The lighting devices are fixed in the concrete crash barrier of freeways. Alternatively, it is also possible to fix the lighting units to railroad lines.

2.2.12 Cassette Accumulator Battery

The complete cassette accumulator battery is a ready-made battery with a certain capacity of 12/24 V (or any other output voltage). An accumulator or short battery is a rechargeable galvanic element, consisting of two electrodes and an electrolyte, and stores electrical energy on an electrochemical basis. The Latin word accumulator means "collector" (Latin cumulus 'heap', accumulare 'accumulate'). An earlier name for accumulators was collector. The cassette accumulator battery is intended for primary energy storage. Accumulator batteries are necessary for previous turning on of turbine to working cycle, for power supply of the unit of experimental and sensor equipment, for power supply of lighting devices and for primary energy storage and its further supply to users.

2.2.13 Shielding metal net

A Shielding metal net (or shielding synthetic net) is a protective means against the fragments of the turbine in case of breakage. It is located on the side lining of the METUWAK cassettes in the turbine's construction and protects against fragments.

2.2.14 Cover plate

The system cover plate in the upper part of the cassette is made of recycled plastic or metal. It is coated with a rust-protective and light-absorbing material and is intended to protect the turbine against rain and rain snow. Alternatively, solar panels can be attached to the cassette and generate additional electricity.

2.2.15 The external system control panel
The external system control panel is designed for the control of the system segments and the system itself, for data registration and control value output. The console is located outside the METUWAK cassettes, i.e. the cassette setting zone. It can be permanently installed or portable.

2.2.16 Receiver device
A receiver is a device that captures energy or torque from the RÜM and uses it to generate the result of its own work.

Receiving devices can be:

a) a general cassette generator that generates electricity immediately;

b) a compressor which produces compressed air as a "working body";

c) a flywheel or super flywheel that stores kinetic energy (e.g. the Chakratec storage device or Mr. Nurbei Gulius' flywheels). The flywheel is today the most energy-saving mechanical energy storage device of all known types.

d) another mechanism to absorb the rotational movement, e.g. a reduction gear to generate the required rotational speed.

The "operation" as a METUWAK product (or as a physical unit) can be used to lift water up into the air and store it in tanks, then discharge it into the blades of hydraulic turbines to generate electricity. The flywheel stores kinetic energy, which can be quickly converted into electrical energy by a generator. The flywheels make it possible to compensate for surges in the mains voltage.

2.3 Description of METUWAK’s components of and their coupling
The cassette is the main construction element of METUWAK. All other components are hard attached to the cassette. If a general cassette generator is used, a RÜM is installed in the process room in addition to the generator itself. In case of installation of generators individual for each turbine, the latter are rigidly connected to the cassette at the lower (technological) level of the cassette, hereinafter referred to as the technological section, which is a rectangular niche where other elements of METUWAK equipment are also installed: a control and measurement unit (hereinafter referred to as the KuME), and the battery, as well as laid control and connection cables. When the cas-

sette is mounted on the deflector, the mounting brackets are first "placed on the deflector" and then, after the cassette has been adjusted to horizon level, are firmly attached to the cassette. When the cassette is installed inside the deflector plates, the weights of the supports are first installed on the ground, then the supports themselves are inserted into the deflector plates and the cassette itself is installed on the deflector plates with a crane and after the cassette is adjusted to horizon height, it is rigidly fixed to the supports. The cassette is then connected to the previous and the next segment cassette by connecting and control cables. The system for fixing the lights or spotlights to the cassette (sockets, extensions, plugs) is designed and built in the factory so that the installation angles with respect to the roadway cannot be changed by the personnel during installation. In addition to the connecting elements, the structural elements are also electrically connected. The generators (and the motorcycles) are powered by the battery to achieve operating speeds (optional), and the electricity generated is transmitted via cables either to the consumer or to the battery. All units are conveniently electrically connected to the KuME.

2.4 Functionality of METUWAK and its components

The METUWAK cassette stands firmly on the adjustable fusing units and is connected to the adjacent segments of the cassette by cables. The airstreams of passing cars hit the turbine blade. This creates the rotational movement around the stationary turbine axis. The turbine axes are hard coupled to the own generator and are rotated by the rotor. The KuME controls the preliminary turbine rotation (optional), the battery charging, switching on and off of the lighting devices, the transfer of the energy contained in the generators through the cables to the users or consumers. The KuME receives electricity from all generators in the cassette, "mixes" it, adjusts it according to the span and rate and other parameters. It also passes the constant current (or alternating current) to the users. The KuME collects information about the working parameters of the cassette and transmits it through the control cables or WiFi to the external system control panel, which processes all the information from all the cassettes of the segment and if necessary gives the task for intensive work of the generators.

2.5 Advantages of the METUWAK compared to comparable systems

2.5.1 Installation of METUWAK on the concrete crash barrier

The installation of METUWAK on the concrete crash barrier allows the turbines to rotate in the same direction (counterclockwise) under the effect of the air flow of passing cars.

2.5.2 Casette generator

When using a general cassette generator with higher power output, METUWAK allows the torque of all (5-30) turbines to be used for one generator. In this case, a generator with a capacity of up to 20 kW (e.g. Maglev permanent generator 100RPM 220 380 VDC) can be installed in the cassette. Then the installed capacity of 1 kilometer of METUWAK segments (20 kW x 150) = 3000 kW or 3 MW.

2.5.3 Charging station for electric cars

METUWAK makes it possible to set up a charging station for electric cars in every parking lot along the highway by installing a segment of 5-10 km of cassettes in the area of the future station.

2.5.4 Generation of hydrogen

METUWAK allows the installation of a water hydrolysis station at any location on or near the highway to produce environmentally friendly (green) hydrogen (H2) by installing a segment of the required length on the highway. And at any location on the highway, hydrogen car refueling can be arranged. METUWAK cassettes can also be installed on any flat roof of a building - in residential, office and industrial buildings to ensure the activities of the latter. With the National Hydrogen Strategy, the German government is creating a coherent framework for action for the future production, transport, use and reuse of hydrogen and thus for corresponding innovations and investments. It defines the steps necessary to contribute to achieving the climate targets, to create new value chains for the German economy and to further develop international energy policy cooperation. A successful energy turnaround means combining security of supply, affordability and environmental compatibility with innovative and intelligent climate protection. To achieve this, we need alternative options to the fossil fuels currently still in use. This applies in particular to gaseous and liquid energy sources, which will remain an integral part of the energy system in an industrialized country like Germany in the long term. Here, hydrogen1 will play a central role in the further development and completion of the energy turnaround.

The entire hydrogen strategy can be found here:

https://www.bmbf.de/files/die-nationale-wasserstoffstrategie.pdf

2.5.5 Railroad tracks

METUWAK can also be used along railroad tracks with the installation of cassettes both between the tracks and to the side of the track.

2.5.6 Casette principle

The cassette principle makes it possible to install up to 5-30 low-power motors (generators) in a cassette with turbines whose individual output power lies between 100-400 W each. The total output power of the cassette is summed up from the individual cassettes in the KuME and delivered from 500 W/h to 5-6 kW/h to the grid.

2.5.7 Time and deforestation

Installation and connection to the cassette requires much less time compared to other stand-alone wind generators. METUWAK also does not require any metal guy wire (except cassette stiffeners for spotlights). The installation of METUWAK does not require deforestation compared to the wind generators with the tilting axis.

2.5.8 Energy source

In darkness, METUWAK segments can also supply energy from other sources, so that the energy networks can reduce their consumption at night. Here it is important to mention that conventional wind generators have to be stopped because consumption is decreasing. It is also possible to install a photoelectric element (photovoltaic) above the cassette in regions with higher solar activity.

2.5.9 Independent of the weather

METUWAK works regardless of weather conditions and is not dependent on sun or wind (like conventional wind or solar power systems), as the turbines are driven by the wind of passing cars.

2.5.10 Simple repair

METUWAK is a very repairable system, as any part can be easily removed and replaced by other parts. The repair does not require a specialized company.

3. Market analysis

3.1 Wind power system (Definition)

A wind turbine or wind power system converts the energy of the wind into electrical energy and then feeds it into a power grid. Colloquially, the terms wind power plant or wind turbine or wind power converter are also used. Today, wind turbines are by far the most important form of using wind energy. By far the most dominant form of construction is the three-bladed lift rotor with horizontal axis and rotor on the windward side, whose nacelle is mounted on a tower and actively follows the wind direction. A number of other construction forms, especially with a different rotor design, have not yet become established.

Wind turbines can be used in all climate zones. They are installed on land (onshore) and in offshore wind farms in the coastal foreland of the oceans. Today's plants are almost exclusively operated with grid connection and, in contrast to older plants with a direct grid-connected asynchronous generator, have a very good grid compatibility. The typical output of today's turbines (as of 2016) is around 2 to 5 MW for onshore plants and 3.6 to 8 MW for offshore plants. In stand-alone operation, even small systems in the power range from a few 100 watts up to several kW can be economical. They are treated under wind generator. Groups of several wind turbines are discussed in the article Wind farm, further applications and energy policy aspects in the articles Wind energy, Renewable energies, Energy system transformation and Energy system transformation by country.

3.2 (Conventional) wind turbines in Germany

There are 30,000 wind turbines in Germany (including around 1,200 turbines in offshore wind farms in the North and Baltic Seas). Together, these wind turbines have a total capacity of over 56,000 megawatts - equivalent to the power of over 50 nuclear power plants. Germany thus has the largest wind power capacity in Europe and is well on the way to a climate-friendly energy future. What counts with wind power plants is what can ultimately be fed into the grid as electricity yield. The electricity yield does not depend exclusively on the output of the wind turbines. Other factors play a role:

- THE POWER OUTPUT DEPENDS ON THE LOCATION OF THE WIND TURBINE

There are particularly windy places in Germany such as coastal areas or exposed locations, e.g. hilly country. Other places, on the other hand, are considered to be weakwind regions: They get less wind, but still do not have to do without electricity generation by wind energy - there are wind power plants that were specially designed for locations with low wind speeds. However, the output of these WKAs is usually lower. If the site has particularly high wind turbulence, wind turbines also run at lower output to minimize the risk of damage. A simple comparison: If the conditions are adverse - e.g. on an uneven dirt road - you will not drive your car at full power. Better safe than sorry.

- IS THE PLANT USED ONSHORE OR OFFSHORE?

For good reason, most wind turbines are located a bit out in the sea. Due to the overall better wind conditions, such an offshore plant produces on average more electricity with its output than an onshore plant inland.

- WHAT IS THE STATE OF THE ART?

The newer a wind turbine is, the more likely it is to have a better technological standard. It works more quietly and above all more efficiently. Modern wind turbines do not have to feed the power generated directly into the grid. If there is acutely no demand for the electricity produced, it is simply stored temporarily.

3.3 Wind power stations: Current developments in Germany

In the first half of 2020, 178 gross new turbines with 591 megawatts were added, twice as many as in the same period last year. This is shown by figures from Deutsche Windguard, commissioned by the German Wind Energy Association and the responsible mechanical engineering association VDMA Power Systems. The associations forecast an increase of at least 1.5 gigawatts this year. However, the industry is coming out of an extremely bad year - in 2019, only 86 turbines or 287 megawatts were newly installed in the first half of the year. For comparison: between January and June 2018, 523 wind turbines with 1,714 megawatts were still in operation. For this reason, the associations criticized the current gross addition as "still clearly too low". This is also due to hurdles in the approval process. According to the figures, a total of 29,546 turbines with around 54 gigawatts were in operation at the end of June. The fact that the interest of operators in the construction of new plants is still very low is also shown by the joint green electricity tender on July 1. At the auction, onshore wind power was again clearly signed, as the Federal Network Agency announced on Thursday. Only

26 bids for 191 megawatts were submitted for the tendered quantity of 275 megawatts. All projects were therefore awarded the contract - most of them in Schleswig-Holstein, followed by Lower Saxony and Brandenburg. As in the preliminary round, the hammer price was 6.14 cents per kilowatt hour. In contrast, around four times as many bids were submitted for solar plants as were put out to tender - 174 bids with 779 megawatts, the limit being 193 megawatts. Only 30 project developers were awarded the contract. The average price fell slightly from 5.36 to now 4.69 cents per kilowatt hour. The trade associations see pressure for action for around 15,000 onshore wind turbines with a total output of around 16 gigawatts. For these, the subsidy under the Renewable Energy Sources Act (EEG), which was designed for only 20 years from the start, will expire by the middle of the 2020s. According to the BWE and VDMA Power Systems, this calls for a repowering strategy that minimizes subsidy costs, uses land efficiently and ensures acceptance. The Federal Ministry of Economics had already signaled its intention to tackle the problem of small green power plants when the EEG was amended in the fall.

With a view to the climate targets and the hydrogen strategy of the Federal Government, the associations demanded more speed in the expansion of green electricity. "The legislator therefore urgently needs to create and enforce a coherent framework for action in order to secure investment incentives and the technological lead of the wind industry in Germany as a business location in the long term and to avoid an electricity gap in renewable energies.

4. Financial plan in the context of a stress analysis

Stress is the term used to describe a condition that could potentially cause financial or economic damage to shareholders and stakeholders. Stress tests are used to test the resilience of an infrastructure investment under adverse economic conditions. If an infrastructure investment meets all the requirements for the fulfillment of possible liabilities in a stress test, a stress test is generally referred to as "passed". Stress tests also serve to better assess and manage risks, which is why many financial industry regulators require stress tests for infrastructure investments. In the insurance context, infrastructure investments allow for lower solvency capital requirements on the part of the investing insurance institution, provided that revenues are predictable and stress resistance can be ensured even during prolonged periods of stress.

However, the question of how the level of stress resistance can be determined in a stress test and how such stress could be structured in principle must first be clarified. EIOPA (European Insurance and Occupational Pensions Authority) has published consultations on this issue. Based on these EIOPA consultations, a potential stress testing framework is presented below using an equity investment in onshore wind projects, taking into account the specific revenue risks.

4.1 Introduction & Definition of the risk profile

Investments in wind projects can be assigned to the category of infrastructure investments. An associated risk profile provides an overview of the various risks to which an infrastructure investment is generally exposed. In general, these are mainly technical risks, market risks, financial risks, sustainability risks and operational risks.

These risks for infrastructure investments are based on special so-called revenue risks, which have a special relevance for the revenues. Based on these revenue risks, the EIOPA has defined nine stress test categories to be applied to the revenue generating factors in a stress test for onshore wind projects. For this purpose it is necessary to be able to measure and forecast the revenue risks. This is followed by the forecast of ex ante cash flows under stress. As the core of a stress test, this provides a statement about the respective financial resilience of the wind project under consideration.

The assumptions about a promised target return for the investor, a conservative base case and an investment within the EU are considered all valid. In addition, the first EIOPA stress test category "bad refinancing conditions" for "debt investments" must be taken into account.

4.2 Quantification & Forecast of relevant revenue risks based on EIOPA stress test categories

Lower payment per KwH

Usually, a payment corresponding to the spot price on the market according to the Physical Electricity Index of the Leipzig Stock Exchange exists or a state-guaranteed feed-in tariff will be paid. In order to be able to forecast the risk of low electricity prices on the market, it is necessary to extrapolate the spot price into the future on the basis of well-fitting models. Common models like the Brownian movement are not applicable to the simulation of electricity prices. In addition, seasonalities, extreme price peaks, no mean reversion, non-stationarity and future political decisions would have to be taken into account in the electricity price simulation. The (hourly) Price Forward Curve over the spot price is more suitable, which specifically forecasts energy prices to the hour over the future three to four years. A low electricity price or a decline in the price of electricity is most likely to occur when the oversupply of generated electricity exceeds the demand for it in an economy. Hardly any existing storage technologies for electricity intensify this effect. Predefined discounts in the electricity price could reflect the stress scenario.

In the near future, however, market price risks can be hedged through long-term power purchase agreements between onshore wind project owners and companies. In this case, the liquidity/willingness to pay of the electricity purchasing company is to be quantified on the basis of its creditworthiness or its respective rating and converted into a stress scenario by means of creditworthiness discounts.

A state-guaranteed feed-in tariff is an exact time-related purchase price, on the basis of which the project planner can check the profitability of the project ex ante with regard to the tariff. The risk here lies in a suspension or reduction of the state feed-in tariffs, i.e. in the credit default risk of the respective state. A country's liquidity/willingness to pay its liabilities is measured by its creditworthiness or rating. A deterioration in a country's rating increases the probability of lower or suspended feed-in tariffs, which is why a notional deterioration in creditworthiness would have to be assumed in a stress scenario. Fitch Ratings gives the Federal Republic of Germany an AAA credit rating, which is why, for example, no suspension of the feed-in tariff is to be expected in Germany. At present, there is hardly any historical data on reductions or suspensions of feed-in tariffs, which is why no quantitative statement can be made on the probability of a reduction or suspension. The current feed-in tariff is 0,04€ per kw/h. Consequently, this feed-in tariff is used for calculation purposes. The calculation is based on a METU-WAK development for 10 km of freeway.

Severe economic disruption
Serious economic disruptions lead to a political risk, which in this context can also be understood as a country risk, because unconventional political actions are often the political response to serious economic disruptions. The risk for the investor therefore lies in the unpredictable unconventional behavior of political decision-makers, which can have a negative impact on the investment process, for example by suspending feed-in tariffs or setting exchange rates for investments in the non-euro area. An assessment of the political risk in a country is usually made on the basis of verified expert opinions or corresponding indices, namely the Business Environment Risk Intelligence Index or the Institutional Investor Credit Rating Index. The first one represents a ranking of the "investment friendliness" of various countries. The second one is based on targeted surveys as well as on a historical analysis and the study of various risk dimensions. A stress scenario for political risk could therefore be represented by negative expert opinions as well as by a lower ranking within the two indices. The probability of severe economic disruptions due to structural changes in political governance in both Germany and the European Union is considered very low. For this reason, a reduction or suspension of the feed-in tariffs is also not to be expected.

Reduced electricity production
Reduced electricity production becomes a stress-inducing risk if the amount of electricity actually produced is less than the amount originally calculated. This case occurs due to not calculated low wind speeds, because low wind speeds have a direct influence on the volume flow and wind power of a wind project.

Using the arithmetic mean of the respective wind speeds, it is possible to make an estimate of the average power kw/electricity generation for a selected time period based on the specific power curve of the onshore wind object. However, no power performance curve for the cassette wind turbines is known so far.

Of course, a lower power generation or rated power can also be caused by unforeseen technical risks and have a direct influence on the skewness of the predicted power performance curve. The output power is calculated by the wind power* efficiency of the wind turbine. The stress scenario for a lower power generation would therefore have to be depicted in the form of a flatter power performance curve, which is formed by lower average wind speeds and a lower efficiency of the plant.

Late construction completion

Late completion of the wind project leads to a stress scenario if sufficient cash flows cannot be generated to meet the covenants within the agreed period due to the late completion. This risk is also known as construction risk. For example, geographical or political factors lead to a delayed completion. Finally, however, the executing construction company is responsible for the construction performance of the onshore wind project. For this reason, it is possible to estimate the approximate probability of a delayed completion based on the references and the quality of the respective construction company. In this context it is necessary to check whether the respective construction company meets certain criteria, namely

- degree of experience of the construction company in the construction of wind turbines
- degree of experience of the construction company in different countries
- degree of experience of the suppliers
- drafting of the contract (e.g. turnkey contract, engineering procurement and construction)

The respective requirements regarding the degree of experience of the construction company can be traced by means of a due diligence on e.g. previous construction projects, experience of the management or construction engineers, customer satisfaction, etc. The drafting of the contracts can be examined by a lawyer. Furthermore, the project engineer should also consult an expert's assessment of the respective degree of difficulty of the construction work. A stress scenario could be depicted by making deductions for the fulfillment of these criteria, since low levels of experience and an inferior contractual design of the construction work increases the probability of late completion. Where historical data is available in this respect, quantitative evidence could also be provided.

No further information has been provided to date concerning a construction company to be commissioned.

Insolvency of the construction company

Insolvency of the construction company entails risks if the wind project is not yet fully completed. On the one hand, this delays the generation of cash flows and, on the other hand, such an event represents a bad investment for the financier. The insolvency of the construction company is also subsumed under construction risks. In order to estimate the probability of the insolvency of the construction company, ratings of the respective construction company can be considered, if available, or an economic analysis of the balance sheets of the respective construction company could be performed in the context of a due diligence. If the liabilities of the construction company exceed its trade receivables in the medium and long term, then the insolvency of the respective construction company becomes more likely. Furthermore, the question should always be answered in this context of wheather the insolvent construction company could be replaced by another construction company easily. In the case of stress resilience, the wind project should also be able to meet the covenants if the contracted construction company becomes insolvent during the construction process and has to be replaced by another construction company, which would also provide the framework for another stress scenario. In addition, the insolvency of the contracted contractor could delay the completion of the wind project, but according to EIOPA, this stress scenario should be considered independent of the insolvency of the contractor.

Insolvency of the operating company

The insolvency of the operating company represents a risk, in case the wind turbines cannot generate the cash flows needed to settle the covenants without the activities of the operating company. In order to estimate the probability of the operating company becoming insolvent, ratings of the respective operating company can be considered, if available, or a business analysis of the balance sheets of the respective operating company could be performed in the course of a due diligence. In the case of stress resilience, the wind project should be able to meet the covenants even if the operating company becomes insolvent during the term of the project and has to be replaced by another operating company. Conversely, a stress scenario could thus be represented by the insolvency of the commissioned operating company in the course of the operation of the wind project. Depending on the degree of difficulty in finding a replacement operating company, different cash flows can be expected.

The present wind project of interest will be operated by the Awingen GmbH.

Disruptions in operations

Disruptions in the operation of a wind project are usually based on technical risks. The occurrence of technical risks leads to a lower efficiency of the wind turbine, which in turn has a negative impact on the rated output of the wind project. Lower electricity production entails the risk of lower future cash flows. Here, the reduction in efficiency can be calibrated on the basis of the manufacturer's specifications. Well-known manufacturers in the wind power industry guarantee a minimum availability of the technology used of approx. 98% in the first years and a minimum availability of approx. 95% in the following years. Detailed information about the efficiency of the cassette wind turbines is not available yet. These will be provided by Awingen GmbH as soon as available.

If the minimum availability falls below the guarantee value, the manufacturer is usually contractually obliged to make a compensation payment to the project planner. Should the manufacturer unexpectedly not be able to make this financial compensation payment, this is referred to as the materialistic risk. In addition to considering the manufacturer's specifications, the probability of the occurrence of the technical risks can be estimated in the quantitative assessment of a verified set of criteria for the technology used. These criteria are:

- High number of wind projects with the same technology
- Good comparative performance of the technology with similar wind projects
- High reputation of the producer of the technology

If these criteria are met only to a limited extent, the occurrence of technical risks could become more likely. If a stress scenario were to be depicted, deductions would have to be made for the fulfillment of these criteria and the materialistic risk would also have to be expected to materialize, since a stress scenario only exists when the materialistic risk occurs.

Financial calculation in a stress szenario

The attached financial planning serves an exemplary analysis and is based on the assumption that Awingen GmbH will operate the present cassette wind turbines over a period of 20 years on a length of 10 km freeway. A production of 3000kw\h energy per kilometer is expected. A capacity utilization of 16h per day/ 7 days per week is assumed. The paid feed-in tariff is 0,04€ per generated kw\h.

Furthermore, it is assumed that the Awingen GmbH will hire about 6 employees from the local labor market during the 20 years of operation, who will each receive a gross annual salary of 50.000€. In addition, expenses for the installation of the cassette wind turbines are calculated for the first year of operation.

The required credit line for the Awingen GmbH is about 22.475.000€. The calculated annual financing interest rate is 1.5%. For the annual corporate tax rate, 31% is estimated on the EBT. A straight-line depreciation method should be applied.

Assuming that the generated energy is not exposed to a stress scenario, the Awingen GmbH would achieve a cumulative cash flow net profit of € 50.400,84 after 20 years. In order to calibrate the stress scenario for the generated kw\h adequately, a reduction of the generated energy by 10% compared to the "scenario without stress" is assumed. Even taking this generous stress reduction into account, the Awingen GmbH would achieve a cumulative cash flow net profit of € 46.078,68 after 20 years of operation based on the above mentioned ratios. Consequently, the considered present wind project for the production of renewable energy can be considered extremely attractive for a potential lender.