I. Introduction

Medical care, schooling and permanent access to energy have become a matter of course in Western countries. However, the industrialised nations often forget about the poverty and poor living conditions of large parts of the world's population. More than two billion people live in countries with increasingly severe water shortages. As a result, the water supply for agricultural products and livestock in particular is becoming more difficult.

The water supply and thus the quality of life of the affected inhabitants can be significantly improved with a small investment of funds!

Low-cost small wind turbines (wind pumps), which can be built in a locksmith's workshop, are particularly suitable for water extraction. With the help of such wind pumps, it is possible to pump clean groundwater to the earth's surface. This can be used as drinking water or for agricultural irrigation.
The use of wind energy is not a new discovery. However, burning coal or oil tended to push it into the background. These dead-end technologies are not sustainable and are increasingly meeting with resistance. For this reason, wind power plants are becoming increasingly important. As a result of climate change, water supply is becoming increasingly difficult, affecting less developed countries in particular. Based on this realisation, the association Green Desert e.V founded a working group for the non-profit project "Open -Windmill", which offers the possibility of pumping groundwater for water supply through wind pumps. *Green Desert e.V* is a group of scientists that deals with worldwide problems of energy supply, agriculture and the consequences of climate change.

The aim of "Open Wind Pump" is to develop easy-to-understand construction instructions and technical documentation for wind pumps, which are to be published worldwide as *open source* (usable, editable and freely accessible by third parties). The pumps should be able to be manufactured with tools available worldwide, materials that are easy to obtain and people who are not specially trained.
Craftsmen, farmers and people with basic technical knowledge are addressed and motivated to rebuild and successfully operate the wind pumps with the help of the instructions offered.

Aims of the construction manual

The objective is to provide easily understandable construction manuals of directly driven wind pumps and wind generators. With the electricity generated by the wind, electric pumps can be indirectly driven and pump water even from great depths. Engineering documentation and background information supplement the manufacturing instructions and provide the basis for situation-dependent modifications.

In the following document, the construction of a wind-powered water pump is explained step by step. The focus is on creating an easily understandable construction manual with easy-to-find materials and technical documentation of the wind turbine. This document will be published worldwide as open source and is suitable not only for experts but also for talented laymen willing to learn. Specific knowledge is required for some steps. For example, the welding work must be carried out by specialists. As this equipment is usually manufactured in working groups, all group members can work independently under the guidance of experts. *Green Desert e.V*. aims to develop sustainable concepts of energy and food supply for the respective regions together with the local population. The organization has been active since 2008 and develops the simplest

possible technical solutions in the field of water, agricultural and energy infrastructure. The focus is on the transfer and exchange of knowledge.

A challenge in this project is to keep the production of the components as simple as possible. The system is to be manufactured in normally equipped workshops using materials that are easy to procure. This means that although welding equipment and drilling machines are required, no special tools or machines are needed. For this reason, simple production steps were considered in the design.

The plant is operated under the name *KUKATE34*. The *KUKATE* turbines are small wind turbines, which have been designed by Professor Crome since 1985 and are constructed with different rotor diameters. They are mainly used for power generation in developing or emerging countries. The simple and robust design of these turbines is also taken up in the present project *KUKATE34*.

Background

More than 30 years of development and self-construction experience

Our more than thirty years of previous experience in the development, self-construction and operation of wind turbines on our own test field is unique worldwide. More than 40 diploma theses, bachelor's theses and master's theses were aimed at the construction, testing and optimisation of KUKATE wind energy converters. Last but not least, we also took into account the experience gained from the operation of over a million wind pumps that are currently in use worldwide.

KUKATE turbines are small wind turbines designed by Professor Dr. phil. Horst Crome and designed with different rotor diameters and numbers of rotor blades from two to twelve. Up to now, they have mainly been used to generate electricity in developing countries or emerging economies.

He described his concept in detail in his "Handbuch Windenergie Technik". It is the best-selling book of its kind.

Development path of the wind water pump KUKATE34

At OPEN-WINDMILL, we have also taken up the simple and robust design of these system types for the KUKATE34.

Because of the rotor diameter of 3.4m, the turbine is known as KUKATE34.

Development of the KUKATE34:

1. Theoretical conception 2014 - 2016
2. Construction of the prototype 2016 und 2017
3. Assembly and installation with the support by BeLu 2017
4. Long-term test operatioins and optimisations
5. Compilation of the construction instructions, technical drawings, material and tool parts lists from 2017

Objective and method

Self-sufficiency with clean water.

All in all, the KUKATE34 project is unique worldwide on this level and in this complexity and will serve to overcome many thousands of problems in autonomous water supply with the help of

regenerative wind energy. Helping people to help themselves and to become autonomous is our priority.

It was therefore a particular challenge in this project to make the production of all components as simple as possible. The equipment can be built from easily procured material.

In concrete terms, the OPEN-WINDMILL KUKATE34 can be manufactured and assembled with angle irons, flat profiles, tubes, sheet metal made of steel and aluminium, round material made of iron and brass/red brass/bronze (for bearings), welding materials, screws, six pedestal bearings, wood and leather (for piston seals) as well as a few springs/rubber straps and long ropes.

The necessary now-how is available worldwide.

Experience shows that countless metal workshops all over the world have the following tools and equipment at their disposal:

Welding equipment, metal saws, a stand drill and some hand drills, mostly a lathe, screw clamps, measuring tools as well as typical metalworking hand tools.

They can be building fitter's shops, small shipyard or agricultural machinery repair shops where the KUKATE's are made.

Own ideas can be easily implemented.

The users of the OPEN-WINDMILL technology can change the manufacturing and the wind pump themselves according to need and possibility

- Simple technical knowledge in the field of metal construction is sufficient for manufacturing..
- All parts can be transported by people.
- The system can be assembled lying down and then erected by people.
- All components are 100% recyclable and do not pollute the environment.
- The mast height and the pump can be adapted to local conditions.
- The foundation can be built depending on the location. No concrete is required for the sleeper foundation.
- In low wind areas, the rotor diameter can be increased without any problems.
- No gears, belt or chain drives are required for the OPEN-WINDMILL water pumps. Only with the electric version of the KUKATE34E are they usually useful for generator adjustment.
- The impeller has no electronic, electric, pneumatic or hydraulic components.
- The piston diameter can be adapted to well pipes on site at any time.
- The piston and valve seals are easy to make and replace yourself.
- The diaphragm pump KUKATE34M does not require any piston seals.
- Depending on the pumping depth and the pumping requirements of the water, a maximum water delivery adapted to the conditions can be installed via the adjustable crank swing stroke and an adapted choice of piston diameter..
- The guide bearings for the hardwood piston rod can be easily replaced at any time.
- The connected rod bearings are simple pillow block bearings available on the market worldwide.
- The gondola bearings are manufactured in-house and can be replaced.
- Power and speed are adjustable via the variable control weight.

IMPORTANT NOTES ON THE CONSTRUCTION OF KUKATE WIND TURBINES!

In some places we have printed the text in the building instructions in italics. At these points in the building instructions we draw attention to alternatives to our construction. Either we describe these alternative modification possibilities or we only point out modification possibilities.

These can be direct deviations from the KUKATE-OPEN-WINDMILL design.

They can also be alternative production methods - the product remains the same.

We would like to expressly point out our disclaimer here once again (1.6 Copyright Haftungsausschluss)

II. Technical introduction

Function of the wind turbine

Like all wings that function according to the lift principle, there is a measurable pressure difference between the windward side (positive pressure) and the leeward side (negative pressure). The pressure difference multiplied by the effective wing area results in the lift force. The lift force - because it points diagonally backwards - acts with a component radially on the wing spars and thus generates the torque. The more wings, the greater the torque - and the lower the speed.

We have determined the rotor diameter of 3.4m from the target of the desired pumping capacity. In this case, we want to pump one litre of water per second from a depth of 10m. This results in a pumping capacity of 100 W. That is over 86,000 litres per day. In order to guarantee enough pump power, the pump efficiency is only calculated at 20%. This results in a necessary rotor area of 6.6m² to generate the 500 W of rotor shaft power that is then required.

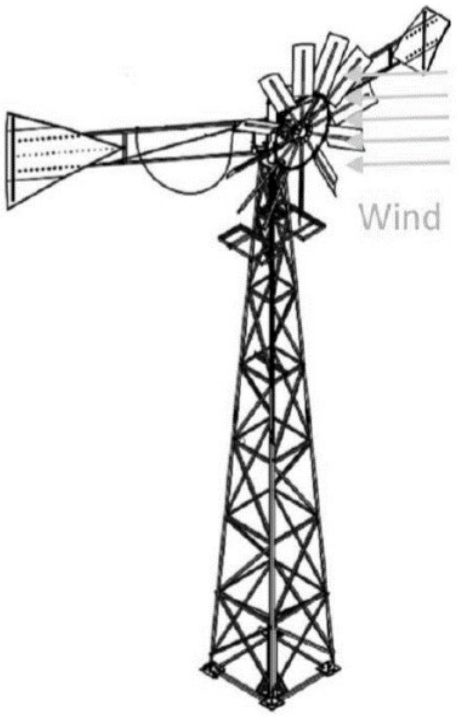

Figure 1 - KUKATE34 under the impact of wind

Fluid dynamics and performance

Wind contains kinetic energy in the form of flow energy. The KUKATE rotors convert this into other forms of energy by means of fluid mechanics. This can be the lifting work when pumping water or the conversion into electricity. We give a brief description of the basic function of the system. We then explain the individual assemblies in detail.

Figure 1 shows the wind flowing into the turbine. The free energy of the wind flows towards the rotor. As soon as the rotor turns, the energy conversion takes place. A torque (Nm) is generated at each blade and, multiplied by the speed of the rotor shaft (per second), a mechanical power is generated. The flow energy of the wind is converted into kinetic energy of the rotor. A crank drive at the rear of the rotor shaft causes the pump linkage to move up and down. This is connected to the piston of the pump at the bottom. The pump pumps the groundwater upwards for the water supply.

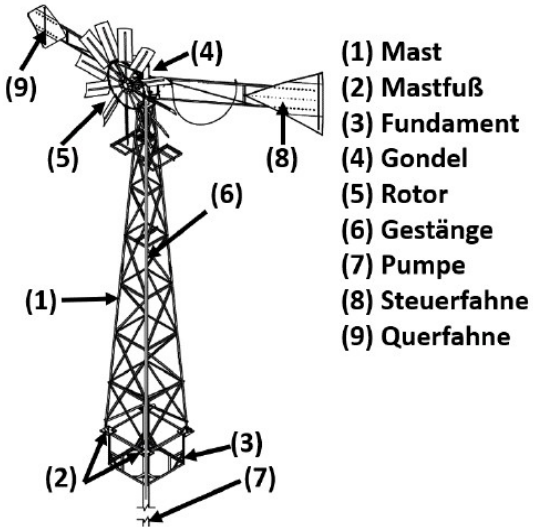

Figure 2 - Construction groups of the system

Construction groups and their function at the

Figure 2 shows the KUKATE 34 system. For an overview, all individual assemblies are labelled. As soon as the rotor turns, the rotation of the shaft is converted into a translatory up-and-down movement of the boom by the crank drive. The boom runs down through the middle of the mast to the pump. It pumps the groundwater to the surface.

The mast is erected on its mast feet. The hinges of the feet form the connection between the mast struts and the foundation. The foundation is buried more than one metre deep in the earth or cast from concrete. The foundation ensures the stability of the KUKATE34.

In addition to the rotor and crank drive, a control vane and a cross vane are attached to the nacelle. The flags serve to align the rotor in the wind direction. The flags together with the control weight are necessary as a mechanical safeguard in a storm. In a storm, the wind pushes the flags together. This turns the rotor out of the wind direction. In this way, the wind pump is protected from storm damage. (The function of the control system is described in detail under section.

Technical data

General technical data of the KUKATE34K OPEN-WINDMILL wind turbine (without guarantee)	
Function	**Implementation**
Assembly	modular
Service Life	> 30 Years
Regulation	Control and side vane with control weight (optional spring)
Start-up wind speed	light wind (about 3-4m/s)
Power off regulate off	7-8 m/s
Transportability	max. 5 m long components
Transport weight (to be transported by people)	Except for the mast segments, no assembly weighs more than 50kg
Surface treatment	Anti-rust coating / paint / or (partially) galvanized
Mast	
Height of mast above ground to azimuth bearing	(6-) 10 m variable adaptable
Mast construction	four stems, truss, L profile
Stem distance	top 0,3 m ; bottom 1,5m
Gondola	
Gondola weight	max. 200 kg
Shaft diameter	40 mm
Shaft bearing	Plummer block with deep groove ball bearings
Bearing of gondola	Plain bearing
Bearing of the control vane	Plain bearing
Rotor	
Incoming flow	Luv
Number of wings	12
max. rotor diameter outside Rotor blade profile length Profile width	3,4 m 1000mm x 370mm
Wing material	Sheet steel or aluminum 2mm
Profile shape	curved plate 1: 10 to 1 : 8
High-speed number	1,1
Nominal wind speed	6 m/s
Pump	
Pump height (= installation depth of the pump)	10 m; variable
Pumping capacity at 10m head	1 l/Sec = 3600l/h = 84.000 L/day
Shaft power	200W at 5m/s 700W at 7m/s 1000W at 8m/s
Piston rod bearing	Plain bearings made of hardwood or plastic

Tabelle 1 - technical data