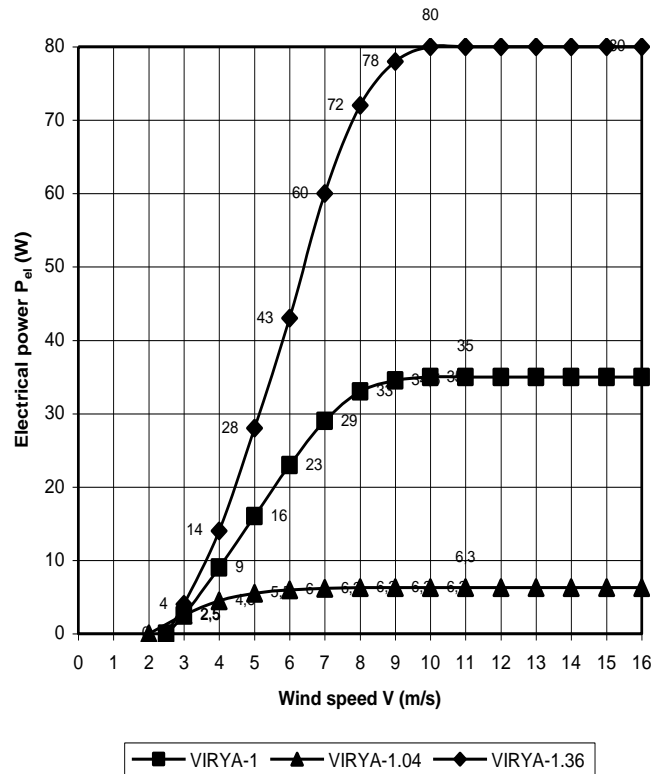Free licence for manufacture and sale of windmills
VIRYA-1, VIRYA-1.04 and VIRYA-1.36
January 2015

VIRYA-1

**P_{el}-V curves VIRYA-1,
VIRYA-1.04 and VIRYA-1.36 windmills**

Kragten Design

Kragten Design (KD) is a one man engineering office founded in 1989 and specialises in designing windmills and wind energy consultancy (see separate folder). Up to now eighteen windmills with rotor diameters from 1 to 4.6 metre haven been developed and more than 570 KD-reports haven been written. Adriaan Kragten, B.Sc., worked for fifteen years in the Wind Energy Group, Faculty Physics of the University of Technology Eindhoven, one of the parties in the former CWD (Consultancy services Wind energy Developing countries). The address of KD is: Kragten Design, ing. A. Kragten
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Description of the windmills

The rotor of the VIRYA-1 has two aluminium blades made out of one strip. The rotor of the VIRYA-1.04 has three separate aluminium blades. The rotor of the VIRYA-1.36 has two separate stainless steel blades. All blades have a constant chord of 123.3 mm and 7.14 % camber which simplifies manufacture. The rotor calculations of the VIRYA-1, the VIRYA-1.04 and the VIRYA-1.36 are respectively given in the free reports KD 574, KD 518 and KD 571.

The VIRYA-1.04 uses a Nexus bicycle hub dynamo as generator. The main disadvantage of this generator is that the maximum power is rather low. The VIRYA-1 and the VIRYA-1.36 have an axial flux generator which must be manufactured completely. The VIRYA-1 generator makes use of the front wheel hub of a mountain bike. It is expected that a battery charge controller with dump load isn't required if the battery has enough capacity. The VIRYA-1 and the VIRYA-1.04 make use of the same head and the same tower pipe. The only difference is that the vane blade thickness is 1.5 mm for the VIRYA-1.04 and 2 mm for the VIRYA-1.

The windmills are provided with a "hinged side vane safety system" to limit rotor speed and thrust at high wind speeds. The rotor axis is offset from the tower axis. The vane juts out along the rotor and the vane blade is connected to the vane arm using hinges. At low wind speeds, the vane blade hangs in almost vertical position and the rotor is perpendicular to the wind. At wind speeds higher than about 6 m/s, the rotor starts to turn gradually out of the wind. At very high wind speeds the rotor turns out of the wind by about 70° and the vane blade is in almost horizontal position. The behaviour of this system is very stable and the rotor speed is well controlled.

The towers of the VIRYA-1 and the VIRYA-1.04 consist of a 1 metre tubular upper section which can be connected to 3 m long wooden pole which can be connected to a supporting structure such as a wall of a house. The VIRYA-1.36 has a 2 metre tubular upper section and a 3 m wooden pole. Ten VIRYA-1.04 windmills have been built during a weekend in spring 2013 by a group of students of the University of Technology Twente. The VIRYA-1 and the VIRYA-1.36 have not yet been manufactured and tested by Kragten Design but a prototype of the VIRYA-1.36 will be built by an Indian company.

These three windmills are designed primarily for serial manufacture in developing countries. However, a prerequisite is that the prescribed material is available. Kragten Design cannot supply materials and parts such as bearings, generators, magnets etcetera. The required workshop skills are sawing, drilling, turning and welding.

Specification

	VIRYA-1	VIRYA-1.04	VIRYA-1.36
Diameter	D = 1 m	D = 1.04 m	D = 1.36 m
Number of blades	B = 2	B = 3	B = 2
Design tip speed ratio	λ_d = 4.25	λ_d = 3.5	λ_d = 5
Gear ratio	i = 1	i = 1	i = 1
Rotor eccentricity	e = 0.09 m	e = 0.09 m	e = 0.12 m
Height tower pipe	H = 1 m	H = 1 m	H = 2 m
Total tower height	H_{tot} = 3.7 m	H_{tot} = 3.7 m	H_{tot} = 4.7 m
Mass with tower pipe only	m = 5.55 kg	m = 4.85 kg	m = 13.6 kg
Starting wind speed	V_{start} = 2.5 m/s	V_{start} = 2.6 m/s	V_{start} = 2.4 m/s
Cut in wind speed (if started)	$V_{cut\ in}$ = 2.5 m/s	$V_{cut\ in}$ = 2 m/s	$V_{cut\ in}$ = 2.5 m/s
Rated wind speed	V_{rated} = 10 m/s	V_{rated} = 8 m/s	V_{rated} = 10 m/s
Survival wind speed	V_{surv} = 30 m/s	V_{surv} = 30 m/s	V_{surv} = 30 m/s
Nominal battery voltage	U = 12 V DC	U = 12 V DC	U = 12 V
Power at rated wind speed	P_{rated} = 35 W	P_{rated} = 6 W	P_{rated} = 80 W
Licence fee	Free	Free	Free

Drawings and manuals

The drawings of the VIRYA-1.04 and the VIRYA-1.36 are given in two separate free manuals. The drawings of the rotor and the generator of the VIRYA-1 are given in free report KD 574. Drawings for tools to camber and twist the blades of the VIRYA-1.04 are also given in the manual of the VIRYA-1.04. Manufacture of the blades of the VIRYA-1 and the VIRYA-1.36 can be done with similar tools which can be derived from the tools of the VIRYA-1.04 but these tools are not given.

All drawings are made on A3 format and then scaled down such that they could be scanned and incorporated in the manual. A set of drawings consists of a main assembly drawing and detailed drawings of all parts. A list with standard parts is given on the assembly drawing. In the manual several aspects are explained in detail including the safety system, manufacture of parts, mounting and installation.

Licence conditions

No licence is required for manufacture and sale of the VIRYA-1, the VIRYA-1.04 and the VIRYA-1.36 windmills so anyone is allowed to build and sell these windmills. It is advised to not deviate from the drawings. Although these windmills have been designed carefully, no responsibility is accepted for the operation of a mill neither as a whole, nor for any of its separate parts.