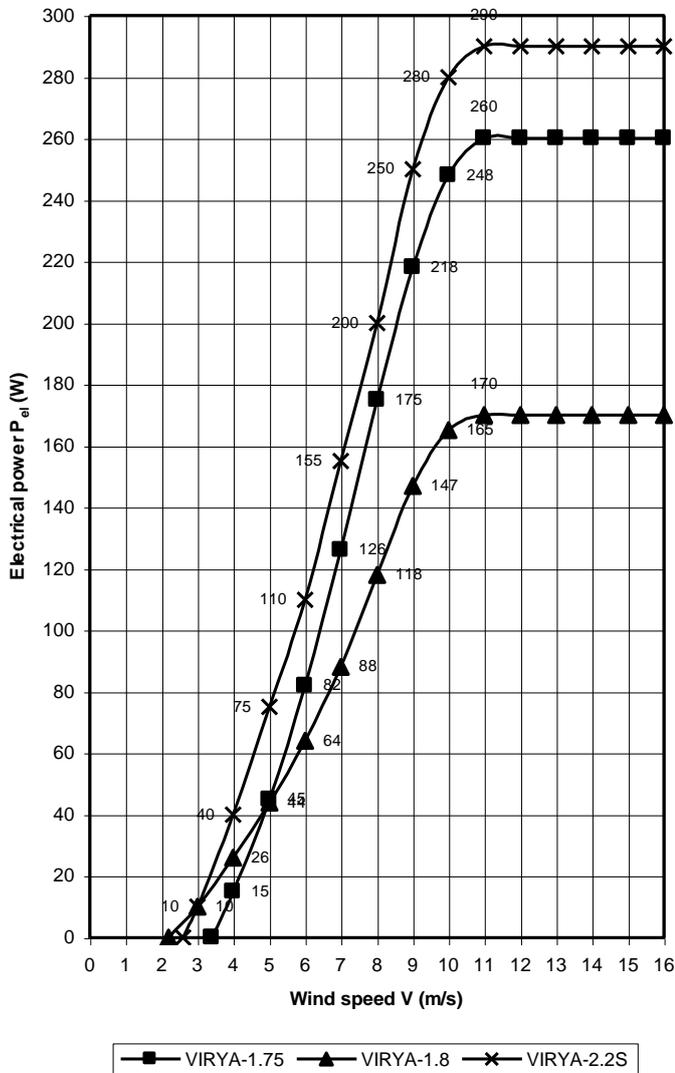


Licence for manufacture and sale of windmills
VIRYA-1.75, VIRYA-1.8 and VIRYA-2.2S
 January 2015

**P_{el} -V curves VIRYA-1.75,
 VIRYA-1.8 and VIRYA-2.2S windmills**



VIRYA-1.8



VIRYA-2.2S

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:

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Description of the windmills

The rotors of the VIRYA-1.75, the VIRYA-1.8 and the VIRYA-2.2 S windmills have three blades which are made from stainless steel sheet. The blades are bolted to a stainless steel hub plate. Each blade is curved and twisted. The three ears of the hub plate are also curved and twisted. Special tools are developed for curving and twisting so these rotors are very suited to serial manufacture. The blades of the VIRYA-1.75, the VIRYA-1.8 and the VIRYA-2.2S have the same chord and can be made with the same tools. The rotor hub, the head, the vane blade and the tower pipe are also made of stainless steel. The INA Permaglide head bearings are waterproof and the mills are entirely maintenance free.

These windmills have generators based on standard rotary current motors with a lengthened stator stamping. These motors are modified with a permanent magnet armature with neodymium magnets and a stainless steel shaft. The windmill rotor is mounted directly to the tapered shaft of the generator. The VIRYA-2.2S makes use of the standard 230/400 V winding for 24 V battery charging with delta rectification of the winding. The VIRYA-1.75 and the VIRYA-1.8 make use of a modified 115/200 V winding for 24 V battery charging. The winding is rectified in delta for the VIRYA-1.75 and in star for the VIRYA-1.8. Modification of the winding results in a higher power at high wind speeds but in a lower power at low wind speeds. The generator can be used as a brake by short-circuiting the generator winding. The VIRYA-1.8 and the VIRYA-2.2S generators have been tested on a test-rig at the University of Technology Eindhoven (see report KD 54 and KD 55). The batteries are protected against over-charging by a 27.6 V battery charge controller with dump load. The VIRYA-1.8 can also be used for 12 V battery charging if the winding is rectified in delta. In this case a 13.8 V battery charge controller is needed.

The mills 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 75° 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 consists of a 2 metre tubular upper section which can be connected to a supporting structure such as a wall of a house. If a supporting structure is not available a 6 metre non-guyed tubular lower section can be used for the VIRYA-1.8 and VIRYA-1.75 and a 6 metre non-guyed lattice lower section can be used for the VIRYA-2.2S. The tower of the VIRYA-2.2S is identical to the one of the 2-bladed VIRYA-2.68 windmill.

These windmills have the rectifier in the generator. The VIRYA-2.2S is provided with a swivel in the min-wiring to prevent cable twist. The VIRYA-1.8 and the VIRYA-2.2S have been tested for many years. The VIRYA-1.75 has not yet been tested. The tubular lower tower section of the VIRYA-1.75 and the VIRYA-1.8 has not yet been tested.

Although these mills are designed primarily for manufacture in industrialised countries, they can be manufactured by a good workshop in developing countries. However, a prerequisite is that one should be able to import some of the materials and standard parts. Kragten Design cannot supply materials and parts such as bearings, generators, magnets, electronics. The required workshop skills are sawing, drilling, turning, milling and welding. Galvanising is advised for the lower tower parts.

Specification

	VIRYA-1.75	VIRYA-1.8	VIRYA-2.2S
Diameter	D = 1.75 m	D = 1.8 m	D = 2.2 m
Number of blades	B = 3	B = 3	B = 3
Design tip speed ratio	$\lambda_d = 4.5$	$\lambda_d = 4$	$\lambda_d = 4.5$
Gear ratio	i = 1	i = 1	i = 1
Rotor eccentricity	e = 0.15 m	e = 0.15 m	e = 0.18 m
Height tower pipe	H = 2 m	H = 2 m	H = 2 m
Total tower height	H _{tot} = 7.8 m	H _{tot} = 7.8 m	H _{tot} = 7.5 m
Mass with tower pipe only	m = 26.6 kg	m = 27.2 kg	m = 40.5 kg
Mass with lower tower part	M = 106.4	m _{tot} = 107 kg	m _{tot} = 97.6 kg
Starting wind speed	V _{start} = 3 m/s	V _{start} = 3.1 m/s	V _{start} = 3.6 m/s
Cut in wind speed (if started)	V _{cut in} = 3.4 m/s	V _{cut in} = 2.4 m/s	V _{cut in} = 2.6 m/s
Rated wind speed	V _{rated} = 11 m/s	V _{rated} = 11 m/s	V _{rated} = 11 m/s
Survival wind speed	V _{surv} = 35 m/s	V _{surv} = 35 m/s	V _{surv} = 35 m/s
Nominal battery voltage	U = 24 V DC	U = 24 V DC	U = 24 V DC
Power at rated wind speed	P _{rated} = 260 W	P _{rated} = 190 W	P _{rated} = 290 W

Drawings and manuals

A set of drawings consists of a main assembly drawing of the whole mill, sub-assembly drawings of rotor, generator, head, tower, swivel and battery charge controller and detailed drawings of all parts. Also drawings of tools to curve and twist the blades and the hub plate are included. Lists of parts to be manufactured and of standard parts are also included. In the manual several aspects are explained in detail including the safety system, manufacture of parts, mounting and installation. The battery charge controller is described in a separate manual.

Licence conditions

A licence for manufacture of the VIRYA-1.75, the VIRYA-1.8 or the VIRYA-2.2S windmill is available only for professional manufacturers or trading companies. For licence conditions ask Kragten Design. The licensee will be informed of important modifications and can ask Kragten Design for support (at the normal hourly fee). Although the mills have been designed and tested carefully, no responsibility is accepted for the operation of a mill neither as a whole, nor for any of its separate parts.