



## Kragten Design

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*Specialized in designing small electricity  
generating windmills and PM-generators*

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### Development procedure of a range of wind turbines

In March 2005 I wrote the note: Development procedure of a windmill. In this note it is described how generally my VIRYA windmills were developed. Assume a western company wants to develop a range of modern direct drive wind turbines. The optimum procedure to do so will have many similarities with the procedure for the VIRYA windmills but will also differ at some points. In this new note I give the sequence of all the steps which I think are necessary to realise a high quality product.

- 1 Brainstorming about the optimum range of wind turbines. To my opinion the nominal power of the wind turbine has to double for every next turbine. So the range can be 0.25 kW, 0.5 kW, 1 kW, 2 kW, 4 kW, 8 kW, 16 kW, 32 kW and so on. As the power for a certain wind speed is proportional to the swept rotor area, the range in rotor diameters will increase about with a factor  $\sqrt{2}$ . However, if the bigger wind turbines have higher towers, the wind speed will be higher for larger rotors and this results in increase of the rotor diameter with a factor smaller than  $\sqrt{2}$ .
- 2 Choosing of the principles for rotor, generator, head, safety system, tower, foundation, storage of energy and electronics. To my opinion almost all principles must be identical for all wind turbines out of the chosen range. This simplifies calculations and scaling and it demonstrates that the company believes in its own choices. It is cheapest to first develop a prototype for the smallest wind turbine out of the chosen range.
- 3 Making of the calculations for the rotor geometry and strength.
- 4 Making of the calculations for the safety system and estimation of the characteristics.
- 5 Making of the calculations for the generator and the electronics
- 6 Making of the strength calculations for the tower.
- 7 Making of a composite drawing.
- 8 Making of detailed drawings for rotor, generator, head, tower and electronics.
- 9 Making of the assembly drawing and the parts lists.
- 10 Manufacture of the generator.
- 11 Testing of the generator and making of a measuring report.
- 12 Checking of the  $P_{el}$ -V curve using the measured generator curves and the estimated characteristics of the rotor and the safety system.
- 12 Development of tools for manufacture and installation.
- 13 Manufacture of a complete prototype and installation on a windy test site.
- 14 Testing of the prototype.
- 15 Modification of the design (if required) and modification of the prototype.
- 16 Long testing of the modified prototype for harsh conditions.
- 17 Making of a manual of the wind turbine and the electronics.
- 18 Making of a selling folder of the wind turbine.
- 19 Development of a production line for mass production.
- 20 Selling of the wind turbine or components of it, or selling of licences.
- 21 Developing of bigger wind turbines out of the chosen range.