Project RH2-WKA – Making Wind Energy a Steady Power Source

M. Weiße

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Project RH_2-WKA – Making Wind Energy a Steady Power Source

Martin Weiße, WIND-projekt Ingenieur- und Projektentwicklungsgesellschaft mbH, Boergerende, Germany

1 Summary

RH_2-WKA aims at the development and operation of a wind farm as an adjustable power plant. To attain that goal an energy storage system has to be integrated into the wind farm. The production, storage and power reconversion of the storage medium are regulated by demand. The storage cycle will enable the operator to store discontinuously available wind energy independently of time and - via the power reconversion unit - feed power back into the grid later at a constant rate. The project initiators, WIND-WASSERSTOFF-projekt GmbH & Co. KG (WiWa) and WIND-projekt Ingenieur- und Projektentwicklungsgesellschaft mbH (WIND-projekt), are sure that Wind-Hydrogen-Systems (WHS) will be one possible solution in this regard.

WiWa is responsible for the project management in RH_2-WKA and is going to operate the planned innovative energy park consisting of approximately 30 wind turbines and one hydrogen based energy storage unit. The project development is undertaken by WIND-projekt who also came up with the initial project idea and did the preliminary planning.

The project implementation area will be approx. 120 km north of Berlin in the federal state of Mecklenburg-Western Pomerania. The singularity of RH_2-WKA is defined by the interaction of the pure hydrogen-based (100 %) and CO_2-free energy system directly fed with electricity by a wind farm, its size and the integration of local energy consumers.

Similar projects which have been realized are for instance HyWindBalance (Germany) and Utsira (Norway). One thing they all have in common with each other is a power class in lower kW level.

Table 1: Advantages of RH_2-WKA at a glance.

Advantages of RH_2-WKA at a glance:
Technical ▪ self-supply of power for the wind turbines ▪ link between different energy branches ▪ hydrogen production unit as controllable system load ▪ optimized efficiency through multi-stage power reconversion unit
Commercial ▪ independence from energy resources that are subject to fluctuating prices and uncertain availability (e.g. biogas) ▪ preparation for the market of balancing energy

Environment protection and sustainability ▪ CO_2-free power storage circle on hydrogen basis ▪ CO_2-free hydrogen production ▪ sustainable, demand based and decentralized heat and power supply based on wind energy (CHP)
External effects ▪ long-term stable and predictable energy costs for local consumers ▪ creating new and qualified jobs ▪ strengthening the public acceptance of wind energy and hydrogen ▪ strengthening the domestic innovation basis by using new technologies and integrating manufacturers and service providers from Germany ▪ starting point for equalized wind power on decentralized level
Project planning ▪ advanced level of knowledge as basis for similar projects ▪ stepwise project implementation

2 Project Initiators

Project initiators of RH_2-Werder/Kessin/Altentreptow[1] (RH_2-WKA) are the WIND-WASSERSTOFF-projekt GmbH & Co. KG (WiWa) as well as the WIND-projekt Ingenieur- und Projektentwicklungsgesellschaft mbH (WIND-projekt). WiWa is responsible for the project management and is going to operate the planned innovative energy park consisting of approximately 30 wind turbines and one hydrogen based energy storage unit. The project development is undertaken by WIND-projekt who also came up with the initial project idea and did the preliminary planning.

WIND-projekt is an independent engineering company headquartered in Börgerende (county Bad Doberan/Federal State Mecklenburg-Western Pomerania). It deals exclusively with the planning, realization and operation of wind turbines and other regenerative energy systems as well as with the topic of energy storage. The company was founded in 1994. From the very beginning its aim has been the realization of an "affordable kilowatt hour" based on a clean power generation.

The company's success is reflected in the development of the already realized projects. Altogether more than 150 onshore wind turbines with an installed power of round about 200 MW were planned and built. In addition, WIND-projekt could successfully finish the planning for the offshore wind farms *Baltic I* (2006) and *Kriegersflak I* (2005) + *II* (2006) with approx. 230 wind turbines and a total capacity of around 1,000 MW. In 2006 the company initiated the installation of the first offshore wind turbine in the German Baltic Sea. For the latter WIND-projekt has been doing the technical operation management since then.

[1] RH_2® - *Renewable Hydrogen* as synonym for hydrogen made of renewable energies

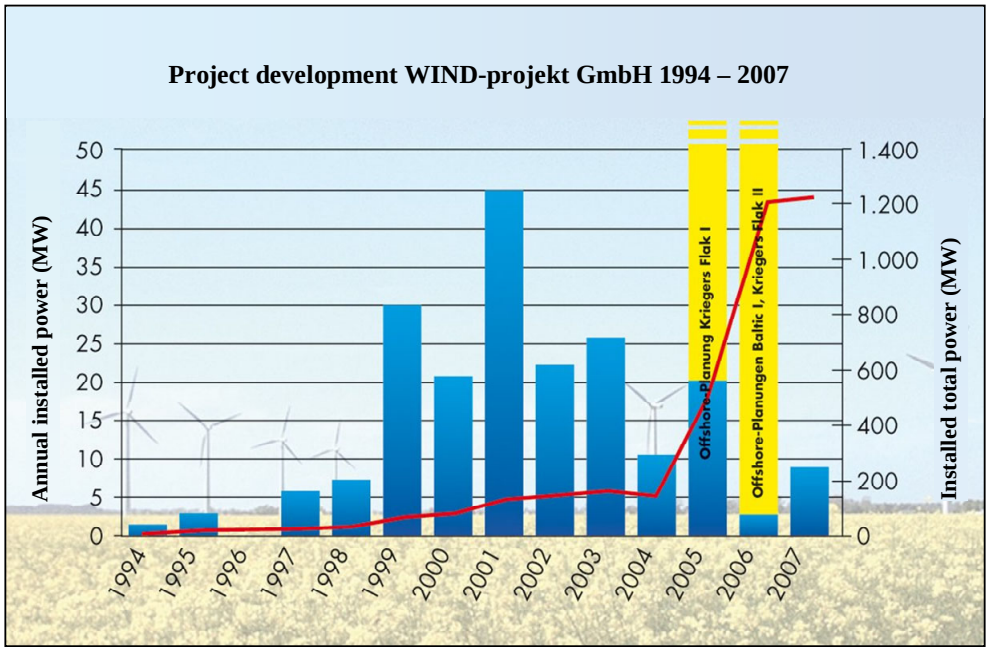

Figure 1: Project development WIND-projekt GmbH.

3 Problems to Solve

With increasingly powerful wind farms and the accompanying rising wind power feed-in into the power grid new challenges for operators and energy providers arise. Primarily these are:

- Balancing of fluctuating power production
- Integration of powerful (offshore) wind farms into the power grid
- Increasing requirements for grid management
- Bottlenecks in the power grid capacity
- Enlargement of energy storage capacities

Beside answers to the aforementioned problems the solutions must be affordable for the consumers on the one side and sustainable on the other side. The initiators are sure that Wind-Hydrogen-Systems (WHS) will be one possible solution.

4 Project Objectives

RH_2-WKA aims at the development and operation of a wind farm as an adjustable power plant. To attain that goal an energy storage system has to be integrated into the wind farm. The production, storage and reconversion of the storage medium are regulated by demand. The storage cycle will enable the operator to store discontinuously available wind energy independently of time and - via the power reconversion unit - feed power back into the grid later at a constant rate.

WiWa intends to develop, build and operate a practical and marketable solution that is free of CO_2. That's one of several reasons why the company decided to use hydrogen as energy carrier. The operation period is separated in different phases. In the first step the storage

system is going to be optimized and shall supply the power needs of the wind turbines themselves. That allows the operator to run a self-contained energy system in the sense that the wind farm is still power supplier to the grid but not consumer anymore. The main aim of the second step is the supply of local consumers with electricity, heat, hydrogen and oxygen. In addition, RH_2-WKA is used as preparation for similar projects or projects that aim to supply control energy from renewable sources (final stage of development).

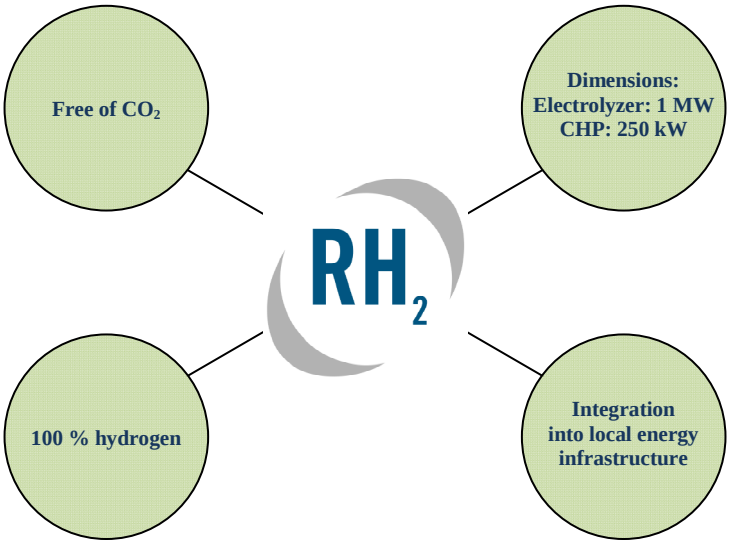

Figure 2: Singularity of RH_2-WKA.

The singularity of RH_2-WKA is defined by the interaction of the pure hydrogen-based (100 %) and CO_2-free energy system directly fed with electricity by a wind farm, its size and the integration of local energy consumers.

For economic and ecological reasons the use of the system's heat is planned (combined heat and power generation). Thus, the overall efficiency of the plant shall be maximized.

The first construction measures are planned for the 2nd quarter of 2011.

RH_2-WKA is going to be partly funded by the "National Innovation Programme for Hydrogen and Fuel Cell Technology" (NIP).

Table 2: Innovations created by the RH_2-WKA project.

Innovations created by the RH_2-WKA project:
▪ Development of an intelligent control software between wind turbines and H_2-storage circle ▪ Development of a modular hydrogen power reconversion unit in the 250 kW class ▪ Development of a measuring and control software for the entire hydrogen system ▪ Development of an energy storage system which produces no CO_2 ▪ Integration of a sustainable energy storage system into an already existing energy supply structure based on fossil energy sources ▪ Direct storage of wind power without using the power grid

5 Hydrogen-Storage-System RH_2-WKA

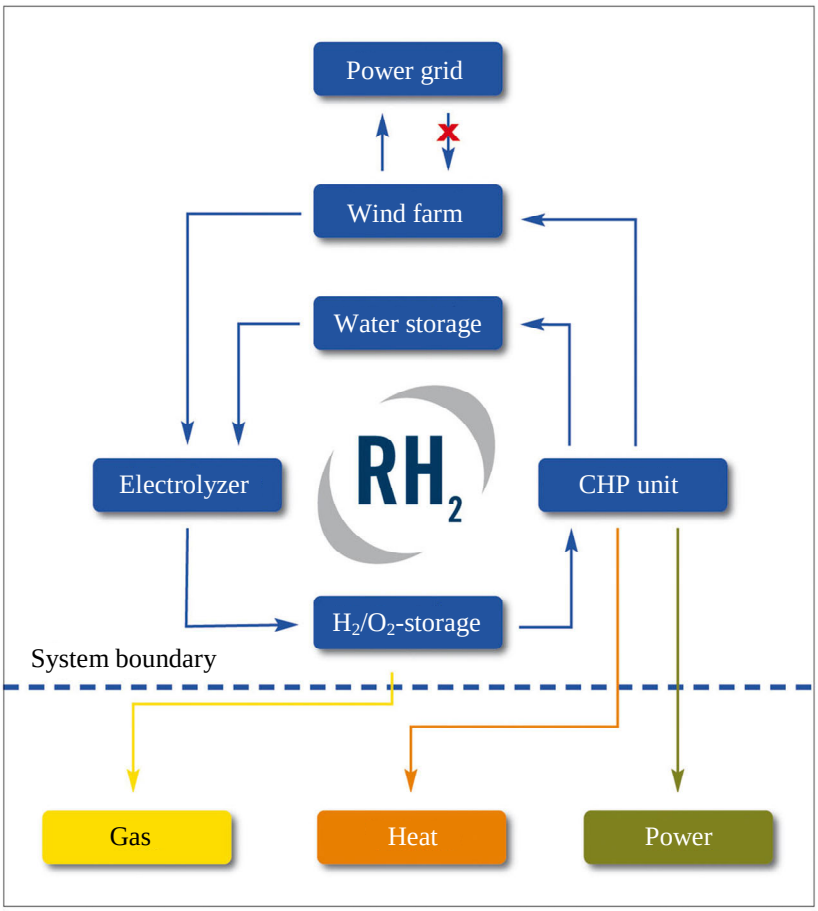

Figure 3: Drawing of the Wind-Hydrogen-System in RH_2-WKA.

The loop contains the production, compression, storage and power reconversion of pure hydrogen (purity 5.0). Oxygen (purity 2.5) is a by-product within the process and can be used internally or externally if needed. The final energy forms (after the reconversion of hydrogen) are electricity and heat (CHP). In addition, gaseous hydrogen can be taken out of the storage unit for external needs. It is planned to recycle the fumes of the CHP unit, which is mainly water vapour, to make it available again to the electrolysis (via water storage).

Table 3: Components of the hydrogen system.

Component	Capacity/size
Electrolyser	1.000 kW (ca. 200 Nm³/h)
Hydrogen compressor	300 bar
Hydrogen storage tanks	ca. 9.500 Nm³
CHP	250 kW_{el} (ca. 400 kW_{th})

6 Project Area RH_2-WKA

Figure 4: Project area of RH_2-WKA.

The project implementation area will be between the communities Altentreptow, Werder, Kessin and Grapzow, which are located approx. 120 km north of Berlin in the federal state of Mecklenburg-Western Pomerania. At this location WiWa plans the installation of a wind farm with a total installed capacity of up to 170 MW. A great deal of it is going to be provided by wind turbines with a rated power of 5 MW each and above. This fact allows the collection of important data regarding the control behaviour of powerful turbines in connection to an additive energy storage system at an early stage. This becomes increasingly important as the turbines in planned offshore wind farms are similar to those foreseen for the RH_2-WKA project.

Table 4: Advantages of the project location.

Advantages of project location:
▪ very good wind regime at coastal hinterland ▪ close to motorway A 20: - fast connection to Berlin, Hamburg, Isle of Rügen - easy and quick supply of potential H_2-fuelling stations possible - well suited transport route for wind and hydrogen components (e.g. multi-MW-class wind turbines and electrolyser) ▪ natural gas pipeline crosses area ▪ local consumers for power, heat and hydrogen available ▪ adequate space for extension available ▪ wind farm with offshore characteristics (total power, turbine power, spatial dimensions) ▪ direct connection to 380 kV-transmission grid

Contact

WIND-WASSERSTOFF-projekt GmbH & Co. KG
Seestraße 71 A
18211 Börgerende
Germany
Homepage: www.wiwa-projekt.de

General Manager:
Dipl.-Ing. C. Schmidt
Tel. +49 (0)38203-9126 0
Fax: +49 (0)38203-75313
e-mail: c.schmidt@wind-projekt.de

WIND-projekt Ingenieur- und Projektentwicklungsgesellschaft mbH
Seestraße 71 A
18211 Börgerende
Germany
Homepage: www.wind-projekt.de

Project Manager Hydrogen RH_2-WKA:
Dipl.-Geographer M. Weiße
Department for Hydrogen Technology
Tel. +49 (0)38203-9126 26
Fax: +49 (0)38203-75313
e-mail: m.weisse@wind-projekt.de

Project Manager Wind RH_2-WKA:
Dipl.-Ing. M. Heinicke
Department for Wind Energy
Tel. +49 (0)38203-9126 17
Fax: +49 (0)38203-75313
e-mail: m.heinicke@wind-projekt.de