

WIND POWER for the World

The Rise of Modern Wind Power Geschichte der modernen Windkraft

Preben Maegaard

Nordic Folkecenter for Renewable Energy

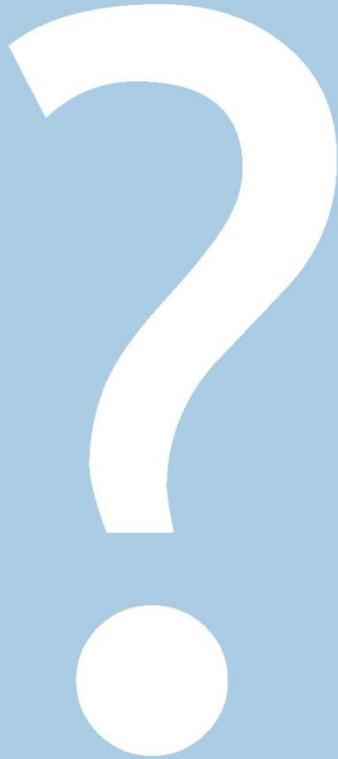
President Emeritus, World Wind Energy Ass. WWEA

Senior Vice President, EUROSOLAR

16. Internationale Solarkonferenz Mecklenburg-Vorpommern
Wietow, 5. August 2013

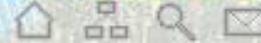


MODERN WIND TURBINE



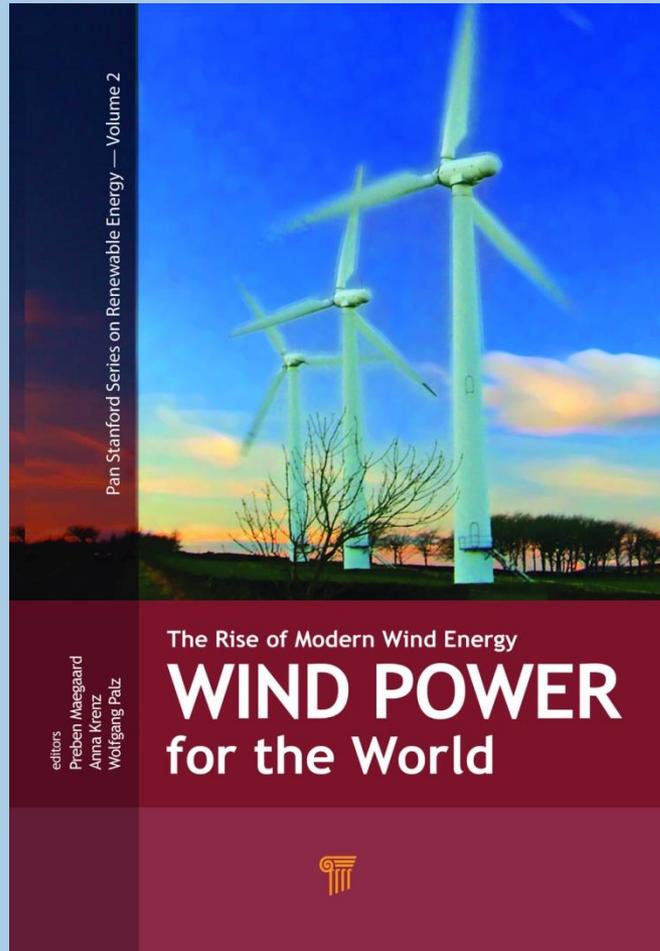
MODERN WIND TURBINE

How did it come into being?



WIND POWER for the WORLD

The Rise of Modern Wind Energy



edited by

Preben Maegaard, Anna Krenz

(Nordic Folkecenter for Renewable Energy, Denmark)

& Wolfgang Palz

(World Council for Renewable Energy)

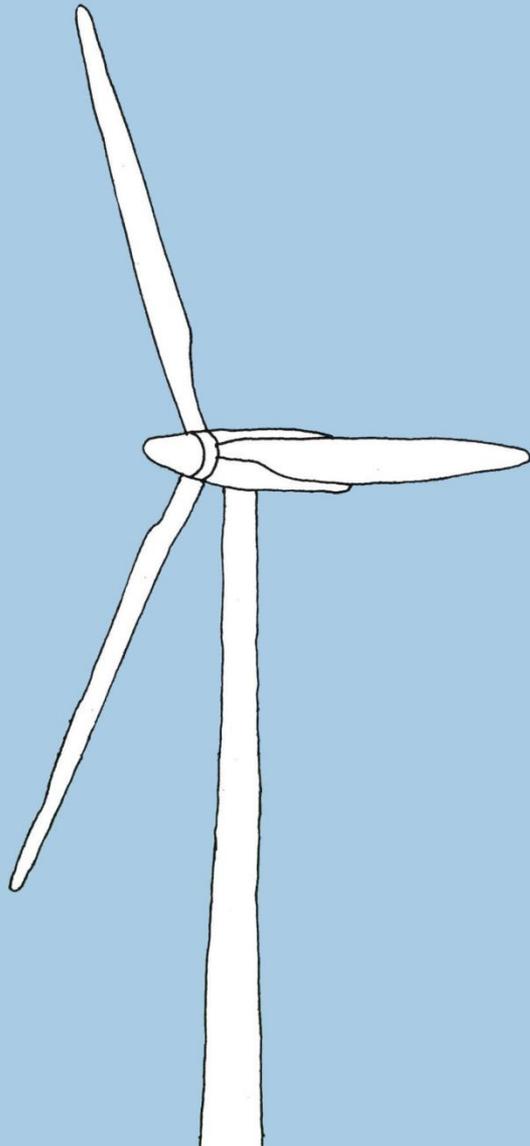
„Wind Power for the World tells an exciting tale of hope and promise - how a small band of activists, dreamers, and entrepreneurs built one of the world's fastest-growing and most dynamic industries. It is a must read for anyone wanting to understand how we got to where we are today.“

Paul Gipe, author of *Wind Energy Comes of Age*



Nordisk Folkecenter

for Vedvarende Energi



Most wind energy history writing relates to the important industrialisation that emerges in the early 1980s; but how the product, the modern 3-bladed wind turbine came into being, who, how and what in the proceeding period caused the success are fragments of a broad and often subtle process. We endeavour to put more light on that period in the first part of the book entitled **“The Rise of Modern Wind Energy”**.



Nordisk Folkecenter

for Vedvarende Energi

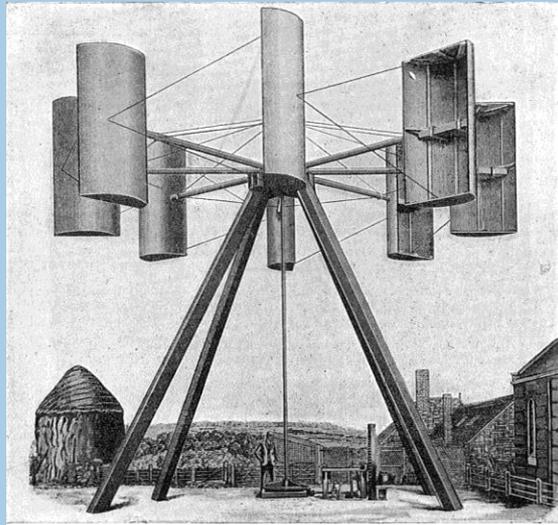
Denmark's pioneering role...

At the time of publication of this book we look almost 40 years back to find the roots of this exciting development. It is a long cavalcade of developers, inventors and manufacturers who each gave their bigger or smaller contributions to what took its beginning in 1975 and in the course of five to eight years, became a real modern industry. When recognised that the cradle of the modern wind turbine stood in Denmark and a bottom-up development was the solution it is the right time to get authentic stories told by the Danish authors who themselves often were part of the breakthrough.

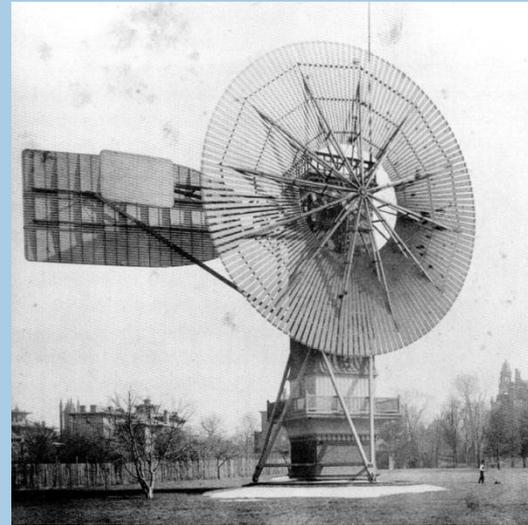


Wind power has been used since centuries. The first windmills were in use in Iran at least by the 9th century and possibly as early as the 7th century. The use of windmills became widespread across the Middle East and Central Asia, and later spread to China and India. Windmills were used extensively in Northwestern Europe to grind flour from the 1180s, and wind pumps were used to drain land for agriculture and for building.

Wind energy - mechanical power



July 1887: the Scottish academic, Professor James Blyth, built a cloth-sailed wind turbine in the garden of his holiday cottage in Marykirk and used the electricity it produced to charge accumulators for the lights in his cottage.



Winter 1887/88: US inventor Charles F. Brush produced electricity using a wind powered generator which powered his home and laboratory until about 1900.



1890s: the Danish scientist and inventor Poul la Cour constructed wind turbines to generate electricity, to produce hydrogen and oxygen by electrolysis and was stored for use as a fuel.

Wind energy - electrical power



La Cour was the first to discover that fast rotating wind turbines with fewer rotor blades were the most efficient in generating electricity.

Poul la Cour (1846 -1908)



Nordisk Folkecenter
for Vedvarende Energi



Johannes Juul (1887 -1969)



2-bladed wind turbine, Bogø



3-bladed Aeromotor, Fjerritslev

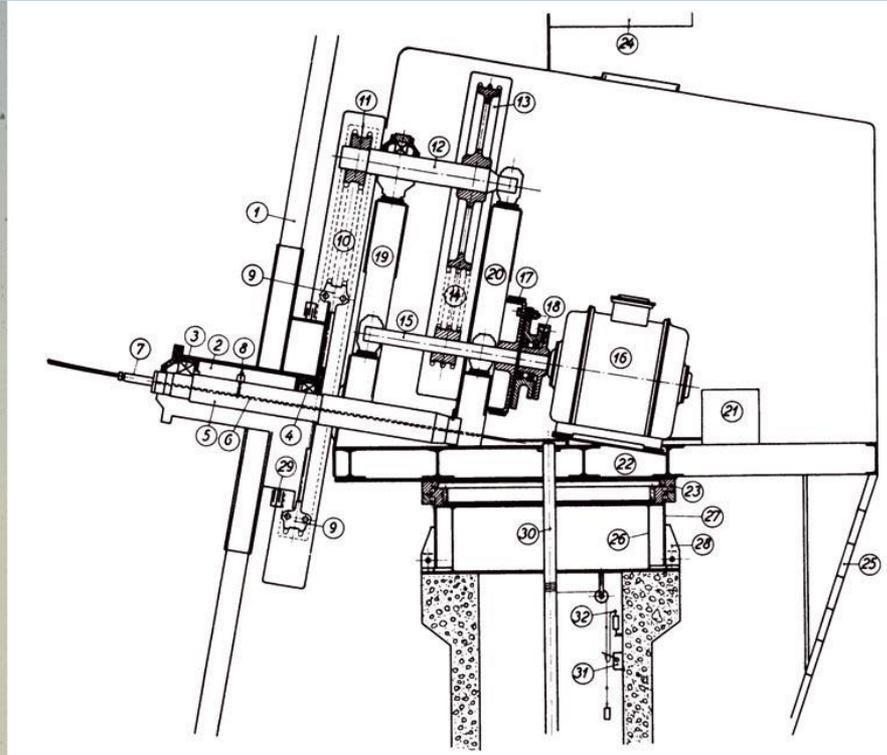
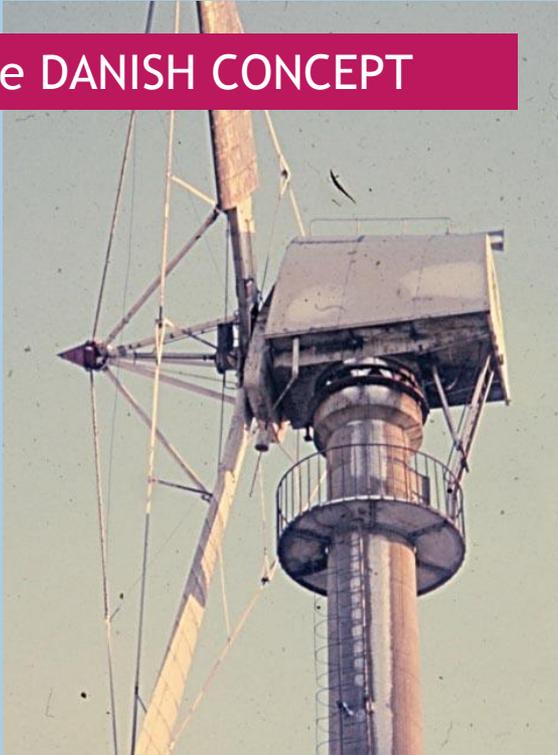


FLS Aeromotor, Gedser, 1943.

F. L. Smidth (FLS) Aeromotors



Towards the DANISH CONCEPT



In 1957 J. Juul erected a 200 kW wind turbine in Gedser. It was an up-scaled version of the 3-bladed Bogø wind turbine, but with a more advanced system of self-regulation. Features: 3 blades, stall-regulated, tip brakes, integrated gearbox, asynchronous generator, chain drive transmission, 25 m concrete tower.

The only large-scale modern wind turbine in the world that had worked steadily for 10 years and was a major technological breakthrough of modern wind power.

FLS Gedser wind turbine



Self-builders' wind turbines

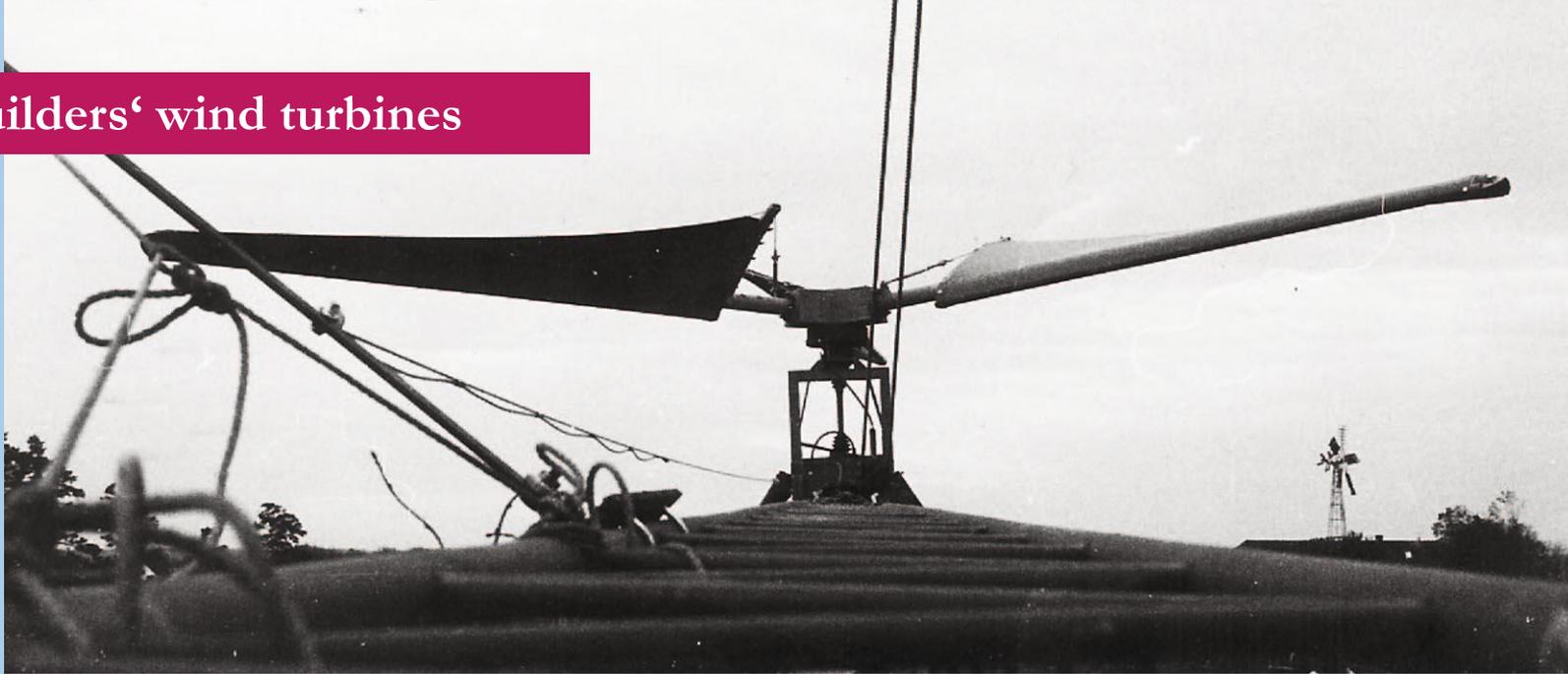
The modern wind turbine as we know it, was not developed overnight in a big industrial company – its birth and development was marked by hard work of many inventors, engineers, pioneers and amateurs.



In Denmark during the 10 year period between 1974 and 1984 a great number of enterprises and inventors emerged, who worked on many different versions and concepts of windmills.



Self-builders' wind turbines



Sailwing-mølle ved Flauenskjold, Vendsyssel 1978 (Foto udlånt af Flemming Hvidbak, Sulsted)



Poul Rykjær, Lendum - Jacob Overgaard, Thy - Arne Brogaard, Vittrup - Jens Erik Skourup, Vorbasse - Jørgen Andersen, Serritslev (Fotos: Flemming Hagensen og Benny Christensen, DVS)



Self-builders' wind turbines

This bottom up process is part of the one of the flourishing periods of innovation and dynamics that led to the foundations for a new Danish industrial sector, which soon acquired importance on the international scale.





Towards the DANISH CONCEPT



The first grid-connected wind-turbine in Denmark in the seventies was erected in 1975 by **Christian Riisager** at Skaebaek near Herning.

22 kW Riisager wind turbine

Christian Riisager (1930 - 2008)



The 2 MW Tvind
windmill, designed
and built by a
group of amateurs
and idealists from
the Tvind School.



TVIND Wind Turbine (1975-78)

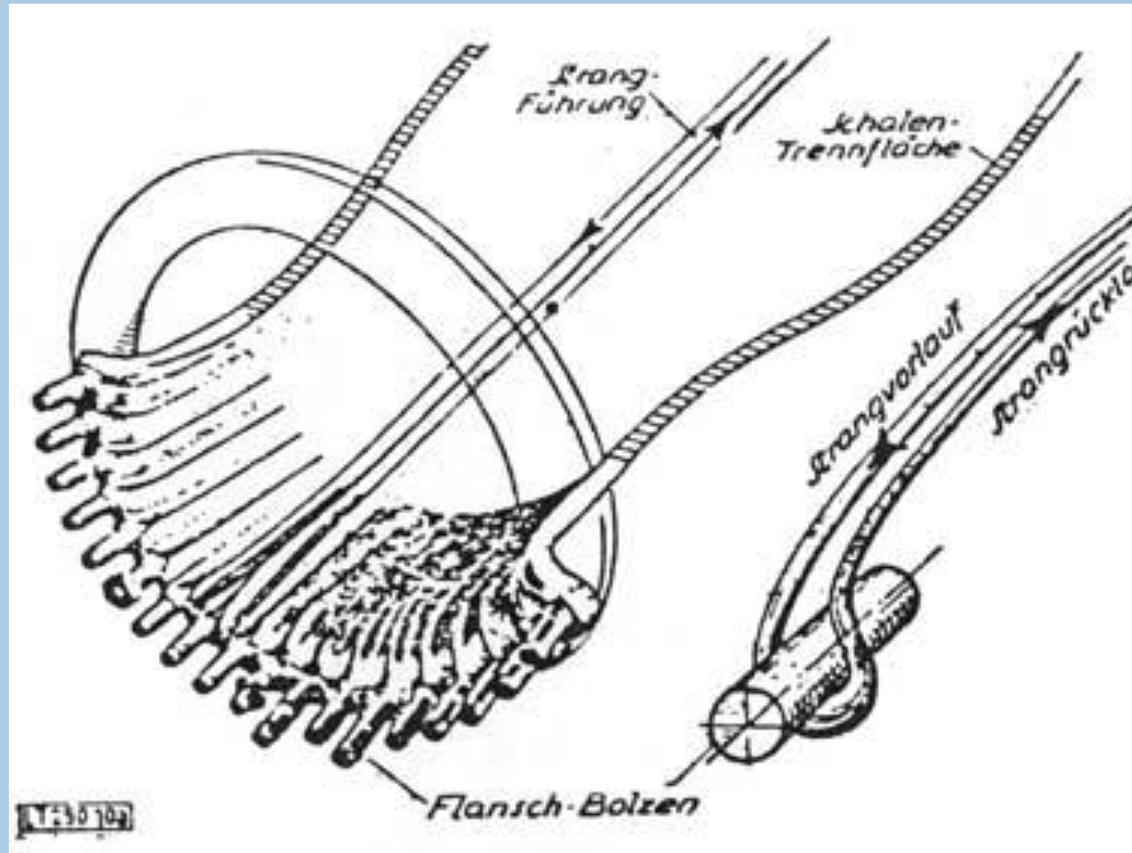
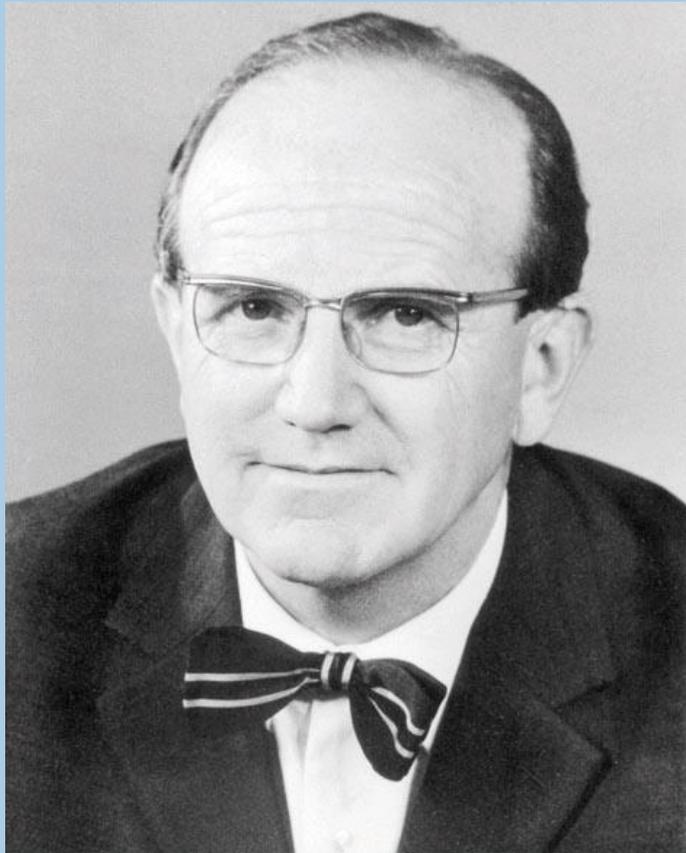


**After over 30 years
- still in operation.**



The last remaining TVIND
blade exhibited at the
Folkecenter

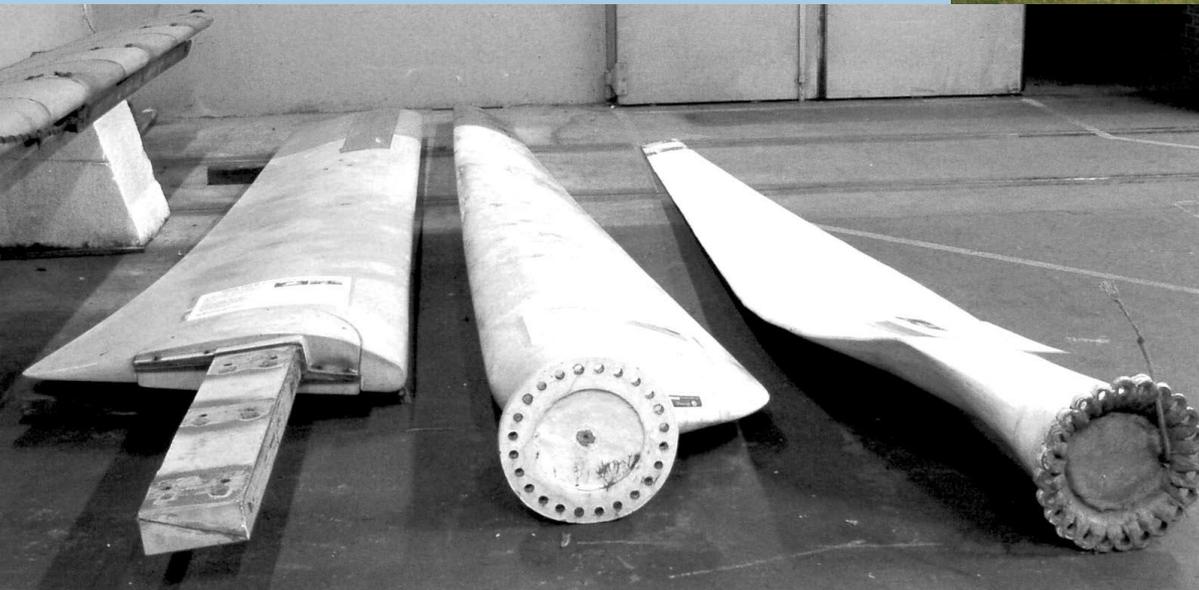
TVIND Wind Turbine (in 2013)



Ulrich W. Hütter (1910 - 1990)



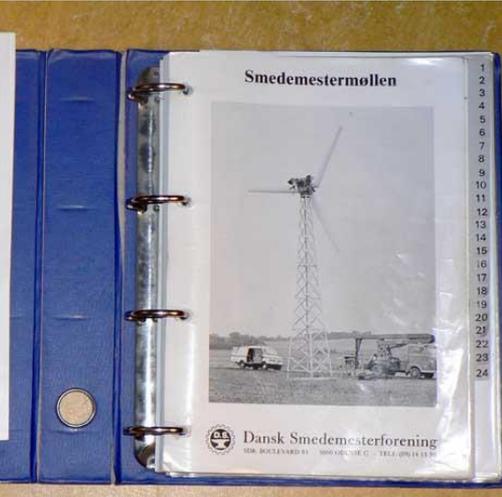
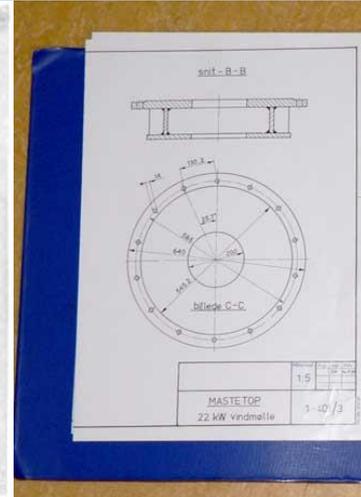
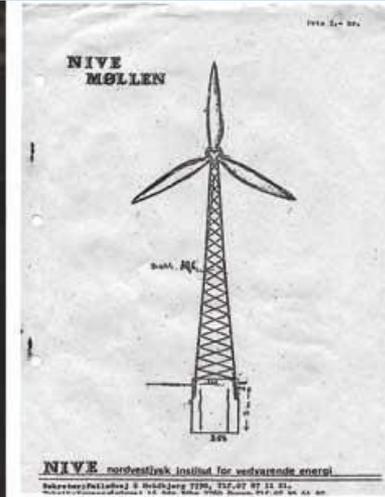
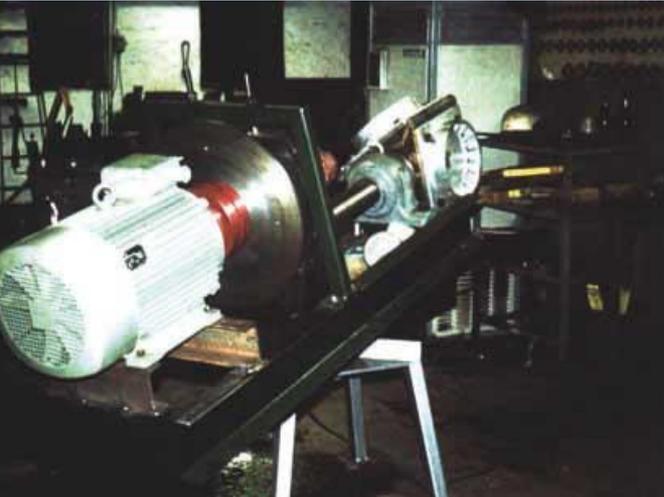
The newly founded Økær Vind Energi brought to the market Tvind's downscaled 4.5 m fibreglass blade, the basis of the emerging component wind turbine.





NIVE divided up a wind turbine's structure into four basic elements that were manageable items within the existing specialised industries.

Specifications were defined for modular wind turbine components (blades, controls) which lead to the emerging supply chain that enabled the Herborg blacksmith, members of the Danish Blacksmith's Association and other small enterprises to manufacture and assemble reliable and affordable 15 to 22 kW wind turbines.





Folkecenter for Renewable Energy



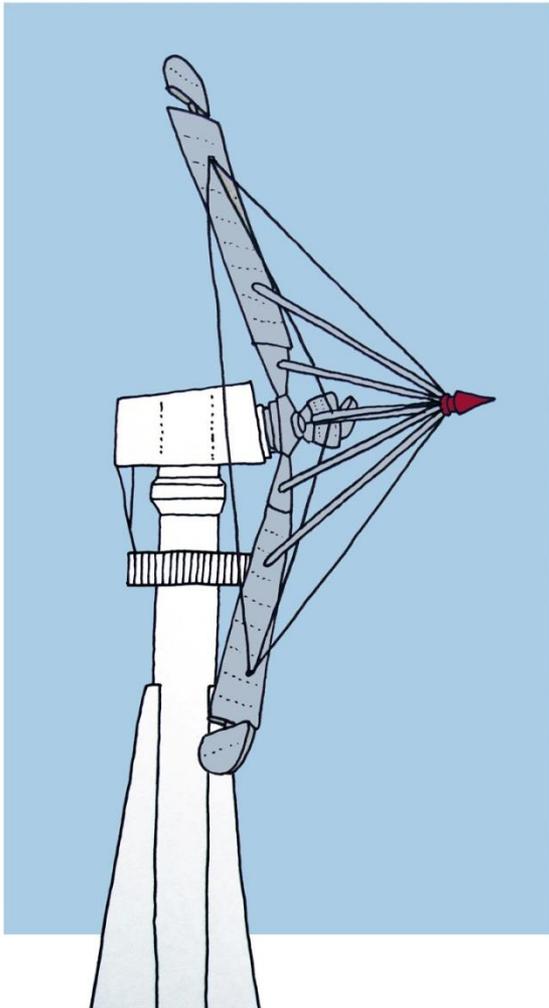
Two generations of gearboxes. To the left, FLS-type integrated gearbox from 1942 as used on the Bogø and the first Gedser windmill. The white gear to the right came from Tacke Getriebe in 1992. It is installed in Hanstholm, on the 525 kW windmill designed by Folkecenter and similar Tacke wind turbines.



Bendy Poulsen and Preben Maegaard with the prototype 22 kW made 1978 at H. Poulsen & Søn's workshop in Lyngs, using the technical counselling of NIVE.



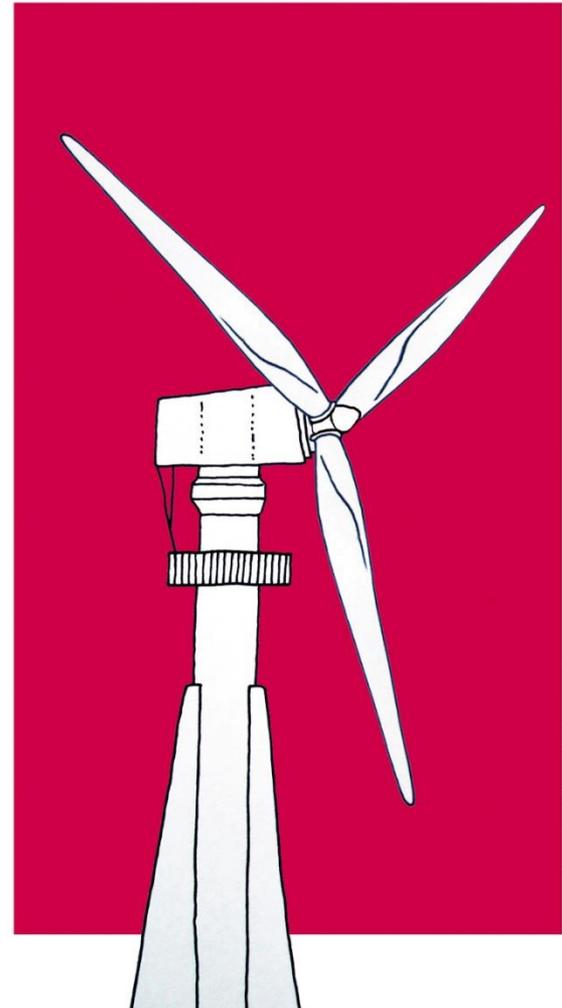
A hybrid of J. Juul's turbine with U. Hütter's blades is the **DANISH CONCEPT**



+

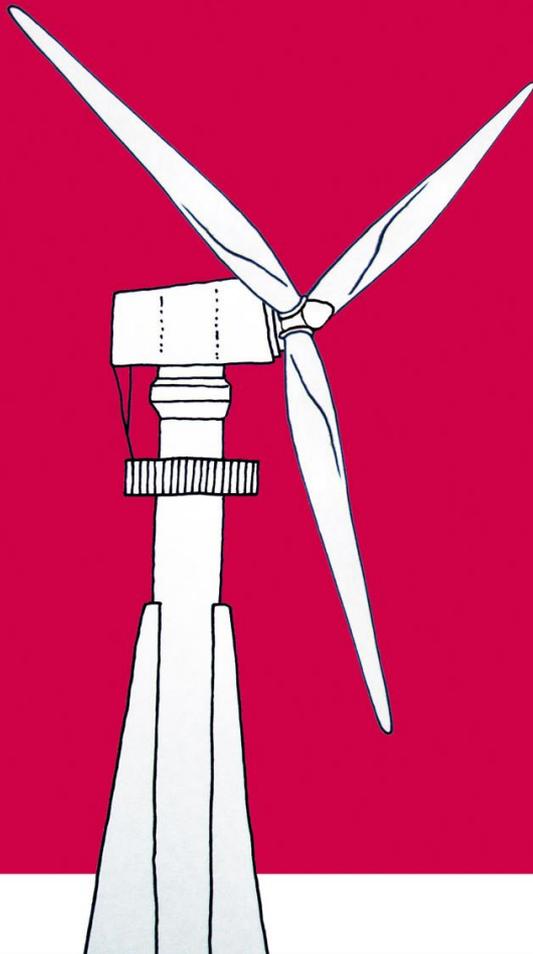


=





MODERN WIND TURBINE



Anna Krenz/NFC/2012

- Heavy
 - upwind
 - 3-bladed
 - asynchronous generator
 - stall-regulated
- +
Hütter/Tvind blade design
/ root system



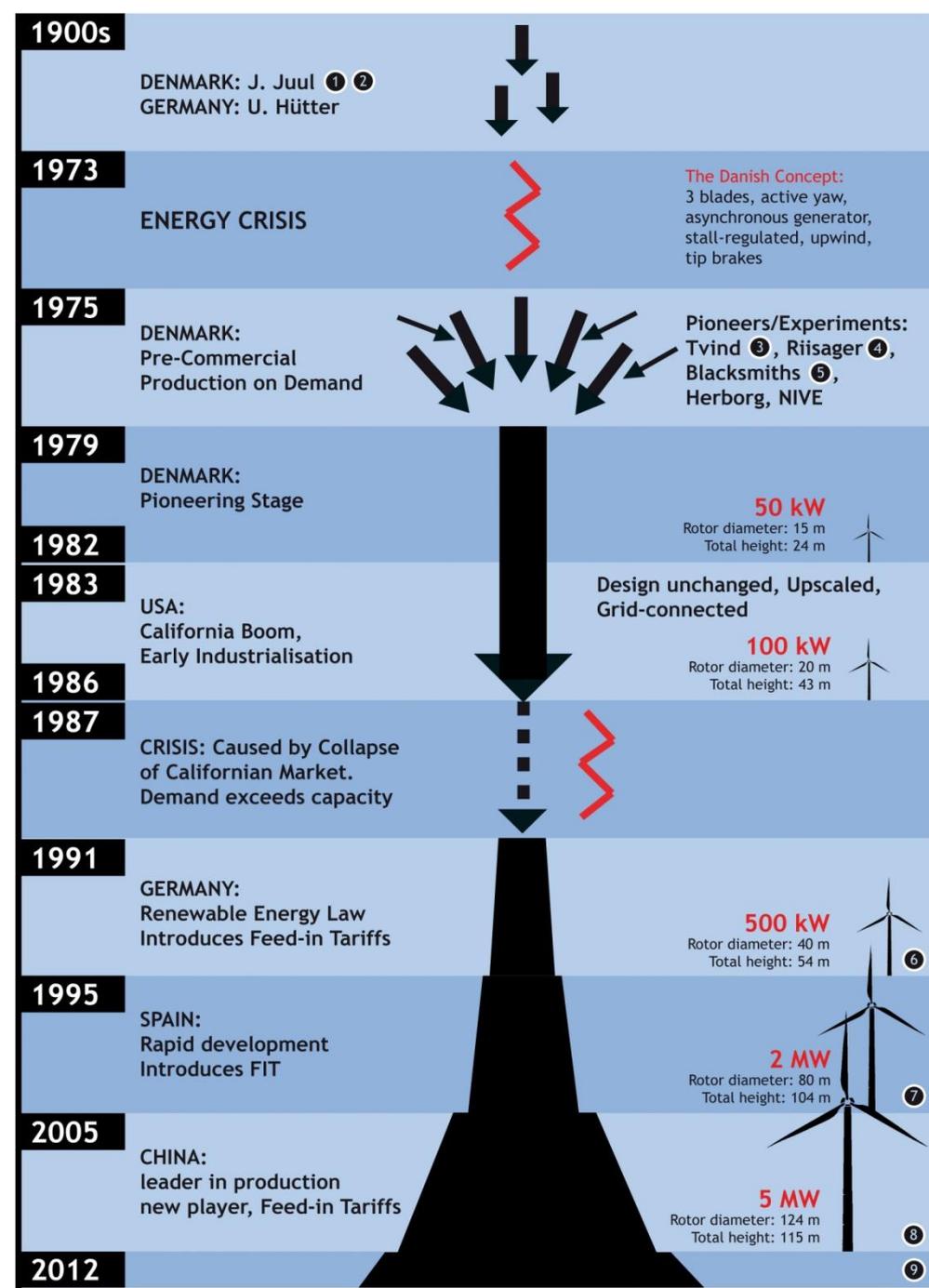
Nordisk Folkecenter

for Vedvarende Energi

This book describes how the combination of J. Juul's principles (heavy, up-wind, 3-bladed, asynchronous generator, stall regulated) with Ulrich Hütter's/Tvind's advanced blade fibreglass design and root assembly resulted in the winning wind turbine concept, called the **Danish Concept**.

This process took place 1975-79 when the later successful manufacturers Vestas, Nordtank, Bonus etc., commercialised the concept. During the Californian wind rush from 1983 small workshops became regular factories with series production. The leading companies step by step scaled-up the concept and took it to the world market that they dominated for the succeeding 15 years. When other countries like Germany, Spain and later China, got into commercial wind turbine manufacturing their designs were J. Juul-Hütter hybrids that had become the industrial standard. Some manufacturers changed to synchronous generator, however, within the same basic concept.

A few countries took leadership in the proliferation of contemporary wind power. We, the lead authors of the book, decided to make special focus on the three of them: **Denmark** with its absolute dominance from 1975 and the following 15 years; with progressive legislation **Germany** demonstrated that political visions and will, more than good wind resources soon made Europe's largest economy the champion of wind energy; and finally **China**, that in 2005 from almost zero with a concentrated effort entered the arena and just five years later could celebrate its role as the global No. 1 both in terms of installed and manufacturing capacity. A Chinese proverb says that even on the longest march the first step has to be taken. China has shown a direction. There are many other countries that still need to stop hesitating.





Nordisk Folkecenter

for Vedvarende Energi



1

60kW FLS Aeromotor/1941



2

200kW Gedser/1957



3

2MW Tvind/1978



4

22kW Riisager/1970s



5

22kW Blacksmiths/NIVE/1970s



6

525kW Hanstholm/1992



7

V90-2MW Vestas



8

D1 5MW REpower/2004



9

SWT-6MW Siemens/2012



The development of modern wind turbine



Nordisk Folkecenter
for Vedvarende Energi



Successful Danish manufacturers like Vestas, Nordtank, Bonus (Siemens) etc., commercialised the Danish Concept.

DENMARK





CALIFORNIA, USA



Californian Wind Rush

During the 1980s, wind industry in the USA, the biggest economy of the world, passed through a rapid rise and fall with later ups and downs.



GERMANY

The German progressive legislation (Renewable Energy Law) and innovative Feed-in Tariffs demonstrated that political visions and will, can make Europe's largest economy the champion of wind energy.



Preben Maegaard & Hermann Scheer



CHINA

Rapid growth of wind power in China...

In 2005, China in search for additional electricity production capacity and with an eye for a new industrial growth sector also joined the wind energy frontrunners. By opening the door for the best available technology the biggest nation in the world intentionally avoided mistakes that delayed the industrialisation in most other countries. Soon China got its own complete supply chain and more than fifty MW-size suppliers of wind turbines. During a five years period and a concerted effort a completely new industry emerged that made China the absolute leader both in terms of manufacturing and installed wind power capacity.



Wind power in the PRC

	2005	2006	2007	2008	2009	2010	2011
Capacity (MW)	1,260	2,599	5,912	12,170	25,100	41,800	62,000
Production (GWh)	1,927	3,675	5,425	12,425	25,000	44,622	73,200

As part of the environmental goals included in China's 12th Five Year Plan (2011-2015) targets have been set for non-fossil energy to account for 11.4% of the total energy consumption, and for CO₂ discharge per unit of GDP to reduce by 17%.

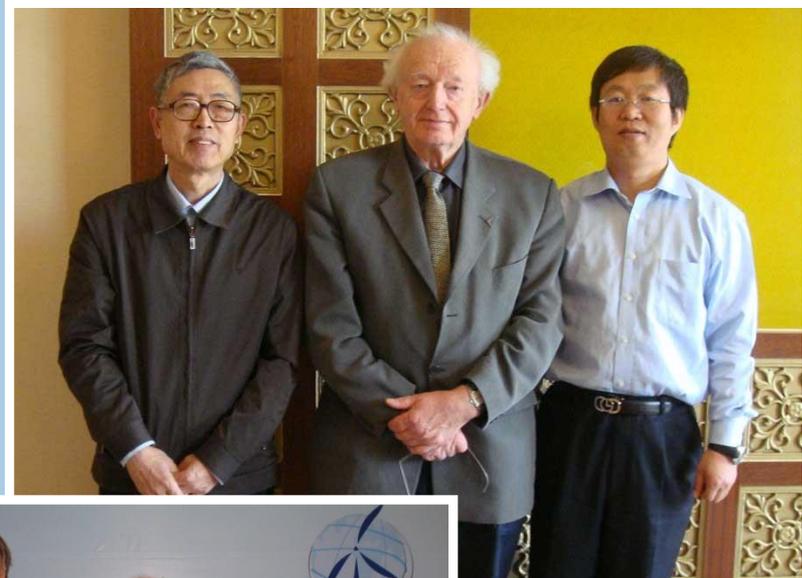


Nordisk Folkecenter
for Vedvarende Energi



... triggered by WWEA

CHINA



World Wind Energy Conference & Exhibition (WWEC), Beijing, China, 2004



Ross Jackson
H.J.M. (Jos) Beurskens
Benny Christensen
Povl-Otto Nissen
Katherine Dykes
Niels I. Meyer
Preben Maegaard
Erik Grove-Nielsen
Henrik Stiesdal
Egon Kristensen
Flemming Østergaard
Bent Gregersen
Jørgen Krogsgaard
Jens H. Larsen

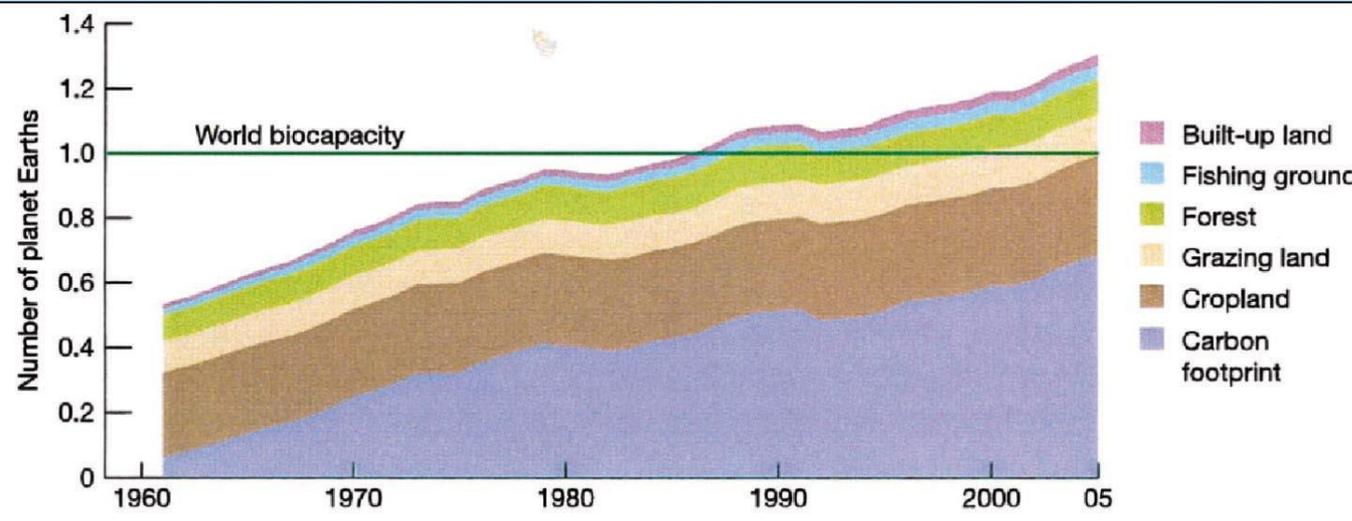
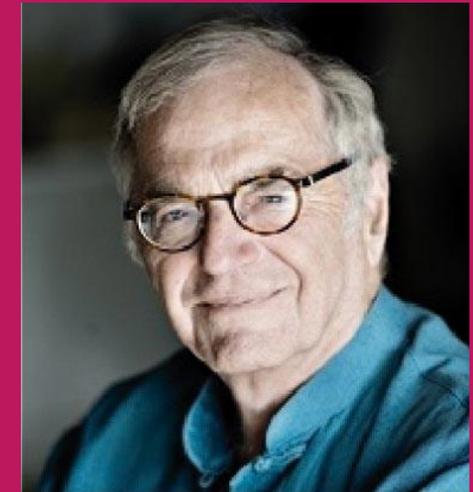
Jane Kruse
Bernward Janzing, Jan Oelker
Arne Jaeger
Friderich Klinger
Jürgen Sachau
Ulrich Jochimsen
Brigitte Schmidt
Arne Jaeger
James Manwell
Steven B. Smiley & Susan J. Kopka
Igor Avkshtol
Qin Haiyan
Zhou Jianxiong

Contributors



„The Wind Power Story“

by Ross Jackson





„Forty Years of Wind Energy Development“

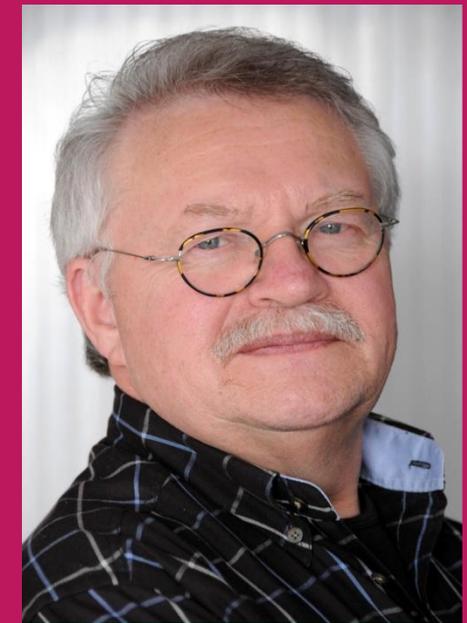
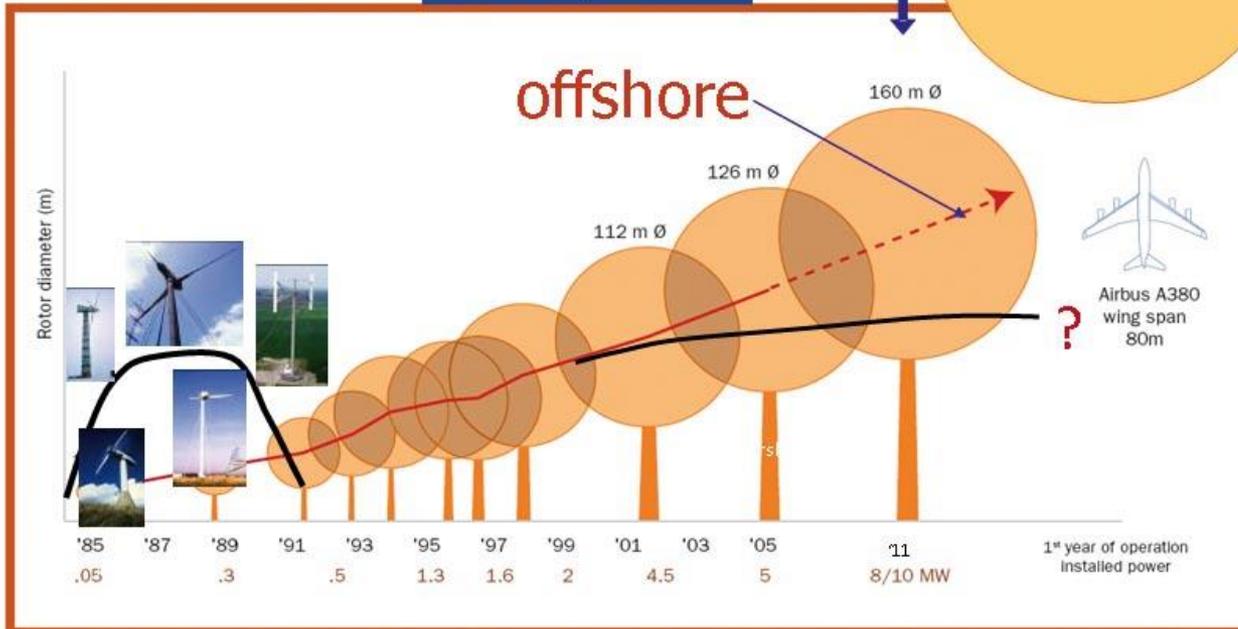
by Jos Beurskens

Up scaling

- Vestas 164 m/7 MW pm-dd
- Nordex 150 m/6 MW pm-dd
- Bard 122 m/6.5 MW pm
- Alstom 150 m/6 MW pm-dd
- NPS 175m/8 MW

2011

200 m
UpWind study (2011)





Nordisk Folkecenter
for Vedvarende Energi



„History of Danish Wind Power“

by Benny Christensen



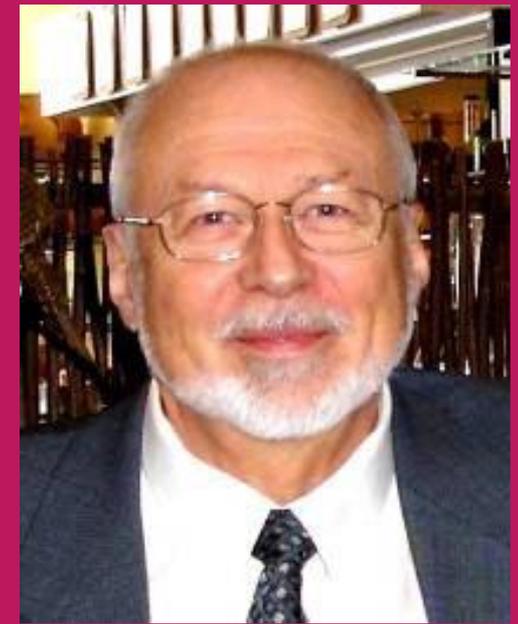


Nordisk Folkecenter
for Vedvarende Energi



„The Aerodynamic Research on Windmill Sails of Poul la Cour, 1896-1900“

by Povl-Otto Nissen



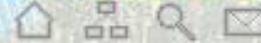
„Networks of Wind Energy Enthusiasts and the Development of the “Danish Concept“

by Katherine Dykes



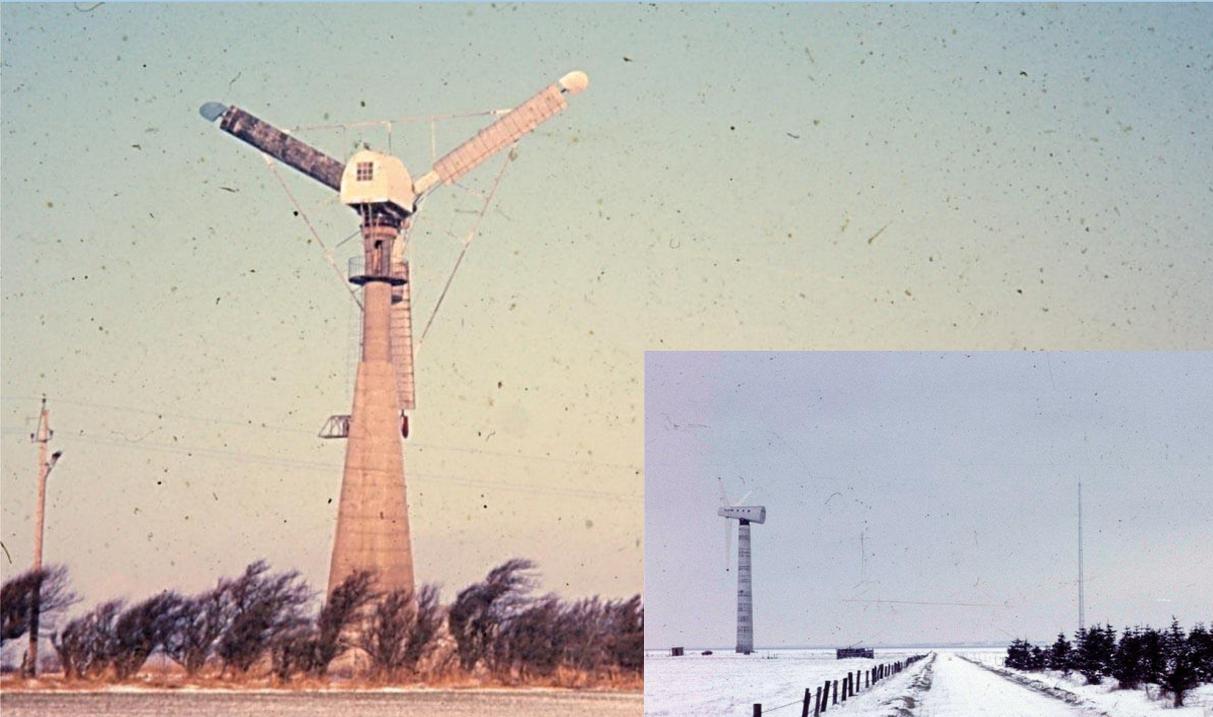


Nordisk Folkecenter
for Vedvarende Energi



„Danish Pioneering of Modern Wind Power“

by Niels I. Meyer

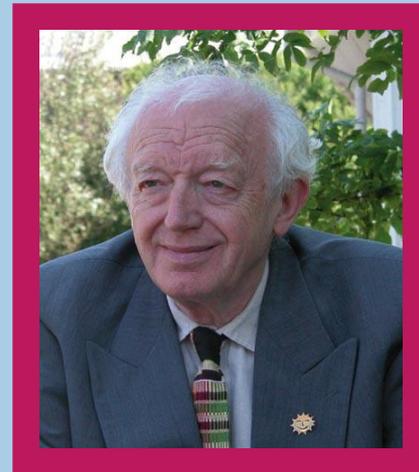
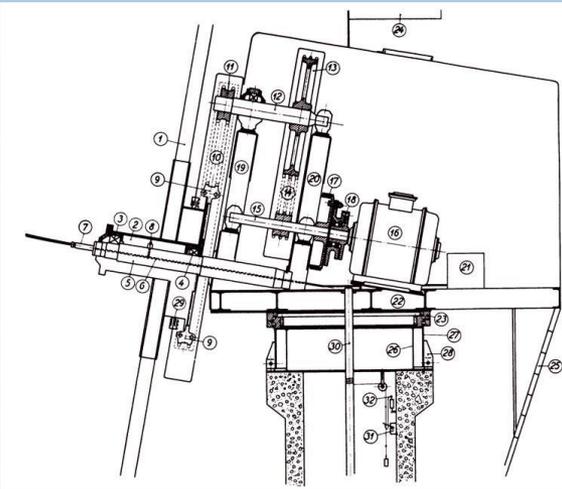
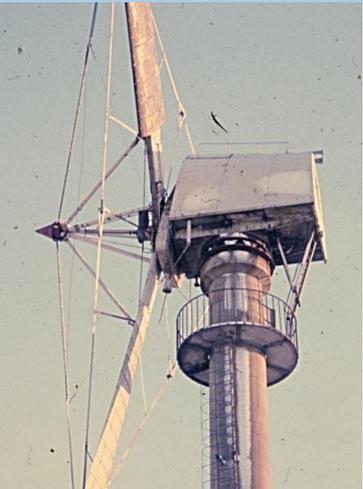




Nordisk Folkecenter
for Vedvarende Energi

„From Energy Crisis to Industrial Adventure – a Chronicle“

by Preben Maegaard





Nordisk Folkecenter

for Vedvarende Energi

„Økær Vind Energi - Standard Blades for the Early Wind Industry“

by Erik Grove-Nielsen



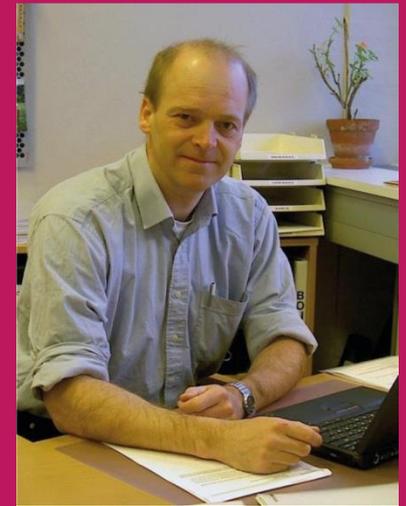
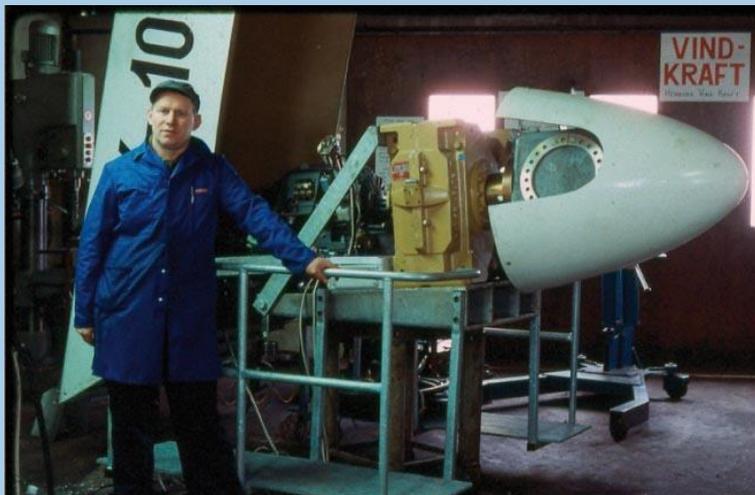
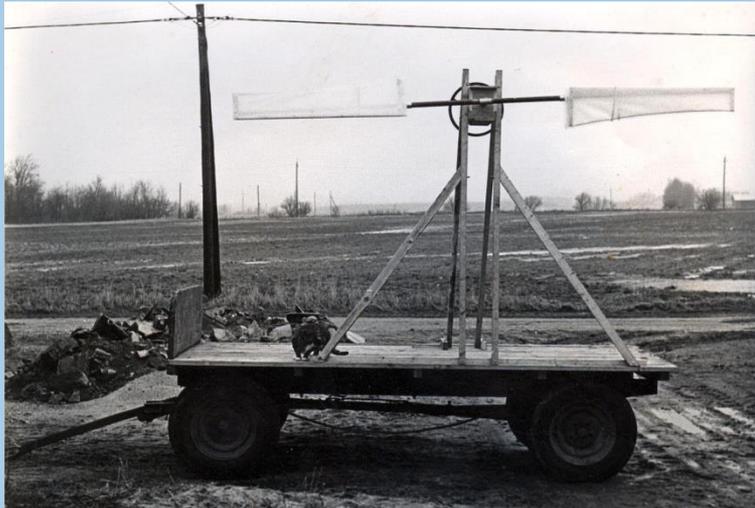


Nordisk Folkecenter
for Vedvarende Energi



„From Herborg Blacksmith to Vestas“

by Henrik Stiesdal

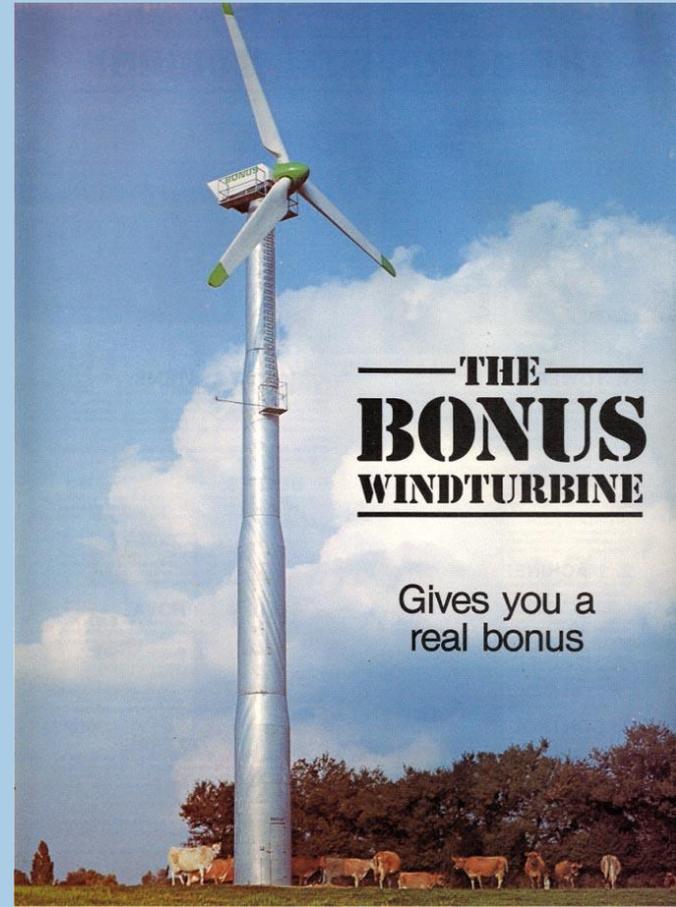
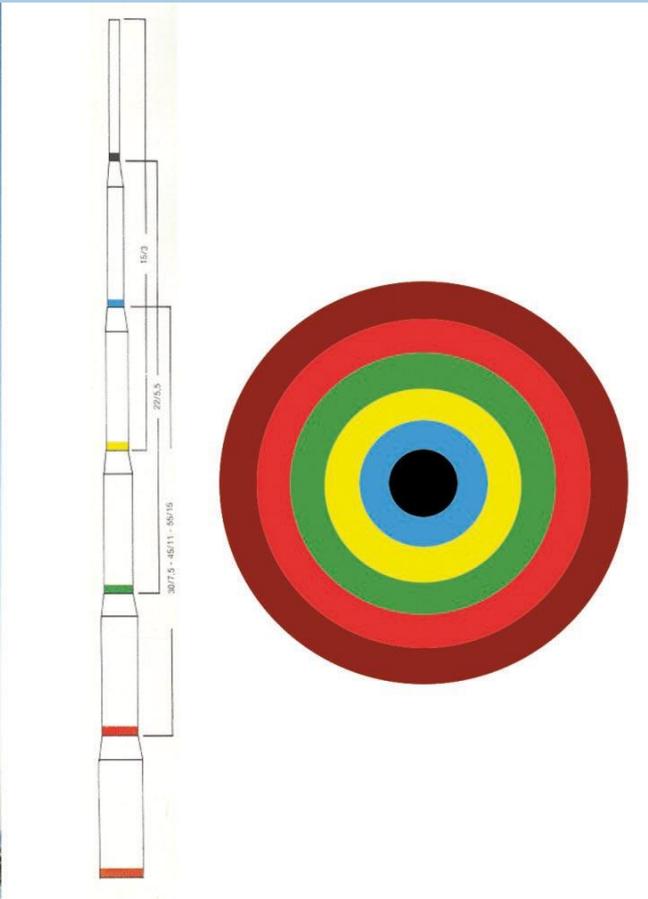
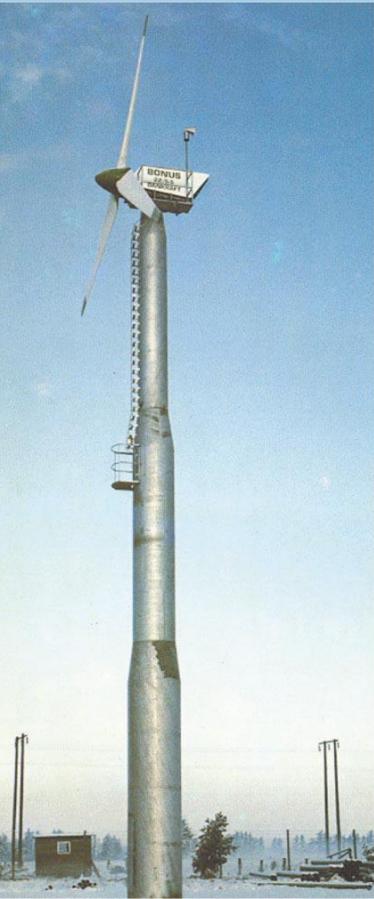




Nordisk Folkecenter
for Vedvarende Energi

„From Danregn to Bonus“

by Egon Kristensen



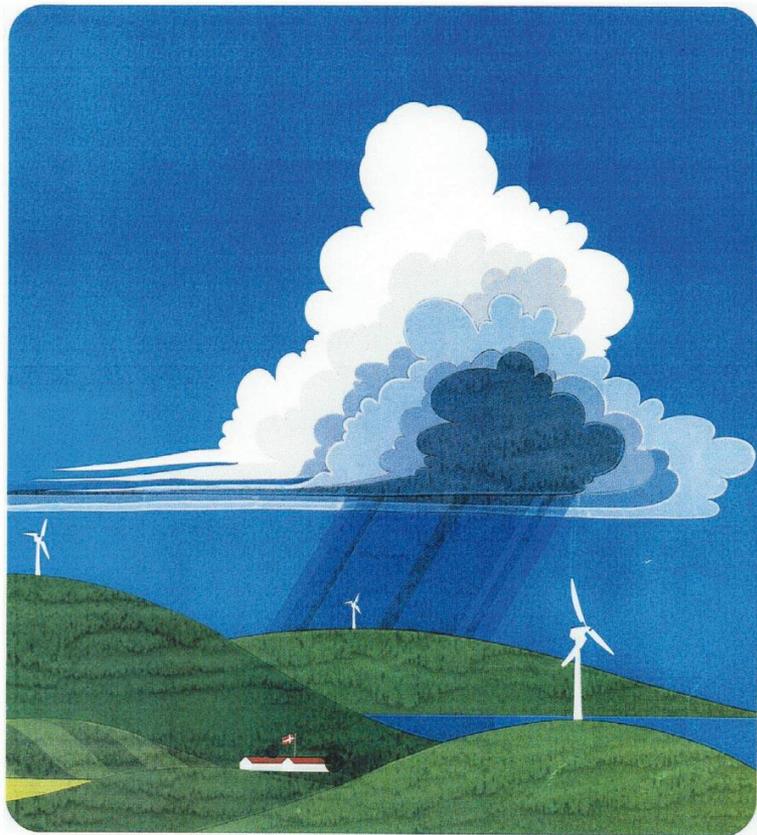


Nordisk Folkecenter

for Vedvarende Energi

„Vind-Syssel 1985-1990“

by Flemming Østergaard



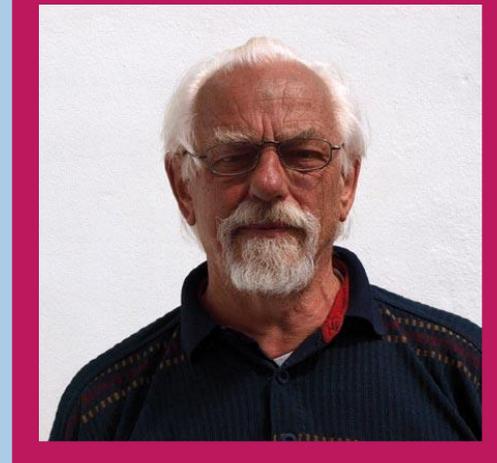
Vind-Syssel
a.m.b.a.





„The Story of Dencon“

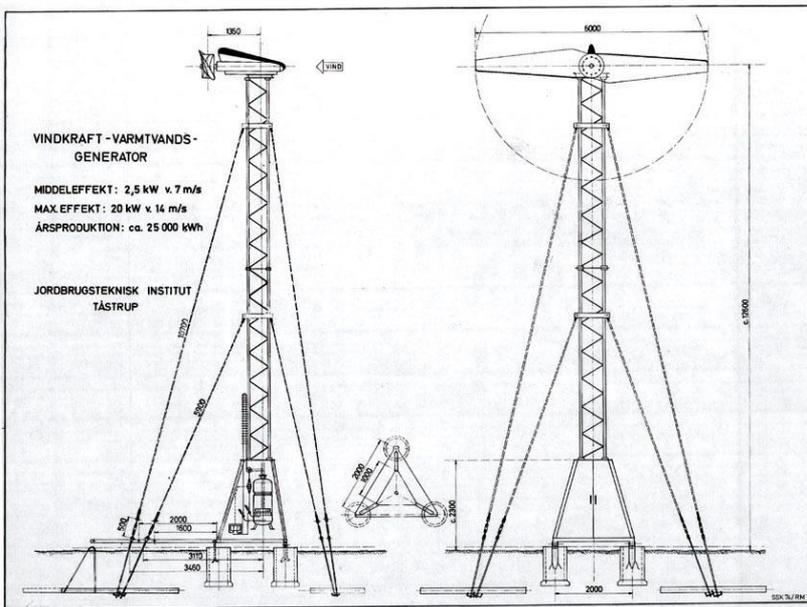
by Bent Gregersen





„Water Brake Windmills“

by Jørgen Krogsgaard





„Cooperative Energy Movement in Copenhagen“

by Jens Larsen





Nordisk Folkecenter
for Vedvarende Energi

„The Danish Small Wind Power“

by Jane Kruse

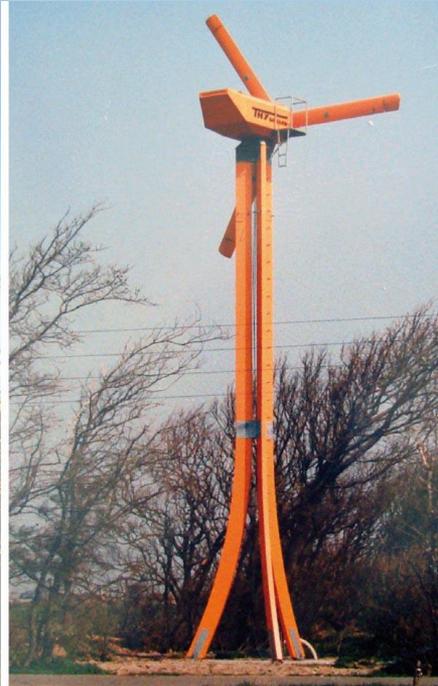
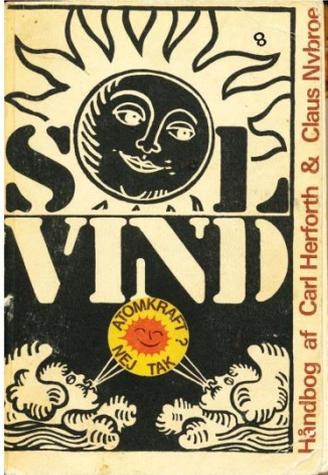




Nordisk Folkecenter
for Vedvarende Energi

„Consigned to Oblivion“

by Preben Maegaard

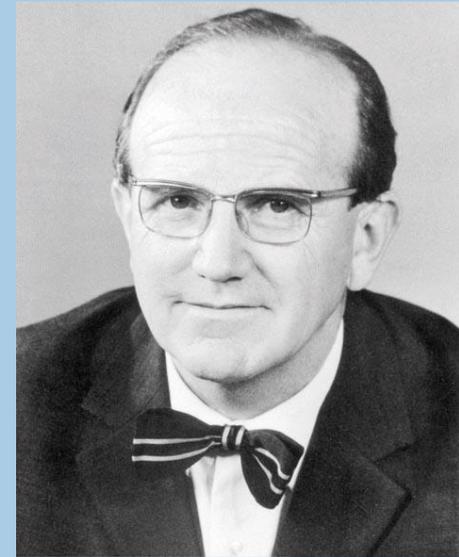




Nordisk Folkecenter
for Vedvarende Energi

„Hütter’s Heritage – The Stuttgart School“

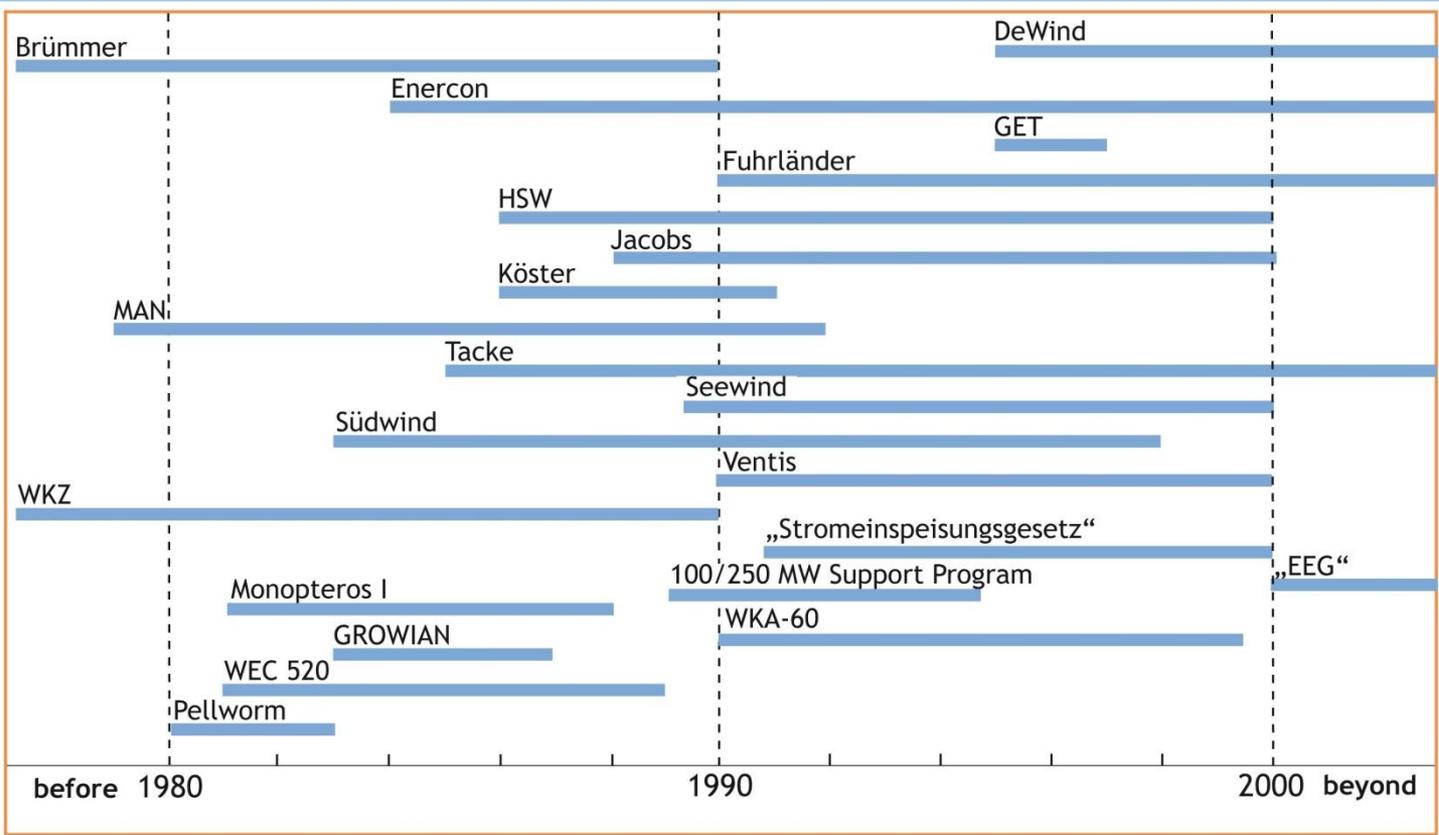
by Bernward Janzing & Jan Oelker





„Overview of German Wind Industry Roots“

by Arne Jaeger



before 1980

1990

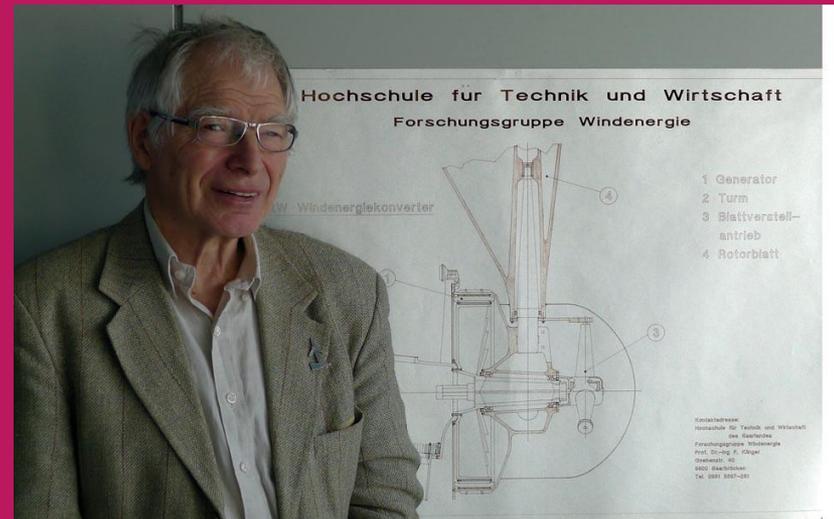
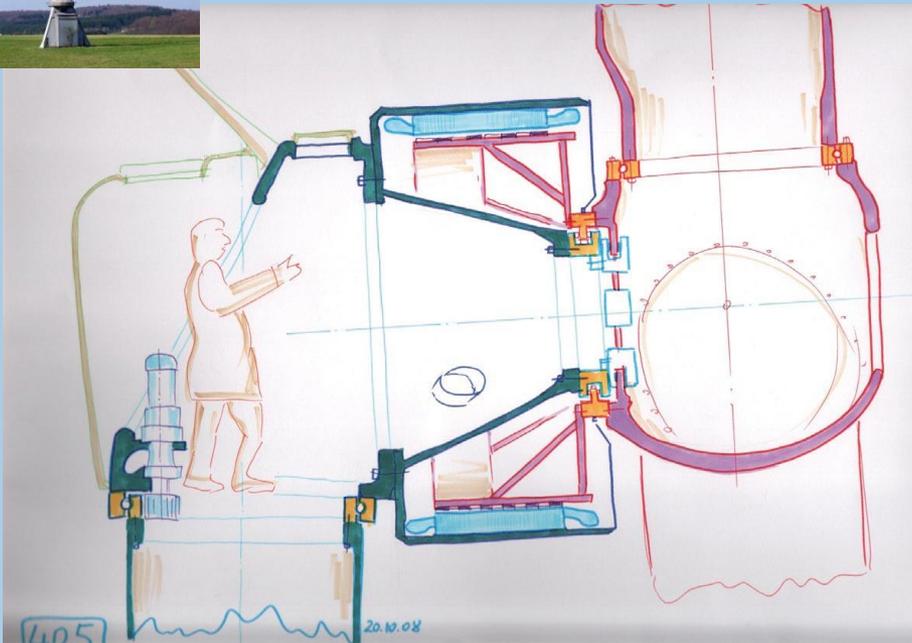
2000 beyond



Nordisk Folkecenter
for Vedvarende Energi

„Direct Drive Wind Turbines“

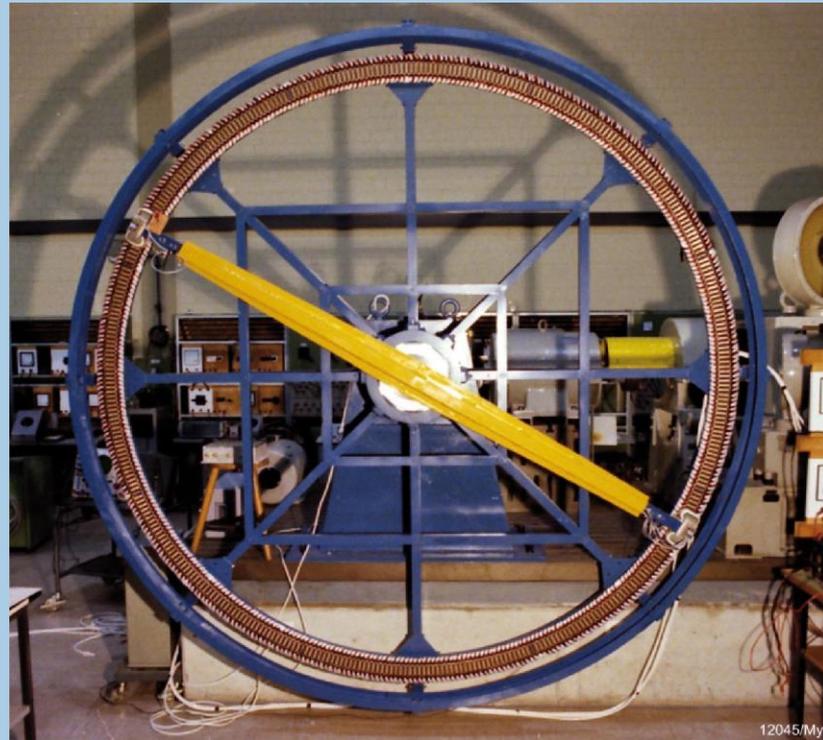
by Friedrich Klinger





„How the Early 1980s Micro- and Power-Electronics Innovation in Germany Revolutionised Wind Energy Systems“

by Jürgen Sachau





„How the Electricity Feed-In Law (Stromeinspeisungsgesetz) Came to Be Passed by the German Parliament, Enabling Renewable Energies to Establish Their Position in the Market “



by Ulrich Jochimsen





Nordisk Folkecenter
for Vedvarende Energi



„Wind, Women, Art, Acceptance“

by Brigitte Schmidt





„California: Wind Farms Retrospective“

by Arne Jaeger



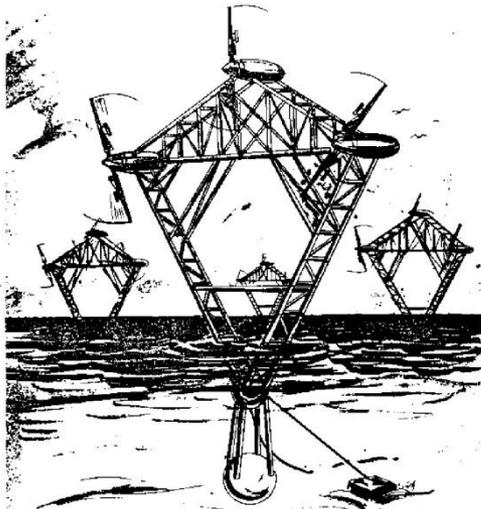


Nordisk Folkecenter

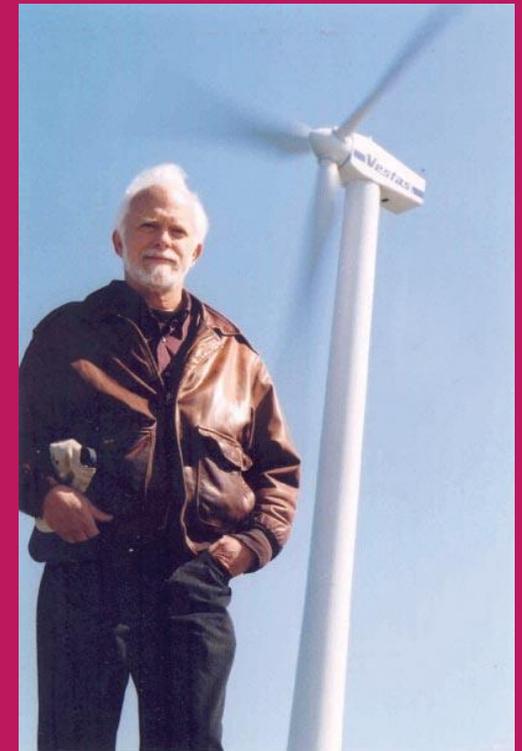
for Vedvarende Energi

„Emergence of Wind Energy: the University of Massachusetts“

by James F. Manwell



POLLUTION - FREE ENERGY
FROM OFFSHORE WINDS





Nordisk Folkecenter
for Vedvarende Energi

„An American Personal Perspective“

by Steven B. Smiley & Susan J. Kopka



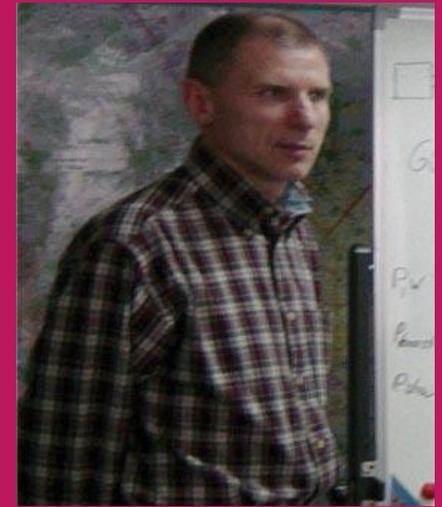


Nordisk Folkecenter
for Vedvarende Energi



„Residential Wind by Way of Illustration“

by Igor Avkshtol





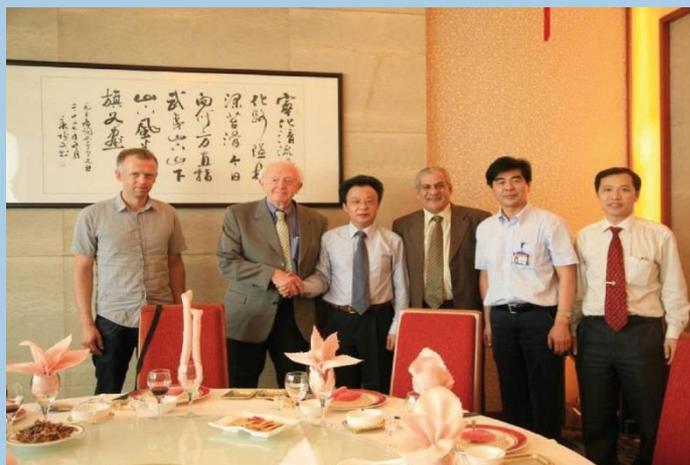
„Wind Power in China: Chasing a Dream that Creates Value“

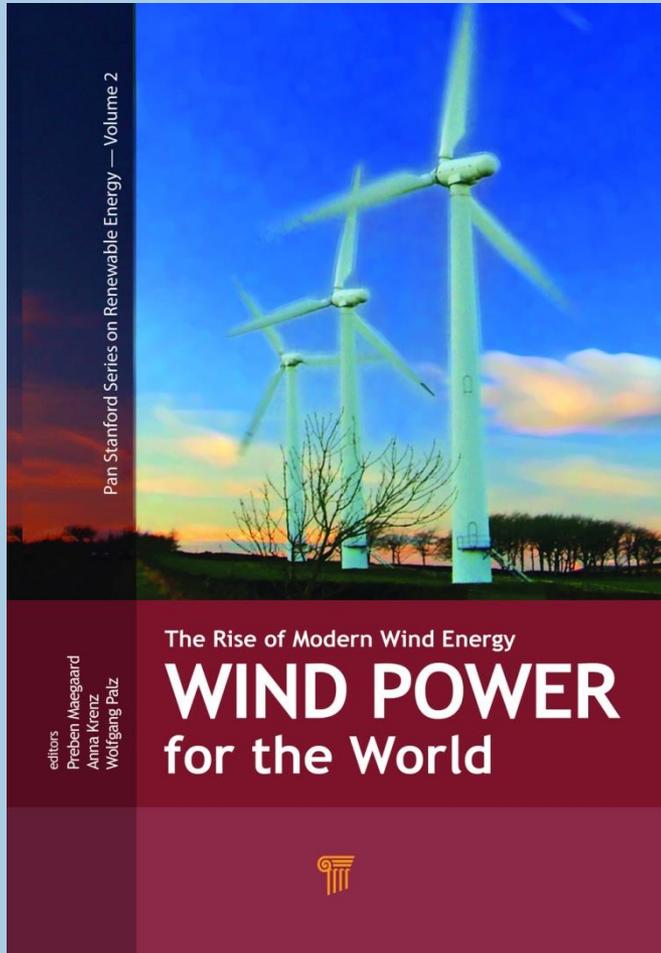
by Qin Haiyan



„Rising Wind Power Industry of XEMC“

by Zhou Jianxiong





Pan Stanford Series on Renewable Energy – Volume 2

Wind Power for the World

The Rise of Modern Wind Energy

edited by

Preben Maegaard, Anna Krenz

(Nordic Folkecenter for Renewable Energy, Denmark)

& Wolfgang Palz

(World Council for Renewable Energy)

The most comprehensive book on wind power to date for the general audience. The book's richly faceted stories describing stages of the development of modern wind industry from the early stage till now (Volume 2) and reviews of wind power history and status quo in selected countries (Volume 3) are presented by 56 international experts from various areas of the renewable energy sector. The book is made for non-specialists. Wind energy science and technology are covered to the strict minimum. The story we want to tell is how it became possible that wind power during a 35-year period has emerged and became a worldwide business of EUR 30 billion per year that by 2013 employs almost one million people.

With financial support of

978-981-4364-93-5 (Hardback)
978-981-4364-94-2 (eBook)
676 pages / June 2013
US\$69.95 / £44.99 / €53



NORDIC FOLKECENTER
for RENEWABLE ENERGY



Nordisk Folkecenter
for Vedvarende Energi



Pan Stanford Series on Renewable Energy – Volume 3

Wind Power for the World

International Reviews and Developments

edited by

Preben Maegaard, Anna Krenz

(Nordic Folkecenter for Renewable Energy, Denmark)

& Wolfgang Palz

(World Council for Renewable Energy)

In the second part of the book “International Reviews and Developments”, we collected reports and overviews of wind power status and history in various countries. The uphill struggle; wind energy strategies and policies that paved the way; the creative persons in politics, agencies, institutes, the industry; the world societies at large, and how the challenges found a solution in different countries at the end are the main issues.



COMING SOON...

978-981-4411-89-9 (Hardback)
978-981-4411-90-5 (eBook)
~600 pages / October 2013
US\$69.95 / £44.99 / €53

PAN STANFORD  PUBLISHING



NORDIC FOLKECENTER
for RENEWABLE ENERGY

With financial support of



Nordisk Folkecenter

for Vedvarende Energi



WIND POWER for the WORLD

> Editors



Preben Maegaard is founder and director emeritus of the Nordic Folkecenter for Renewable Energy, Denmark, chairperson of the World Council for Renewable Energy, Germany, senior vice president of EUROSOLAR, Germany, and president emeritus of World Wind Energy Association, Germany. He is a Danish renewable energy pioneer, author and expert. www.maegaard.net

Anna Krenz is an editor, artist, architect and freelance journalist. Since 2001, she has been associated with the Nordic Folkecenter for Renewable Energy, Denmark, as a freelance creative member. Anna is co-founder of Gallery ZERO, Berlin, and music band The Curators. Currently, her work focuses on social, political and environmental issues, especially wind power. www.annakrenz.net

Wolfgang Palz is chairperson of the World Council for Renewable Energy, Germany. Palz has authored the book Solar Electricity, which was published by UNESCO. He has also edited the book "Power for the World: The Emergence of Electricity from the Sun". Palz is a bearer of an Order of Merit of Germany, has been recognised as a wind energy pioneer in Britain and has received the European prizes for biomass, wind energy and solar photovoltaics.



Nordisk Folkecenter
for Vedvarende Energi

Many of the authors are involved in the World Wind Energy Association. **World Wind Energy Association** (WWEA) was founded in Bella Center in Copenhagen on 1 July 2001.

Since 2002 WWEA organises World Wind Energy Conferences, scheduled every year in a different country. In June 2013 the 13th WWEC will be held in Havana, Cuba.



www.wwindea.org



KEY PEOPLE:

Dr He Dexin, President;
Dr Jami Hossain, Treasurer;
Stefan Gsänger, Secretary General;
Dr Preben Maegaard, President Emeritus;
Dr Anil Kane, President Emeritus;
The Hon Peter Rae, Special Amabassador

It happened on 1 July 2001... HERE!



Nordisk Folkecenter
for Vedvarende Energi

Presentation of the Book, WWEC2013 in Havana

12 CONFERENCIA MUNDIAL DE ENERGÍA EÓLICA
Y EXPOSICIÓN DE ENERGÍAS RENOVABLES

12 WORLD WIND ENERGY CONFERENCE
& RENEWABLE ENERGY EXHIBITION

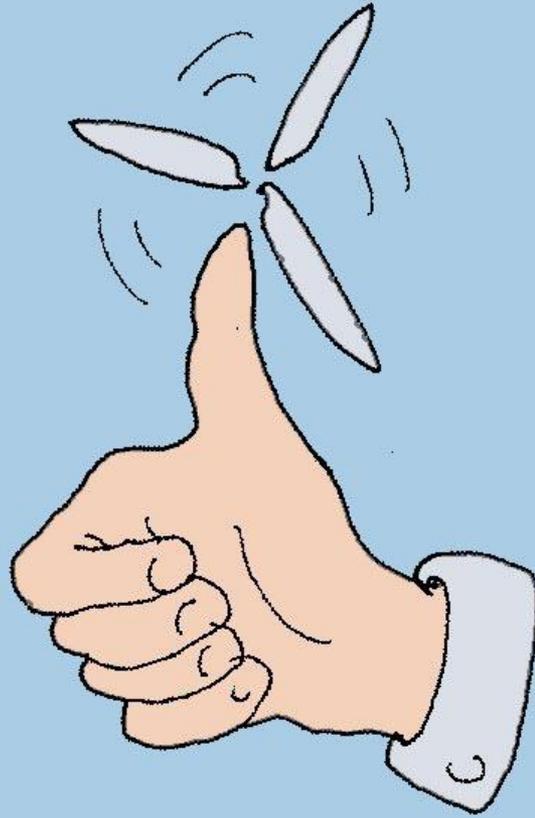
"ABRIENDO LAS PUERTAS A LOS VIENTOS CARIBEÑOS"
"OPENING DOORS TO CARIBBEAN WINDS"

Palacio de Convenciones de La Habana,
3 al 5 de junio de 2013



WWEC 2013





Thank you