소형풍력산업의 과제와 활성화 방안

2011. 3. 25 (금)

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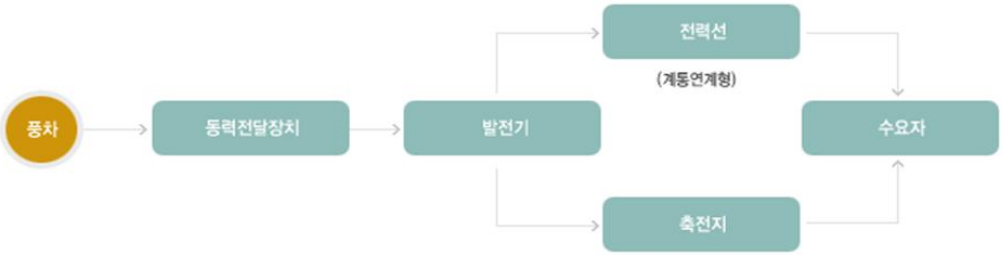
풍력 발전기란?

* Wind is a clean, inexhaustible, indigenous, energy resource that can generate enough electricity to power millions of homes and businesses.

* Wind energy is one of the fastest growing forms of electricity generation in the world.

* Wind Turbine is a machine for converting kinetic energy in wind to mechanical energy. If the mechanical energy used directly by machinery such as pump or grinding stones, the machine is called a Wind Mill. If the mechanical energy is then converted to electricity, the machine is called a Wind Generator or Wind Power.



풍력발전의 잠재성

태양으로부터 지구에 전달되는 에너지

$10^{13}\ kw/hr$

총 에너지의 3% 가 바람 으로 변환

Wind energy로 전세계의 에너지 수요를 충족 가능

Dr. Wirachai Roynarin

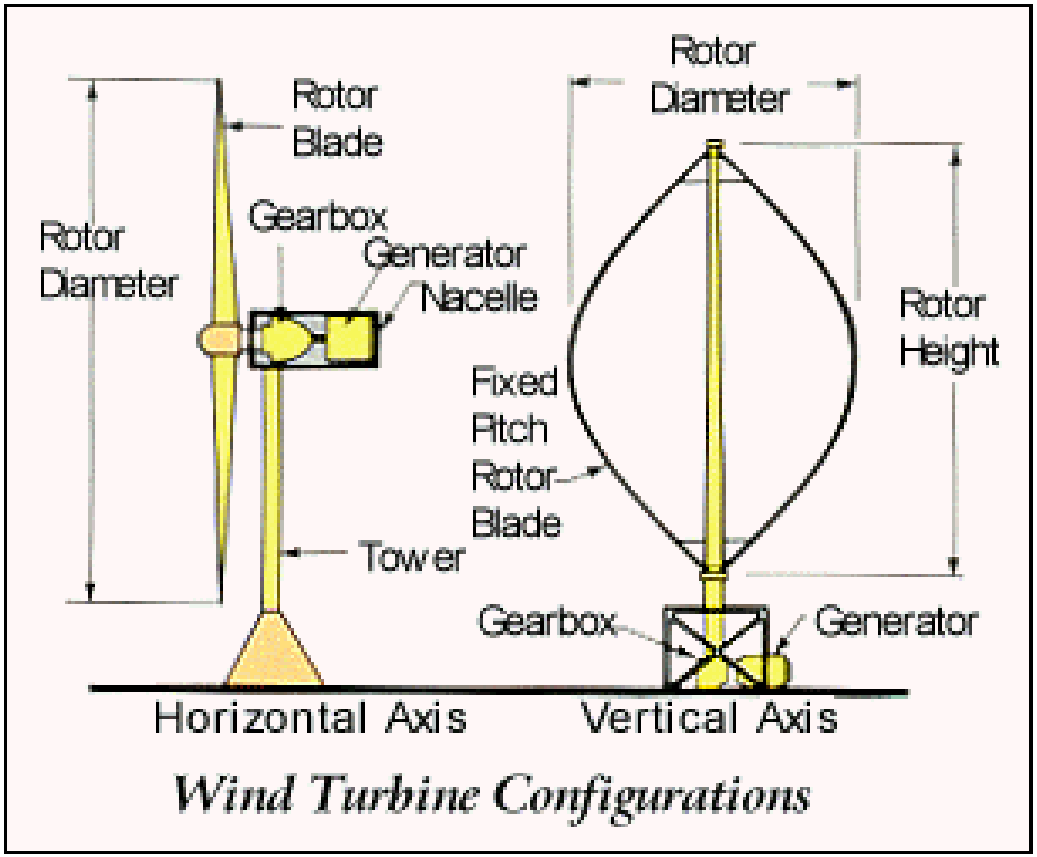
2 MW 풍력발전기

온실가스감축 의무화

탄소배출권 확보

이산화탄소 흡수량 기준 2MW급 풍력발전기 1기는 500만평 이상의산림 대체 효과가 있음

풍력발전기의 전형적인 타입 (수평축 vs. 수직축)

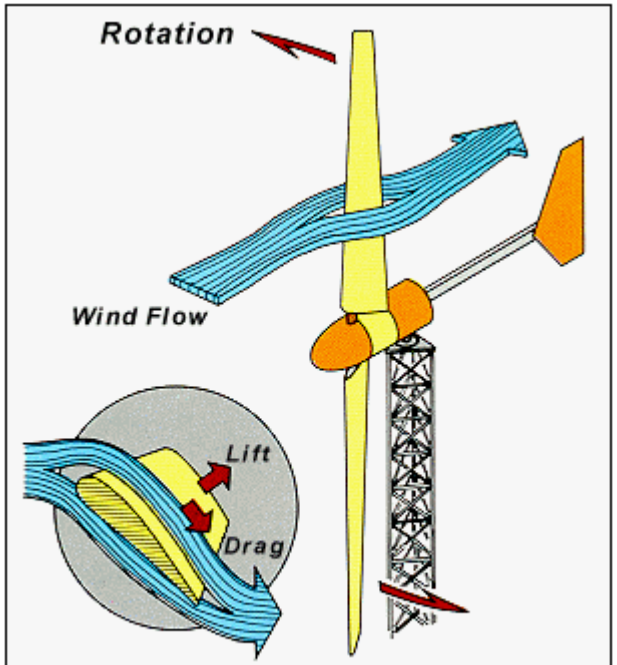


(참고) 수직축 풍력발전기의 주요특성

-. 풍향변화에 관계 없이 출력을 지속적으로 유지할 수 있다.
-. 소음 수준이 상당히 낮으며, 낮은 타워에도 설치 가능하다. → 공용건물 옥상 등에 유리함
-. 동일 정격출력 대비 수평축에 비해 가격이 상대적으로 비싸다.

풍력발전기의 회전원리 (블레이드에서 발생하는 양력이용)

* Basic aerodynamic operating principles of Wind Turbine :



Principles of Wind Turbine Aerodynamic Lift

The wind passes over both surfaces of the airfoil shaped blade. The pressure difference between upper and lower surfaces results in aerodynamic force called 'lift'. This force causes rotation about the hub.

In addition to 'lift' force, a 'drag' force perpendicular to the 'lift' force impedes rotor rotation.

A prime objective in wind turbine design is for the blade to have high lift-to-drag ratio.

풍력발전기의 출력은 풍속의 3승에 비례

Power output in formula

Unchanging for all wind turbines – big or small – are a number of crucial factors that together determine the annual energy-generating potential in kWh/m^2 of rotor swept area. Key factors that impact potential energy yield and their physical relationships are expressed in the image gallery.

$$P = C_P \eta_{me} \eta_{el} \frac{1}{2} \rho v^3 A$$

Where:

P = wind turbine power performance fed into the grid (watts)

CP = aerodynamic efficiency of conversion of wind power into mechanical power, often called the power coefficient

Πme = conversion efficiency of mechanical power in the rotor axis into mechanical power in the generator axis. Encompasses all combined losses in the bearings, gearbox, and so on

Πel = conversion efficiency of mechanical power into electric power fed into the grid, encompassing all combined losses in the generator, frequency converter, transformer, switches etc

p = air density in kg/m^3 (~1.25 kg/m^3 depending on environmental conditions)

v = wind speed some three rotor diameters upwind from the rotor plane in m/s

A = rotor swept area in m^2

Each of the elements of the performance formula has its own distinct contribution to total wind turbine power output and resulting yearly energy yield.

Note:
Cp 의 최대 이론 한계치는 0.593 임!
(일반 방식으로는 절대 넘어설 수 없음)

아주 좋은 아이디어로 Cp를 극대화 할 수는 있으나 반드시 제작단가가 적정선에 있을 수 있어야 경제성을 가질 수 있음!

단가를 유지하면서 Cp를 최대화 하는 기술은 이미 충분히 알려져 있으며, 저 풍속에서 발전량을 올리려면 A(면적)을 늘여야 하는데 이는 보통 제조단가 상승으로 이어짐.

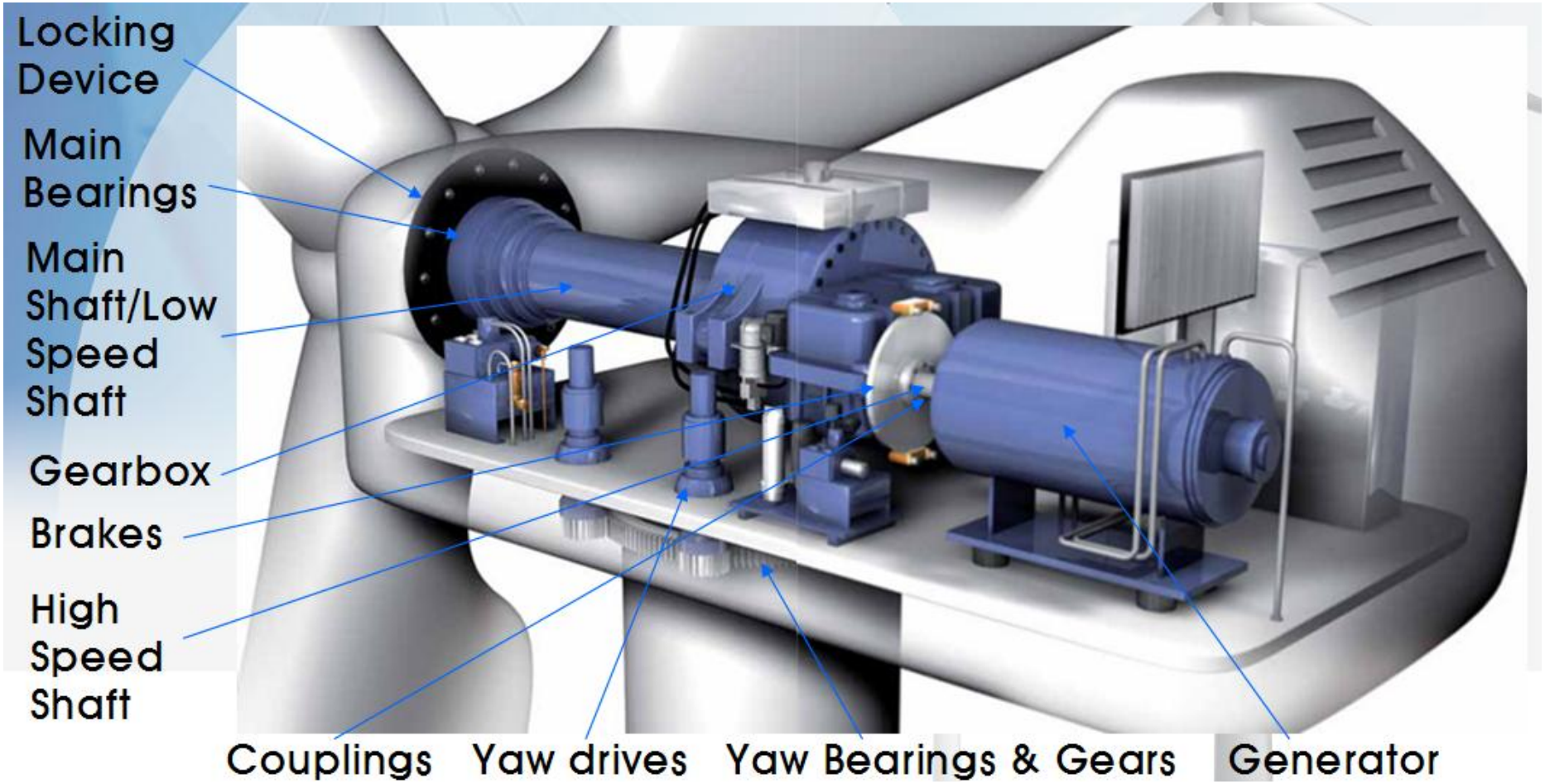
풍력발전기의 효율성(상품성)은 다음의 사항을 종합적으로 고려해야 함.

풍력발전기 자체효율 + 설치비 포함 가격

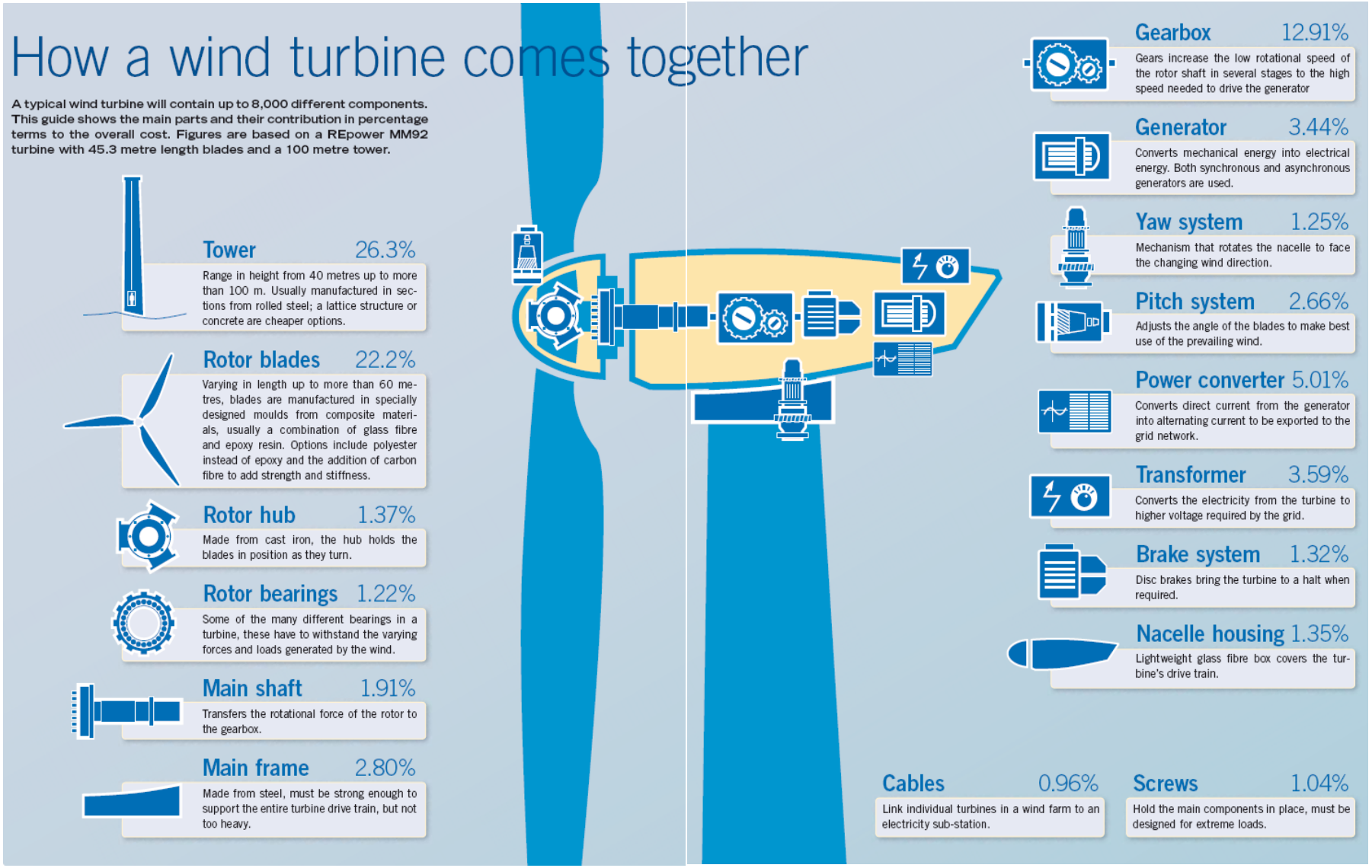
→ 기준 풍속에 대한 단위 kW당 생산 단가가 척도임!
→ 물론 설치지역의 평균 풍속은 5m/s 이상은 되어야 함

[검토사항]
풍력발전기 효율이 아무리 좋은 경우라도 가격이 비싼 경우는 보통 저렴한 모델 다수 개를 설치하는 총 누적 발전량이 많은 편임 (내구성은 동일 기준으로 보았을 때)

대형 풍력발전기의 부품구성 (예)

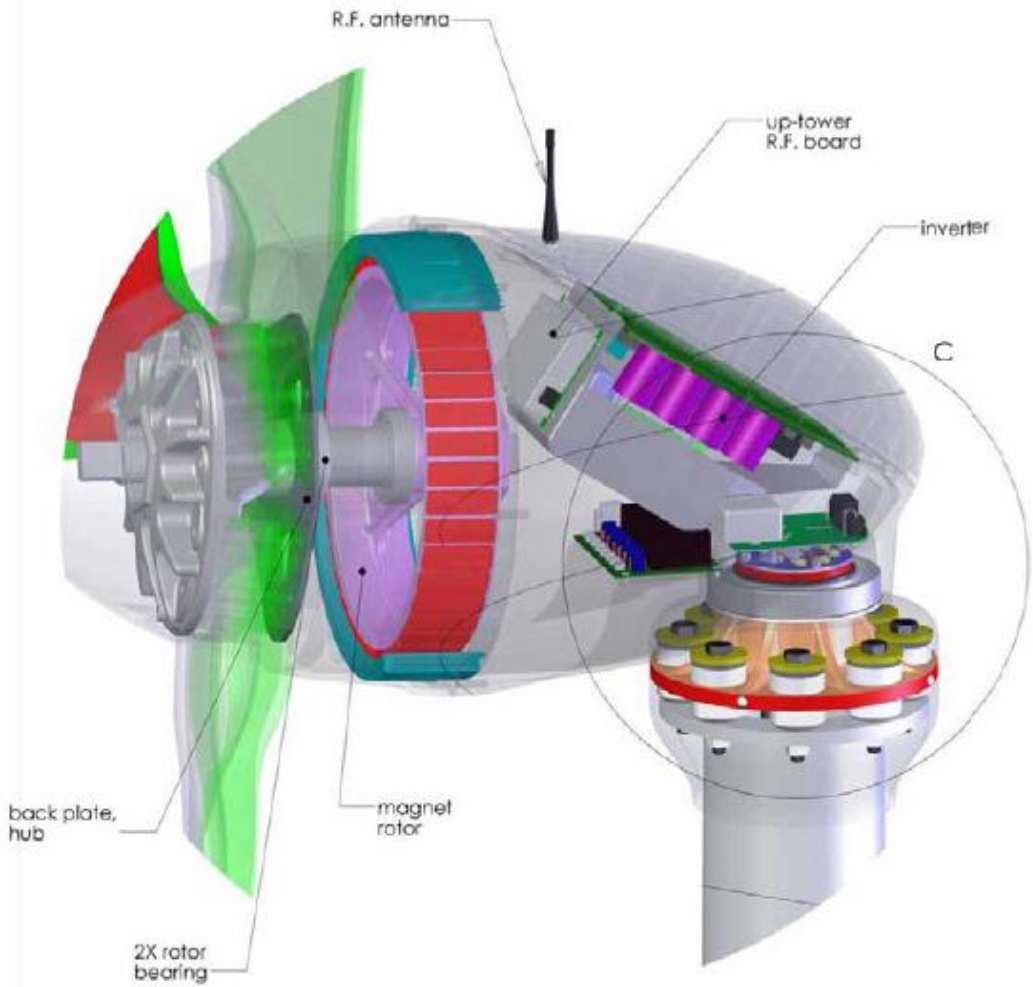


Introductions to Wind Turbine
(풍력발전기 시스템 구성품 동향 – 대형시스템)

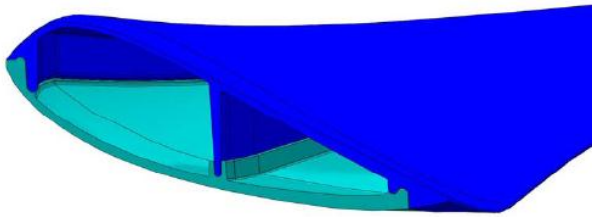


소형 풍력발전기의 부품구성 (예)

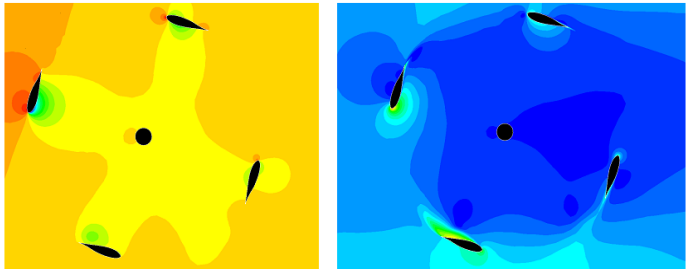
- 소형 풍력발전기의 경우도 크기만 적을 뿐 주요 구성요소는 유사하며, 대형의 경우와 마찬가지로 고효율, 신뢰성 및 저단가 설치가 중요



- Integrated Universal inverter/charger
- Internationally certified for 110 through 277 volts, single and split phase and 3 phase.
- Integrated wireless for monitor/control/upgrade
- High net efficiency (0.33 -0.34 Cp net)
- Large swept area per cost and rating for low wind areas
- 20 year design life in extreme sites
- Maintenance free
- "Type" certified to most stringent international design standards by the most respected lab (GL)

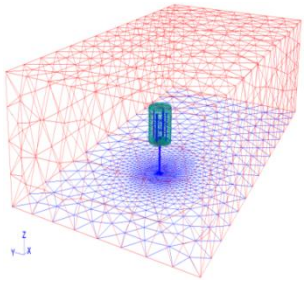


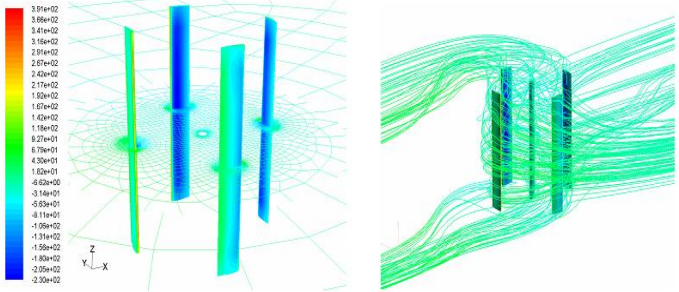
(참고자료)



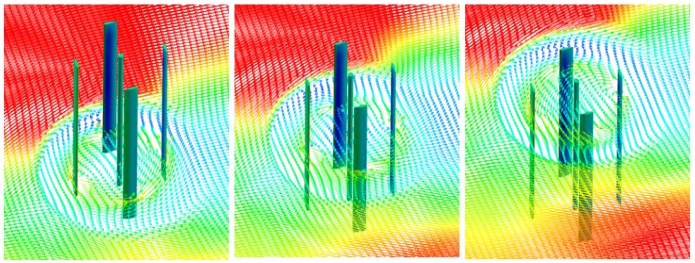
(a) pressure contour (b) velocity contour

4 blade 풍력발전기의 velocity contour 와 pressure contour

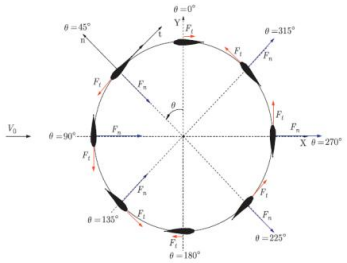


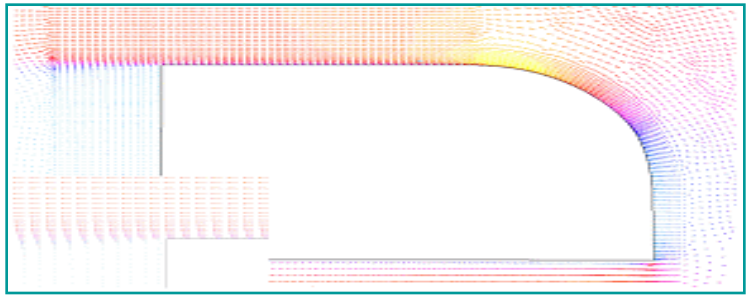


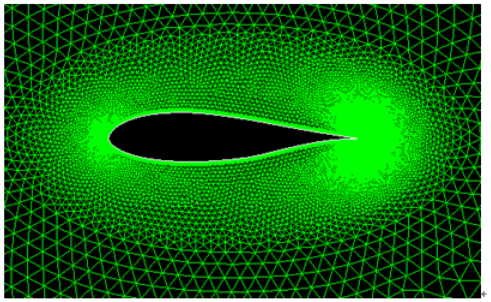
수직축 블레이드 3D 공력해석 contour



10% Blade Span 50% Blade Span 90% Blade Span





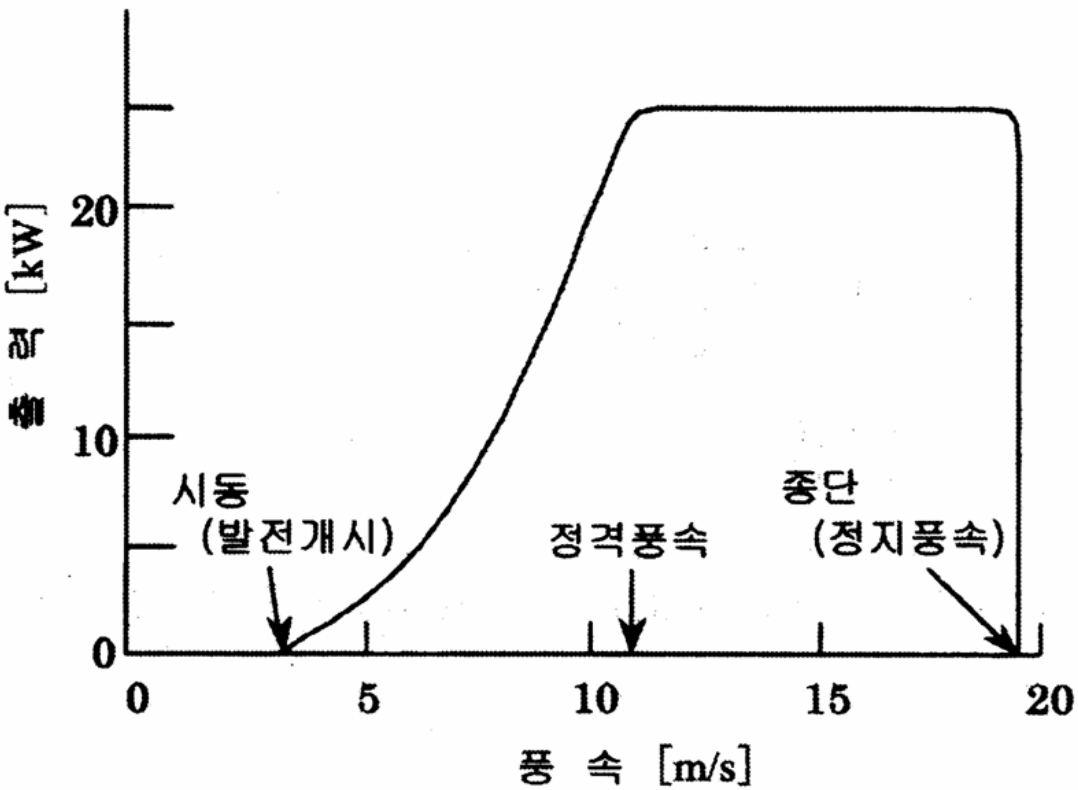


Grid Size

Level	Cells	Faces	Nodes	Partitions
0	114482	177953	63260	1

시험차량 비정상 유동해석 contour

풍속과 출력과의 관계



$$\text{설비가동률}(\%) = \frac{\text{연간가동시간}(h)}{\text{연간시간}(8760h)} \times 100\% \qquad \text{설비이용률}(\%) = \frac{\text{연간발전량}(kWh)}{\text{정격출력}(kW) \times \text{연간시간}(8760h)} \times 100(\%)$$

• 설비가동률(availability)은 시스템 이용상황과 신뢰도를 판단하는 과정에서, 또 설비이용률은 전력취득용량을 계산하는 과정에서 각각 중요한 지표이고, 일반적으로 풍력발전시스템의 설비이용률(capacity factor, C.F.)은 풍차가 건설되어 있는 지점의 평균풍속, 지상으로부터의 높이, 지형, 또 해에 따라 큰 폭으로 변화하기도 한다. 설비가동률 산정 식에서 연간가동시간에 고장, 보수, 정비 등에 요구되는 운전휴지 시간은 제외됨.

소형풍력발전기 응용사례 및 생각해볼 문제

소형풍력 산업 활성화의 기본 척도는 국내외 시장수요에 부합되는
고효율(저단가) 풍력발전기의 개발?

세상에는 다양한 종류의 소형풍력발전기가 많이 있다.

풍력발전기 회사는 생존을 위해 시장개척을 해야 한다.

세계시장의 관점에서 소형풍력발전기 또한 진입장벽이 매우 높다.

국내 소형풍력발전 관련 기업들은 무엇을 하고 있었나?

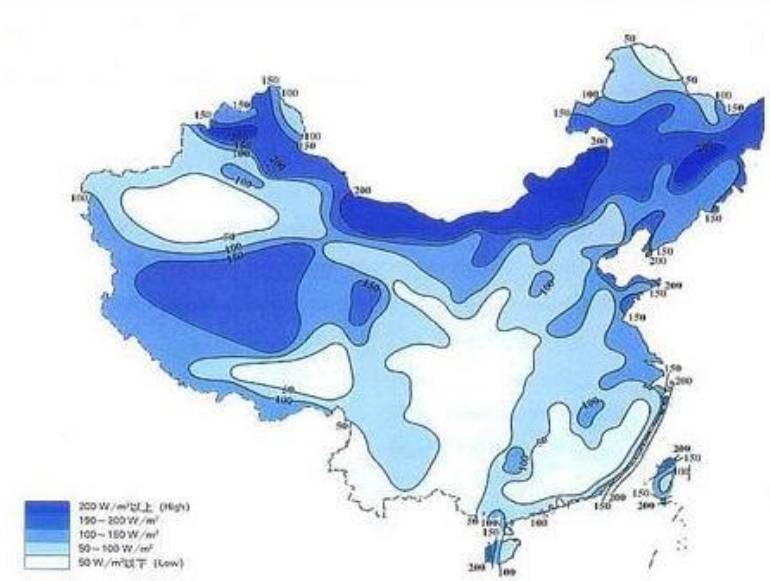
국가 산업아이템의 발전은 대부분 정부의 지원정책과 내수 수요를 기반으로 기술축적
후 세계시장으로 진출하였다. 그렇다면 소형풍력은?

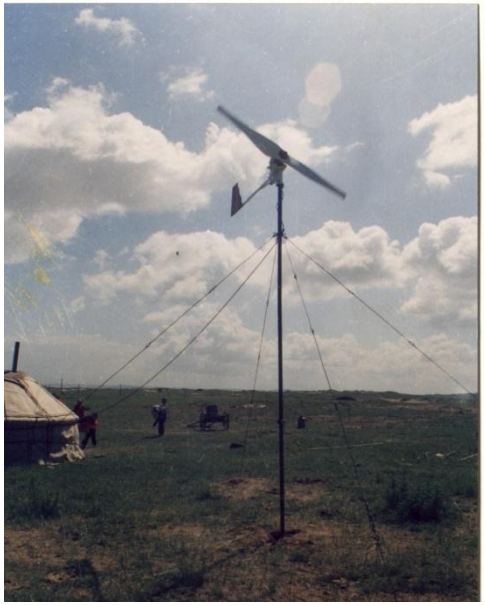
수출기반 없는 소형풍력발전기 회사가 지속적으로 성장할 수 있을까?

세계 소형 풍력발전기 및 부품 시장 진입에 가장 큰 장애요소는 무엇인가?

소형풍력발전기는 도대체 누가 주로 구매하는가?

중국 중소형 풍력발전기 설치사례(중국)






风力发电机在农村牧区应用
Application of Wind Generator in
the Rural Pasturing Area


20 4:20PM

Some 5kW and 20kW Chinese Wind Generators have been exported to Europe


洪湖水上学校
洪湖水上八一希望学校


19 5:50AM

소형 풍력발전기 설치사례

소형 풍력발전기 파기스탄 수출사례(중국)

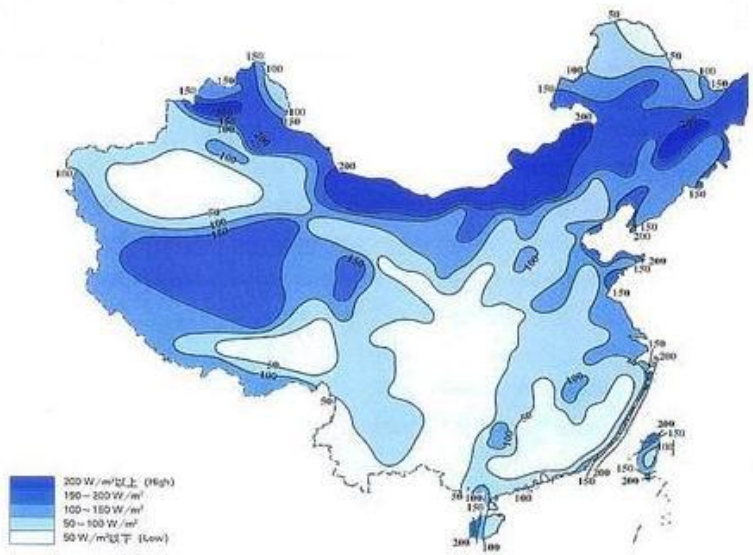
소형 풍력발전기 미국 수출사례(중국)
5kW / 10kW / 20kW

소형 풍력발전기 유럽 수출사례(중국)
5kW / 10kW / 20kW

[참고] 중국 소형풍력 시장분석 요약자료

The contributions of small wind turbines in the construction of rural areas

Chinese Wind Energy Equipment Association



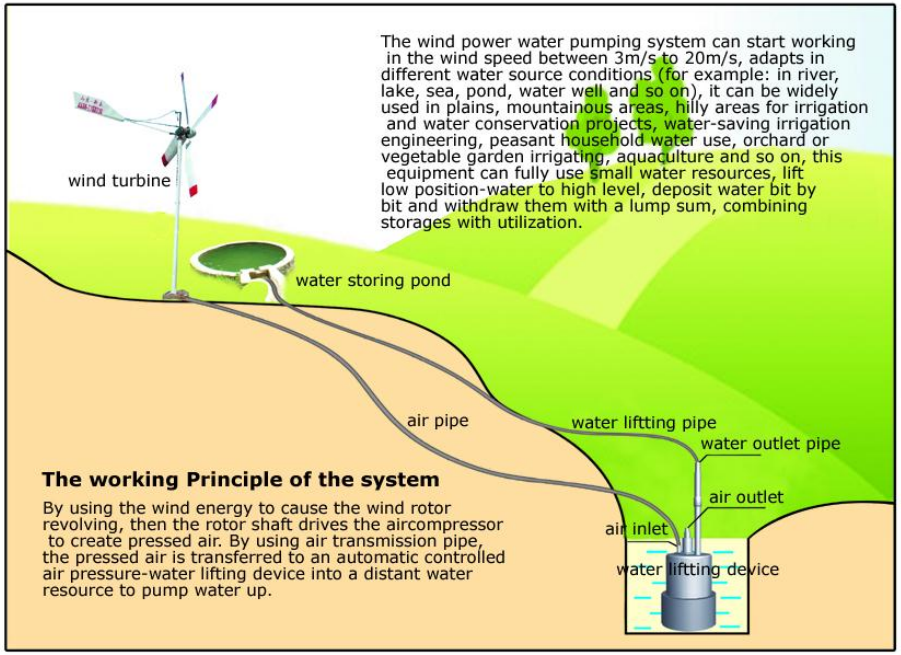
Wind Energy Resources for off-grid wind generators in China

- According to the surveying and calculating carried out by Chinese Academy of Meteorological Science, the total reserves of wind energy at 10 m height is 3.2 billion (3.2×10^9) kW, the practical developable amount is 253 million (253×106) kW.
- The much rich, rich and utilizable regions of wind resources amount respectively is 8%, 18% and 50% of the total area of the country.
- So, the 76% of the total areas of China is suitable to install small-size wind generators, the tower head of majority small wind generators is around 10 m.

Significance of Developing and Utilizing off-grid Wind generators

- Until now, there are still 2.4 million households , 12 million people have not got electricity supplement in remote areas of China. In the windy and off-grid areas, the electricity supply problem of 1.5 million households , 7 million people can be solved by using wind generators. And it is the most effective method in remote areas.
- And it is an act of constructing harmonious society with deep significant, it also has deep significance for strengthening national unite, consolidating frontier defense and promoting economic development of remote areas.

[참고] 중국 소형풍력 시장분석 요약자료



Small-size off-grid wind generators developed in China

- 100W、200W、300W、（400W）、500W、（800W）are very popular used in mass quantity.
- 1kW、2kW and 5kW are used in a small quantity.
- 10kW、20kW、30kW are used in a very small quantity in China. They are mainly exported to other developed countries. Prototypes of 50 kW and 100kW are available.
- Accumulated installation number of Chinese off-grid wind generators: more than 400000
- Inner Mongolia: Occupied 75%
- About 15 main manufacturers （located in Inner Mongolia, Jiangsu, Guangdong, Shandong, Zhejiang provinces and Guangdong province, Beijing city ）with production capacity over 1000kW per year each.

[참고] 중국 소형풍력 시장분석 요약자료

The application of small off-grid wind generator in remote areas

- Diesel electricity generating system bring pollution to the grassland and diesel transportation is difficult.
- Wind resources is sufficient, no damage wind speed occurred on the grassland.
- Small-size wind generating technology is mature and product performance is reliable.
- The wind generators are wanted by herder men urgently and they are affordable.
- Therefore, it is a good combination among resources, technologies, demands and purchasing abilities . Now, 50% of herder men 's home already adapt wind generators for obtain power supply.
- There are 1.5 million households , 7 million people live in windy remote areas, public grid is not available .

The application of small off-grid wind generator in lake areas

- Diesel electricity generating system bring pollution to the lake and diesel transportation is difficult.
- Wind resources is sufficient, no damage wind speed occurred on the lake.
- Small-size wind generating technology is mature and product performance is reliable.
- The wind generators are wanted by fishermen urgently and they are affordable.
- There are 5000 households of fishermen in Honghu lake, public grid is not available .
- Therefore, it is a good combination among resources, technologies, demands and purchasing abilities . Now, 20% of fishermen' home already adapt wind generators for obtain power supply.

Application range of small off-grid wind generators

- Providing 220V AC current or 24V to 120V DC current
- Home illumination: lamp, fluorescent lamp, energy saving lamp
- Home appliances: TV、Radio、VCD、fan、electric carpet、refrigerator 、washing machines and so on.
- Communication devices, road lights
- Small electric tools
- Suitable power supply for households of farmers, headers men, border sentry posts， school ， small railway stations and so on.

[참고] 중국 소형풍력 시장분석 요약자료

•중국측에서 2008년 발표 당시 기준임!

Developing trend of off-grid small generators in China

- *A. The output power will increase from low to high, now the 200W and 300W are the main type of products, in the near future, 500W and 1kW will become main type of products.*
- *B. From one family use expand to joint network of electricity supply, 5kW、10kW and 20kW will be used gradually.*
- *C. From single wind energy to multi-energy compensating system (photovoltaic-wind hybrid system)*
- *D. The utilization range enlarged step by step , from north rural areas to seacoast areas and lake fishery areas.*

[참고] 중국 소형풍력 시장분석 요약자료

Conclusions

1.Acumulated installation amount of Chinese made small wind generators has passed 400,000 sets in China. About 300,000 households, 1.5 million people have solved their family power supply problem by using small wind generators. This has promoted the social civilization and harmonious development of remote rural areas.

2. From 2000 to 2008, More than 80,000 Chinese made small-size wind generators have been exported to other countries, and made beneficial contributions for wind energy application in other developing countries.

Conclusions

3. Small wind generators are suitable to Chinese windy rural conditions， national production rate is 100%， through more than 30 years development, the technologies become mature, products are reliable , performances are improved step by step. Marked demand is wide, It is closed connected with people's production and living conditions in rural areas. It will be continued to develop for a rather longer time.

4. Doing well to develop, spread and utilize small wind generators , to promote the new countryside's construction in remote areas, to bring benefits for weak group of peoples, is the glorious task of wind energy industry and circle.

- 2008년 당시 기준 중국에 약 40만대 정도가 설치되었고, 8만대 정도가 수출되었다고 함.
  (주로 15개의 중국기업이 해당 수요를 담당하였다고 함. → 소형풍력 기업들이 기반을 다질 수

[잠깐 생각해 볼 점]

- 엄청난 수의 중국제 풍력발전기는 모두 인증을 받은 것일까? 중국정부의 소형풍력에 대한 정책 기조는?
- 최근에도 중국업체들은 소형풍력발전기를 전세계로 엄청나게 수출하고 있다고 한다. 어떻게 할 수 있었을까?
  (과연 품질은 괜찮은 것일까?)

- 소형 풍력발전기를 자전거나 스쿠터에 비유한다면 기본 기능하니깐 역시 가격 싼 것이 최고?

❑ 인증 현황

업체명	국가명	보유모델	인증현황
오로라에너지	대한민국	0.5kW,1kW,3kW,10kW	2006.03 1kW,3kW 인증예정(대관령 풍력 실증연구단지) 2002.12 소형 풍력발전기 성능평가 완료(에기연)
준마엔지니어링	대한민국	200W,400W,900W,1kW,3kW,5kW,7.5kW,10kW	인증 현황없음
금풍에너지	대한민국	GWE-200A/B,GWE-500A/B	인증 현황없음
해브림에너지	대한민국	150W,600W,1kW,3kW	인증 현황없음
시그너스파워	대한민국	CM-200,CM-1000,CM-5000	인증 현황없음
서영테크	대한민국	SY-WT-600,SY-WT1000	풍력용 발전기 공급업체
하이에너지코리아	대한민국	DS300(300W),DS1500(1.5kW)DS3000(3kW)	2008.10 3kW 1대,1.5kW2대 국내설치
벤토코리아	대한민국	600W,1kW,2kW,3kW,5kW	2006.04 600W,1kW시제품 제작
이하에너지	대한민국	1kW,3kW,5kW	10kW 풍력발전기 실증실험 설치
대흥기전	대한민국	HWS-102,HWS-103(200W)	2007.10 신재생에너지설비 인증(62W@8m/s)
Abundant Renewable Energy	엘살바도르	ARE110(2.5kW),ARE442(10kW)	인증 현황없음
Aerostar	미국	Aerostar 6 Meter(10kW)	인증 현황없음
Aero Viromment	미국	AVX-1000(1kW system)	인증 현황없음
Bergey Windpower Co	미국	BWC XL.11(Kw),BWC EXCEL(10kW)	인증 현황없음
Gaia-Wind Ltd	영국	11kW	덴마크 HB인증
Mariah Power	미국	Windspire(1.2kW)	UL 인증
Proven Energy.Ltd	영국	Proven 2.5(2.5kW),Proven 6(6kW)Proven15(15kW)	인증 현황없음
ReDriven Power.Inc.	캐나다	2kW,3kW,5kW,10kW,20kW	인증 현황없음
Southwest Windpower Co.	미국	AIR X(400W),Whisper 100(900W),Whisper 200(1kW) Whisper 500(3kW),Skystream3.7(1.8kW)	UL, CE 인증
Ventera Energy.Inc.	미국	VT10(10kW)	인증 현황없음
Wind Energy Solutions Canada	캐나다	WES 5 (2.5kW),WES 18 (80kW),WES 30 (250kW)	인증 현황없음
Wind Turbine Industries Corp.	미국	23-10 Jacobs(10kW), 31-20 Jacobs(20kW)	인증 현황없음

SDCAE
Prof. Kim, Dong-Hyun, Structural /Design Dynamics and Computer Applied Engineering (SDCAE) Lab. (http://sdcae.gnu.ac.kr)
Gyeongsang National University (GNU), Republic of Korea / Tel: 82-55-755-2083 / e-mail: dhk@gnu.ac.kr

Manufacturing

MANUFACTURER PROFILE

At least 219 companies manufacture, or plan to manufacture, small wind turbines in the world. Of these:

- Seventy-four (34%) are based in the United States.
- At least 36 (14 US) have begun sales.
- At least 45 (21 US) manufacturer or plan to manufacture vertical-axis systems.[18]
- A minimum of five manufacturers (two US) began sales in 2008.

• 2008

Company	Country	kW Sold in 2008
Southwest Windpower	US (AZ)	10,000
Proven Energy Ltd.	UK (Scotland)	4,800
Northern Power	US (VT)	4,300
Entegrity Wind Systems	Canada (PE) / US (CO)	3,500
Bergey WindPower Co.	US (OK)	1,700

Table 4. Five Largest Manufacturers in 2009, in kW Sold

Company	Country	kW Sold Worldwide
Southwest Windpower	U.S. (AZ)	11,700
Northern Power Systems	U.S. (VT)	9,200
Proven Energy	U.K. (Scotland)	3,700
Wind Energy Solutions	Netherlands	3,700
Bergey WindPower Co.	U.S. (OK)	2,100

소형 풍력발전기 기업동향 (미국 등)

Manufacturer Profile

Approximately 250 companies in the world manufacture, or plan to manufacture, small wind turbines. Of these:

- 95 (36%) are based in the United States
- At least 47 (12 U.S.) have begun to sell commercially
- 99% have fewer than 100 employees

The number of identified manufacturers in the U.S. increased from 66 to 95 last year, and 26 countries are now home to more than 250 manufacturers. The vast majority are in start-up phases and roughly half the world market share is held by fewer than 10 U.S. manufacturers.

Table 4. Five Largest Manufacturers in 2009, in kW Sold

Company	Country	kW Sold Worldwide
Southwest Windpower	U.S. (AZ)	11,700
Northern Power Systems	U.S. (VT)	9,200
Proven Energy	U.K. (Scotland)	3,700
Wind Energy Solutions	Netherlands	3,700
Bergey WindPower Co.	U.S. (OK)	2,100

2010 AWEA 통계에 따르면 전세계에 약 250개의 기업이 있는 것으로 조사됨. (한국기업이 누락된 것을 보면 수요조사에 오차는 있는 듯)

그 중 95개(36%)의 기업이 미국에 있고, 최소 47개의 기업이 상용제품을 팔고 있음.

99%의 미국 소형풍력 기업이 직원 100명 미만임.

미국에서 확인된 소형풍력 생산기업은 2009년 한 해 동안에만 29개가 늘었음.

미국 10개 기업이 전세계 소형풍력발전기 절반 정도의 시장을 점유하고 있는 것으로 보임.

(참고)
본 자료의 뒷부분에 있는 영국시장 자료를 참조하여 비교해 볼 필요 있음. AWEA가 미국에 있으므로 아무래도 미국 위주의 자료작성이 되었을 수 있음.

소형 풍력발전기 분야는 통계 잡기가 쉽지 않음.

소형 풍력발전기 설치 동향 (미국) – 2009년

Fig. 9: U.S. GLOBAL MARKET SHARE (kW)

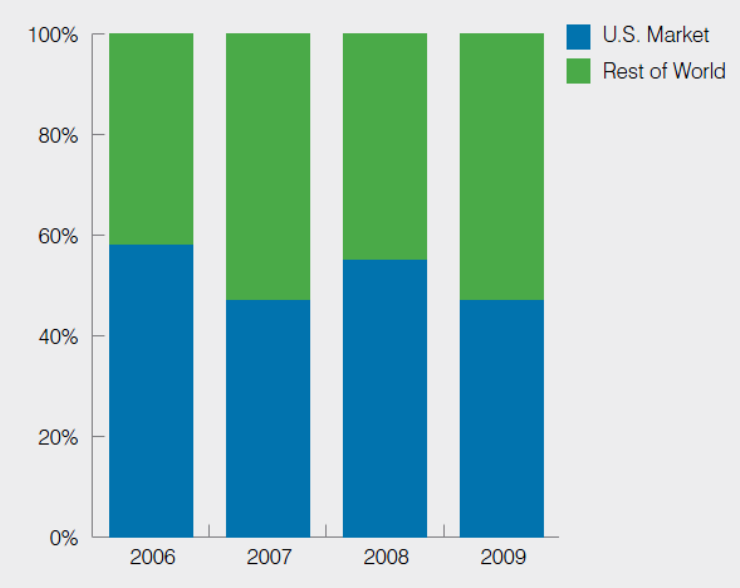
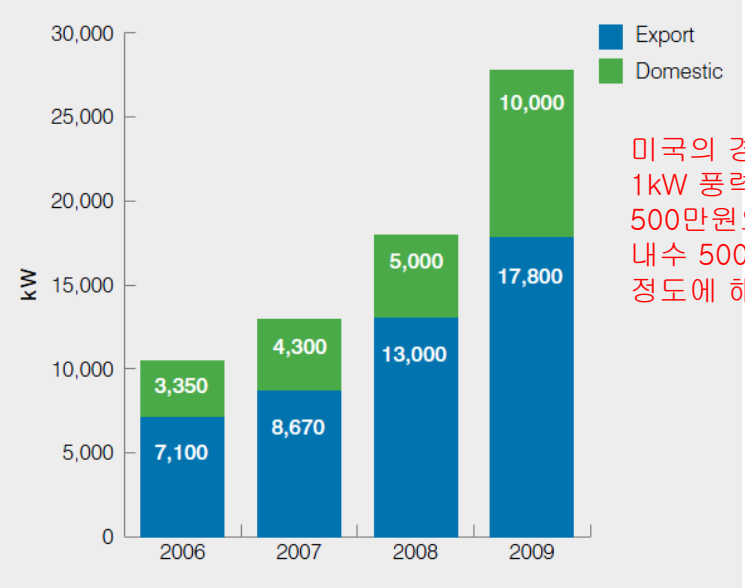


Fig. 10: U.S. MANUFACTURERS' EXPORTS (kW)



미국의 경우 2009년
1kW 풍력발전기 가격을 평균
500만원으로 고려했을 때,
내수 500억, 수출 890억
정도에 해당

The U.S. continues to comprise approximately half the global market, which, according to a 2010 AWEA survey, grew by at least 42.5 MW (10%) and more than 21,000 units in 2009. U.S. manufacturers produced 2/3 of this capacity, maintaining their historically dominant position in the global market.[28]

Exports accounted for approximately 36% of U.S. manufacturers' sales, an increase from 28% in 2008. An overwhelming majority (95%) of units sold in the U.S. in 2009 were produced by U.S. manufacturers, continuing an historical trend.

U.S. state and government policies, particularly incentives, have begun to catch up with those of other major turbine-producing countries. Particularly with an uncapped ITC, the U.S. appears prepared to improve its market share in the global industry. With improved state and federal policies related to permitting, net metering, and grid interconnection, the U.S. could attract not only a larger share of the market, but more domestic jobs from expanding manufacturing facilities. At least two foreign manufacturers intend to create manufacturing facilities in the U.S. due to the market's growth, potential growth, and the federal ITC.

The US continues to command roughly half the global market share and is home to one-third of the 219 identified worldwide manufacturers. Small wind is still in a race with the solar photovoltaic industry toward "grid parity" – price per kilowatt-hour on par with conventional forms of electricity – and now both industries enjoy nearly identical federal incentives for a more level playing field.

2008 U.S. Sales	2008 Global Sales
17.3 MW	38.7 MW
78% growth over 2007	53% growth over 2007
10,500 units	19,000 units
$77 million in sales	$156 million in sales

Other Statistics

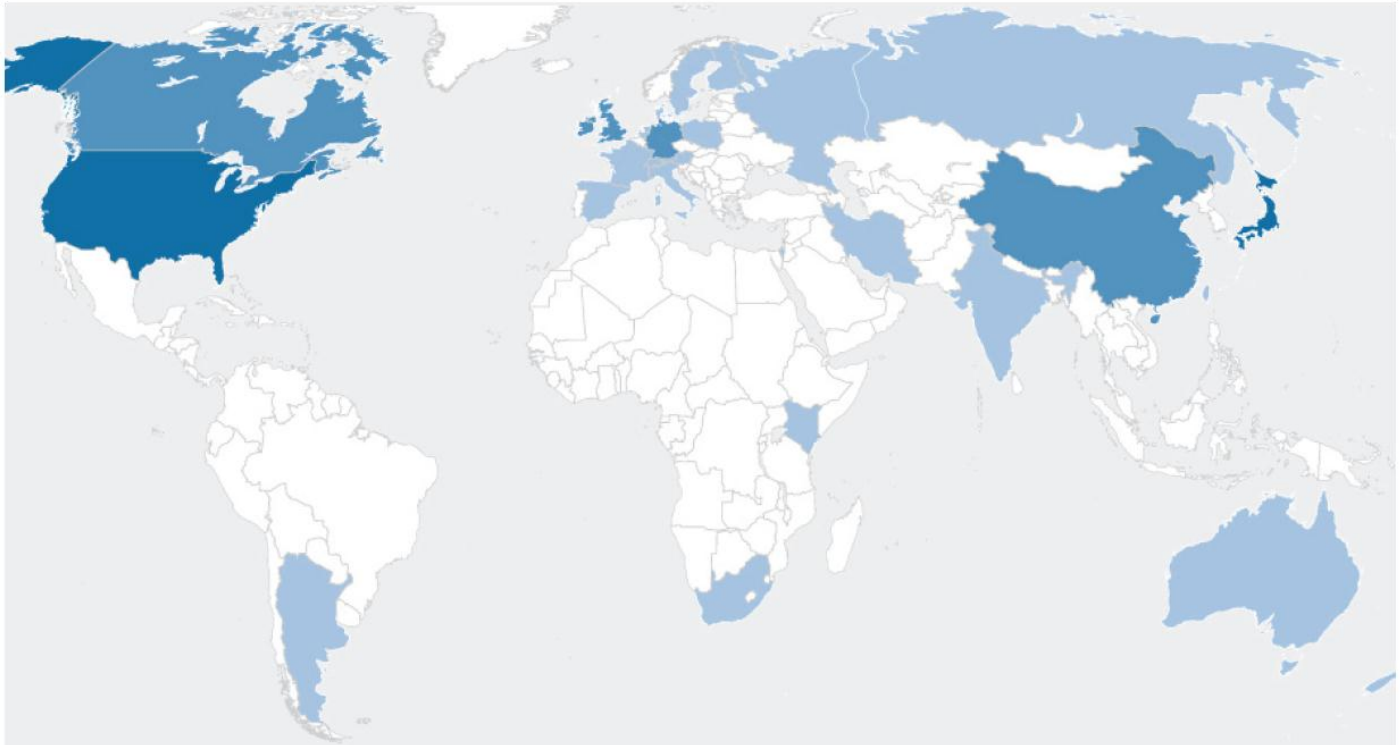
- 80 MW of cumulative installed small-wind capacity in the US.
- US manufacturers' sales account for ½ the global market.
- $160 million in outside investment was injected into 18 manufacturers worldwide over the past three years.
- At least 219 companies worldwide manufacture small wind systems, 35% of which are based in the US.
- Industry predicts a cumulative US capacity of 1,700 MW within five years.

22 Generally, turbines installed at a site with access to average wind speeds of at least 12 mph at hub height.

미국 AWEA 권장사항 → 풍력발전기는 허브 높이에서의 평균풍속이 최소 5.36 m/s 이상인 지역에 설치

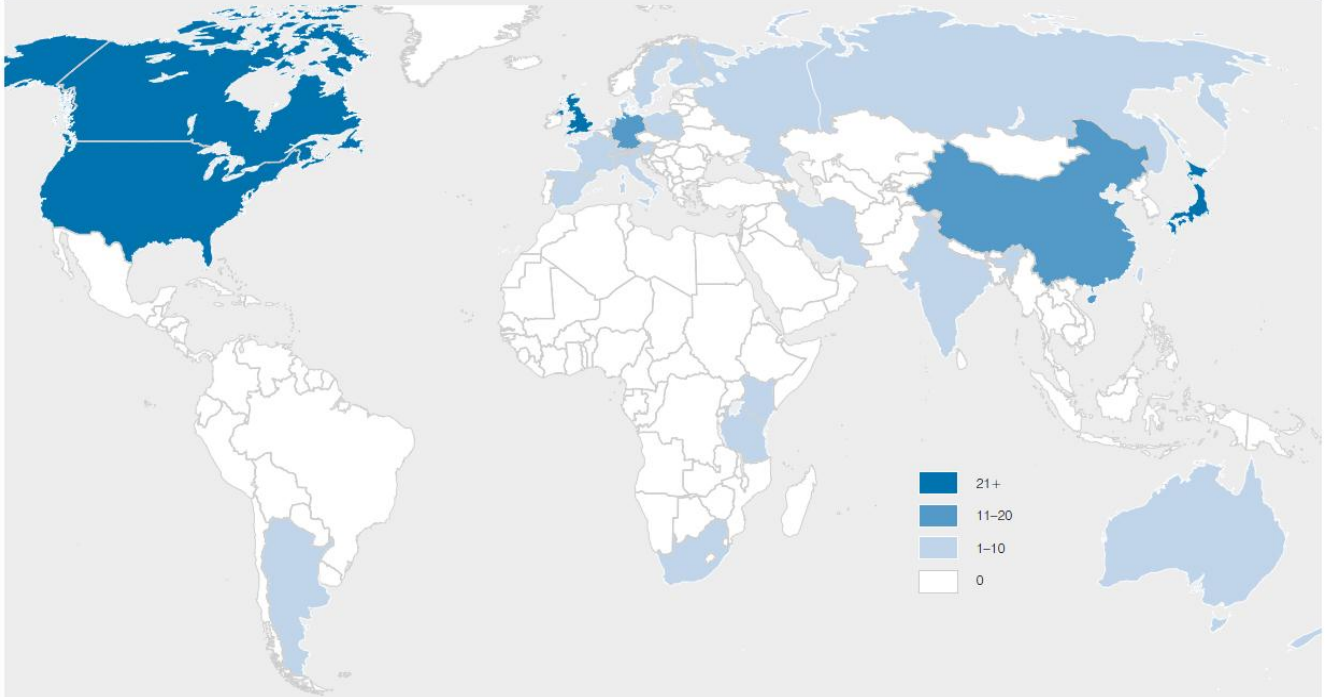
(참고) 풍력발전기의 발전량은 풍속의 3승에 비례함. P = Cp x 0.5 x rho x A x V^3

FIGURE 10: GLOBAL DISTRIBUTION OF MANUFACTURERS



Country (Number of Manufacturers)			
US (66)	Sweden (5)	Israel (2)	Iran (1)
Japan (28)	South Africa (4)	Italy (2)	Kenya (1)
Canada (23)	Spain (4)	Russia (2)	Poland (1)
UK (18)	India (3)	Argentina (1)	New Zealand (1)
Germany (16)	Taiwan (3)	Australia (1)	Switzerland (1)
China (14)	Finland (2)	Austria (1)	
Netherlands (7)	France (2)	Denmark (1)	

Fig. 8: GLOBAL DISTRIBUTION OF IDENTIFIED MANUFACTURERS



Global Distribution of Manufacturers

U.S.	(95)	Spain	(5)	Israel	(2)	Iran	(1)
Japan	(29)	Sweden	(5)	Italy	(2)	Kenya	(1)
Canada	(24)	South Africa	(4)	Russia	(2)	Poland	(1)
U.K.	(22)	France	(3)	Argentina	(1)	New Zealand	(1)
China	(19)	India	(3)	Australia	(1)	Switzerland	(1)
Germany	(16)	Taiwan	(3)	Austria	(1)	Tanzania	(1)
Netherlands	(6)	Finland	(2)	Denmark	(1)		

소형 풍력발전기 설치 동향 (미국)

Costs

Price ranges for small wind turbines – and even for a single model – vary widely due to the numerous factors affecting installation, but costs for a well-sited[22] turbine tend to gravitate between $3 – 6 per Watt, and $0.15 – $0.20 per kilowatt-hour. Costs and cost-recoupment periods can vary due to the following factors, ranked in approximate order of importance:

- Availability and quality of state incentives and state/utility net metering policies
- Average annual wind speed
- Prevailing costs of traditional electricity. Installations tend to be most cost-effective in regions where the cost of utility-provided electricity exceeds $0.10 per kWh.
- Cost of equipment, installation, and maintenance. Estimated operations and maintenance (O&M) costs average $0.01 – $0.05 per kWh. Other calculation methods place O&M costs at roughly 1% of the retail cost of an installation, accrued annually.[23]
- Sales and property tax rates (and incentives)
- Raw manufacturing materials
- Insurance
- Method of financing
- Permitting costs, which can range from $0 to $1,000+ depending on the zoning jurisdiction
- Application type. Installations for businesses may benefit from special tax incentives.

Building-Mounted Turbines

In 2009, 187 units were reported sold for use in urban/rooftop settings in the U.S., representing 400 kW of installed capacity and less than 2% of the U.S. market.

At least 17 companies worldwide manufacture or plan to manufacture building-mounted models, a high proportion of which are of vertical-axis configuration.

Generally, building-mounted installations face challenging performance obstacles due mainly to the turbulent and unpredictable nature of winds around buildings and other structures. Any turbine installed in a location or manner that limits its access to the wind resource will render its performance (i.e., output, measured in kilowatt-hours) below that of a turbine installed in an area where there is a robust, consistent wind resource. A small number of companies are working to address the difficulty of siting building-mounted turbines by using software and other computer models to predict wind resources more accurately in these environments. To date, however, siting and performance challenges have severely limited the size and potential of the market for building-mounted turbines.[25]

소형 풍력발전기 설치 동향 (미국)

Wind-diesel hybrids. Hybrid systems using both wind and diesel generators, usually for remote applications, continue to be an important part of the commercial / light industrial market. In 2009 approximately 20% of turbines 50-100 kW were sold for wind-diesel hybrid systems, nearly all of which were in Alaska. Canada is looking to adopt policies to attract some of this market share. Manufacturers report growth in this application in Caribbean, Pacific, Asian, Russian markets.

(참고) 10MW급 풍력발전기 개발사례

❖ 10MW Class Off-Shore Wind-Turbine

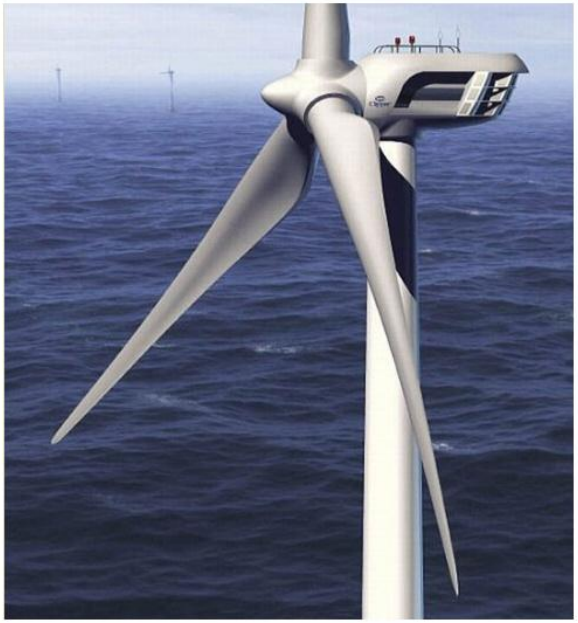
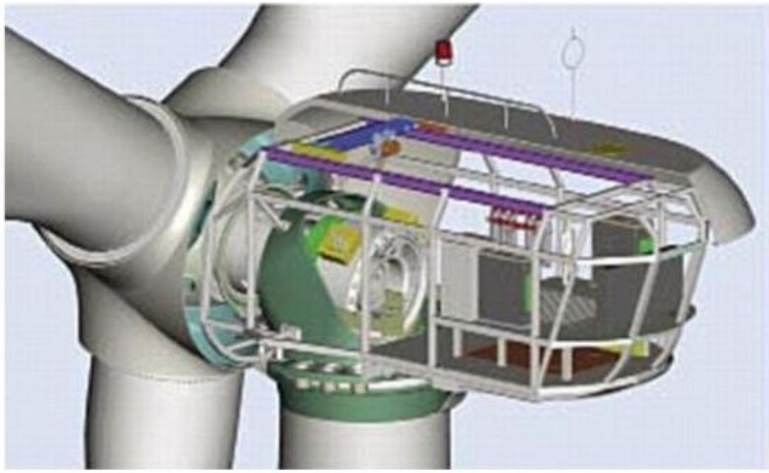


Fig. 1.2 미국 회사가 개발 중인 10MW급 초대형 해상용 풍력발전기 (2013년 영국 설치예정

- ▶ 세계적으로도 갈수록 용량이 대형화 되고 있는 '풍력발전기는 진화하고 있다' (Fig.1.2~1.4) 따라서 관련 핵심 부품기술 또한 진화해야 한다. 향후 풍력발전기 관련 기업의 기술수요 및 분야가 빠르게 변화할 수 있다는 의미이다.
- ▶ 풍력발전기 핵심부품 및 시스템 기술과 관련된 고급인력양성과 취업연계는 철저하게 기업 기술 수요가 있는 분야에 대한 심도 있는 실무연구 과정을 통해 가능하다.
- ▶ 정부는 풍력 산업육성을 위한 강력한 의지를 가지고 있으며, 이를 성공적으로 완수하기 위해서는 핵심부품의 기술개발을 혁신적이면서도 실무적으로 수행할 수 있는 석박사 인력양성에 지속적인 투자가 필요하다.

Eco Factor: Huge offshore turbine to generate 10MW of energy.

In a world where everything seems to be getting smaller and smaller, Clipper Windpower Marine still believes that sometimes bigger is certainly better. This UK arm of the US company plans huge wind turbines with blades bigger than London Eye in British waters. Called the "Britannia," the 10-megawatt turbine will show the way to future green power.



Being constructed at Blyth, Northumberland, the Britannia will include three enormous blades, each weighing more than 30 tonnes. The 500-foot-tall offshore turbine with a diameter of 475 feet is expected to generate enough electricity to power 10,000 homes. Expected to be complete in the next two years, the turbine is capable of displacing the use of two million barrels of oil over its lifetime.

Fig. 1.3 10MW급 초대형 해상용 풍력발전기 (내부도)