2Kw Wind Turbine Generator



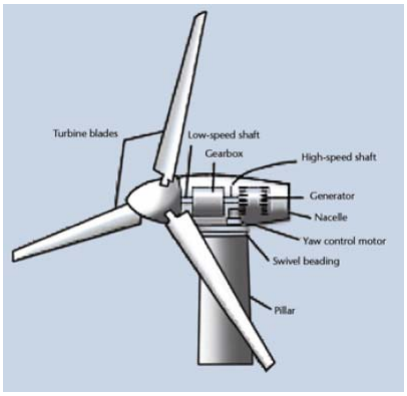
KINEMOTION Co., LTD.

풍력에너지란...

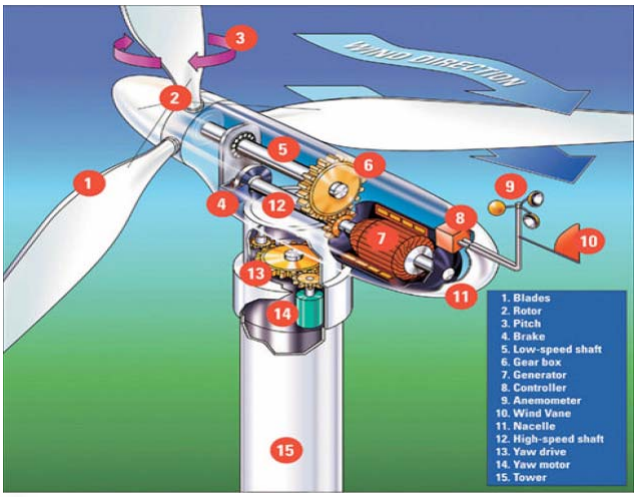
- 태양에너지의 1~3% 풍력 에너지로 변환
  - 지구상 식물에서 발생하는 광합성 에너지의 50~100배 해당
- 지구는 지역에 따라 태양에너지를 받는 양이 다름
  - 극지방은 적도지역보다 적은 에너지를 받음
  - 육지는 바다보다 빨리 에너지를 흡수/방출
- 열적 차이가 공기 대류 발생
  - 가열/냉각에 따라 공기 입자 흐름 발생

풍력발전 원리...

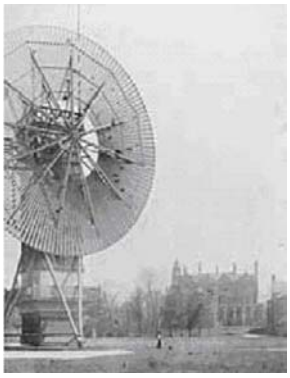
- 바람에 의해 Rotor Blade 회전 (Bernoulli 원리)
- Rotor 회전은 Blade 후방 magnetic Shaft 회전
- 영구자석의 Magnetic Flux 고정자 Copper coil과 쇄교, 교류전류 발생
- 전력변환 회로를 이용 정력 전압 및 전류 생성
- 전력선 이용 전원 공급



풍력발전 원리...



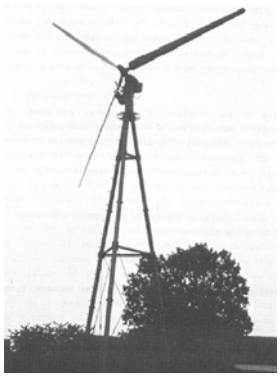
초기 풍력 발전기



Brush 12Kw Wind Gen.
Cleveland, Ohio, 1887



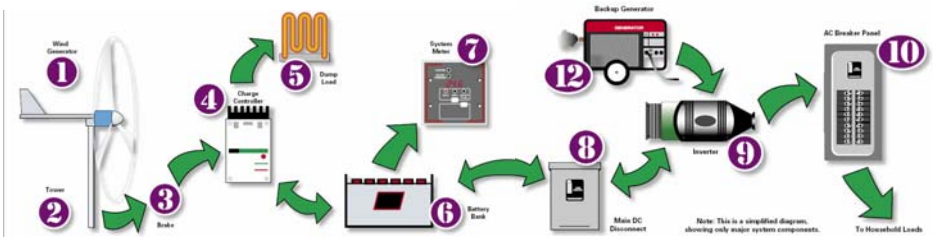
Smith Puttman 1.2MW
Vermont, 1941



U Hutter Wind Machine
Germany, 1957

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Off-grid Wind Generator System



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2Kw Wind Generator Spec.

Specifications	Cut-In	Ratings	Max
Wind Speed [m/s]	4	10	13
Rotor Speed [RPM]	82	204	265
AC Voltage [Vac]	98	179	220
Shaft Torque [Nm]	48.7	107.5	131.8
Power Input [W]	418	2,295	3,655
Rect. Voltage [Vdc]	139	253	311
Rated Current [A]	3.5	8.2	10.4
Rated Load [Ohm]	31.25		
Power Output [W]	350	2,000	3,200
Efficiency [%]	90	90	90
Frequency [Hz]	21~32	36~116	44~158

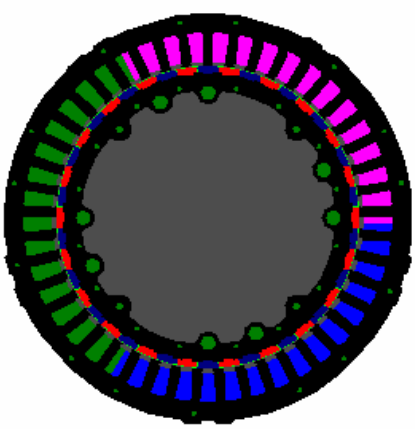


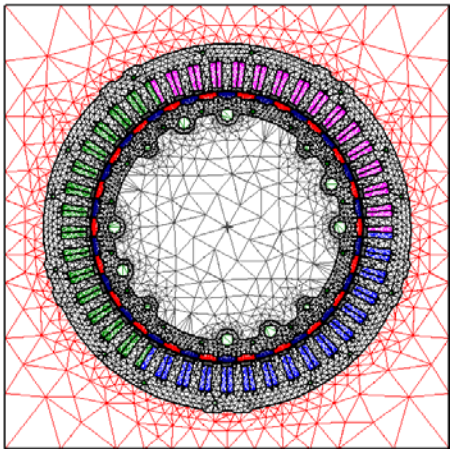
2 Kw Wind Generator

- Light Weight & Maintenance Cost
  - Permanent Magnet type Wind Generator
- Low Cut-in Speed
  - Very Low Cogging Torque Design
    - Stator & Pole Combination
    - Shape of Magnet
    - Manufacturing Cost
- Electric Generating Capability at Low Speed
  - No. of Poles
  - Low Internal Resistance



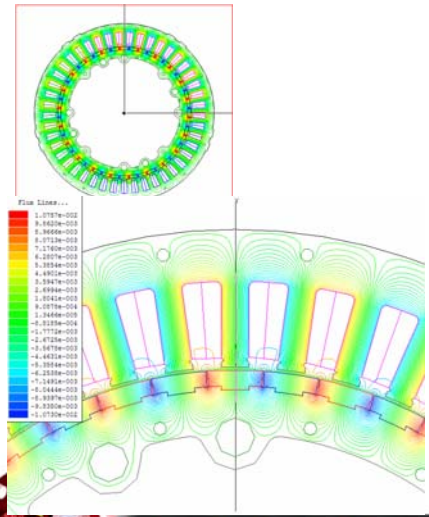
2Kw Generator FEM Model

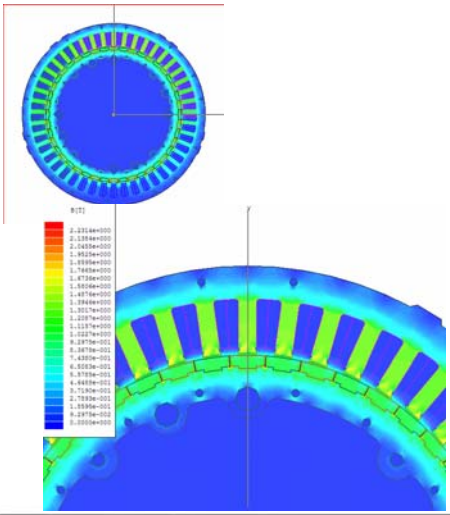




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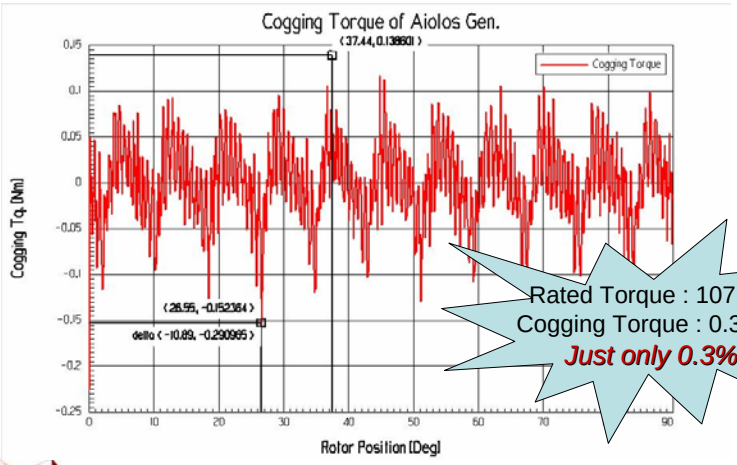
Flux Lines & Flux Density Plot





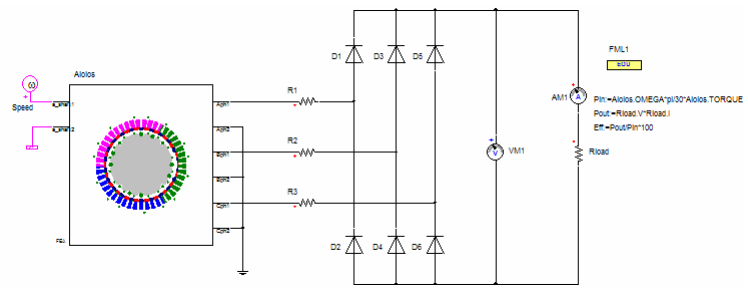
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Cogging Torque Analysis

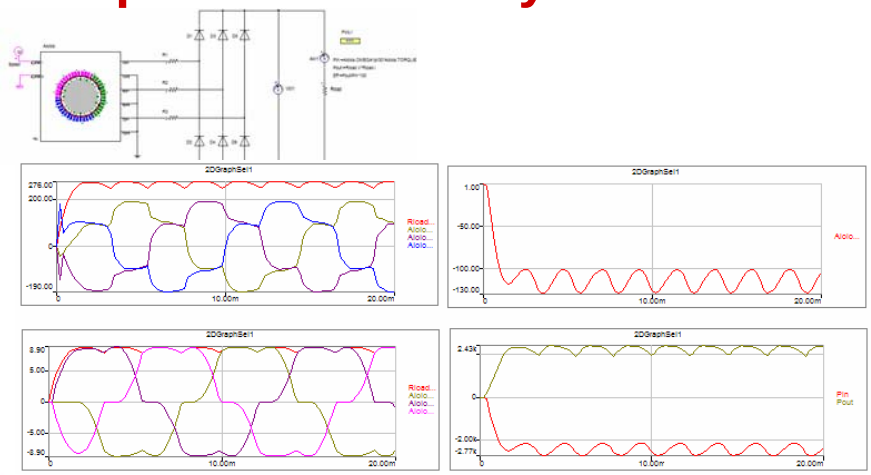


Rated Torque : 107Nm
Cogging Torque : 0.3 Nm
Just only 0.3%

Simplorer FEA Link Model



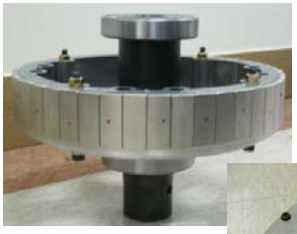
Simplorer FEA Analysis Results



Simulation Results

Wind speed	m/s	3	4	5	6	7	8	9	10	11	12
Rotational Speed	RPM	61	82	102	122	143	163	183	204	224	245
Generator Voltage											
Customer	Vac	85	98	112	125	139	152	166	179	193	206
Kinemotion	Vac	57	77	96	115	134	154	171	189	207	223
Required Torque	Nm	36.8	48.7	59.4	69.8	80	88.9	98	107.5	116	124.2
Gen. Input Power	W	234.96	417.98	634.15	891.30	1197.39	1516.69	1877.09	2295.34	2719.66	3184.90
Retified Voltage											
Customer	Vdc	120	139	158	177	196	215	234	253	273	292
Kinemotion	Vdc	82	109	135	160	186	208	232	257	279	303
Rated Current	Idc	2.6	3.5	4.3	5.1	6	6.7	7.4	8.2	8.9	9.6
Rated Load	Ohm	31.25	31.25	31.25	31.25	31.25	31.25	31.25	31.25	31.25	31.25
Rated Output	W	211.25	382.81	577.81	812.81	1125.00	1402.81	1711.25	2101.25	2475.31	2880.00
Efficiency	%	89.91	91.59	91.12	91.19	93.95	92.49	91.16	91.54	91.02	90.43
Generator freq.											
desired	Hz	18	21	23	26	28	31	34	36	39	42
optional	Hz	18	32	46	60	74	88	102	116	130	144
Kinemotion	Hz	22.37	30.07	37.40	44.73	52.43	59.77	67.10	74.80	82.13	89.83

2Kw Generator Proto Model



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마무리...

- Maxwell 이용 Off-grid용 2Kw 풍력 발전기 성공적 설계
  - 성능 요구 조건 및 Low Cogging Torque
  - Cost Effective 구조 설계
- User 요구 사양의 만족 여부 계산
  - Maxwell과 Simplorer FEA Link 이용 Simulation수행
- 향후 활용 계획
  - Blade 형상 및 설치 환경 조건 등을 고려한 Mechanical Modeling + FEM +Power Electronics 연계 해석 개발

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