

# **Remarkable Change in Korean Wind Energy Industry**

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# 1. Government Strategy

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Low Carbon, Green Growth has been announced as the new paradigm in the future development of Korean Industry by Government.

- Strategic Green Energy Technology Road Map announced in 2009.
- Framework Act on Low Carbon, Green Growth has been signed into law as of January 2010.

# 1. Government Strategy:

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## International Activities:

- Voluntary, unilateral 30% GHG reduction from business-as-usual by 2020 has been reported to UNFCCC
- 5 country Energy Minister Meeting  
(June 2010)
- Hosting and Chairing G20 Submit  
(November 2010)

# 1. Government Strategy

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## Under Legislation in 2010

- Mandatory Cap and Trade System:  
To be introduced in next provisional session of the National Assembly.
- Take effective in 2011 ~2013  
depending upon international negotiation
- Look to incorporate domestic offsets and energy target reduction program.
- Linking to other emission trading scheme

## **2. Regulatory Change**

### **1) Strategy Change to enhance wind energy sector**

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- **Feed-in Tariff has been adopted from 2002 in order to promote the renewable energy.**
- **Subsidy for solar energy was recorded 10 times more than that of wind energy while energy contribution from solar was 25% of wind.**
- **It was not effective to wind energy sector mainly due to lower feed-in tariff for wind energy.**
- **RPS has been adopted by law which will be effective from 2012 applicable to the renewable energy which will enhance wind energy sector.**

## **2) Evaluation of FIT from wind energy point of view.**

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- **Unit price of feed-in tariff for wind energy was too low, recorded mostly lower than SMP and most of wind projects were not viable.**
- **Total budget for subsidy was one basket and most of budget has been allocated to solar energy.**
- **Outcome was not successful as shown in the next page.**
- **SMP is comparatively lower than any other country partly due to contribution from Nuclear and partly due to political populism prevailed so far.**

### 3) Wind Energy Projects enlisted in the 3rd Basic National Plan of Power Supply and Demand. (2006~2020, 2006.12 issued)

Unit:MW

2007	Plan	Implemented	Remarks
Milyang #1(Kyongnam)	50		Delayed /public objection
Hankyung, phase 2(KOSPO)	15	15	Success
Sungsan(KOSPO)	20	12	Delayed(2008)/Reduced(12)
Kangwon Chahang(unison)	22.5		Public objection
2008	Plan	Implemented	Remarks
Sangdo(Jeju Wind)	31.5		Public objection
Yanggu(KOMIPO)	20		Environment
Daegiri(Hyosung)	40	Under progress	Delayed/partly implemented
Milyang #2(Kyungnam)	60		Public objection
Sammu off-shore	30		Delayed/not viable
Taebaeg(KOSPO)	20		Delayed
Pyongchang(KOSPO)	20		Delayed
Kyungju Yangnam(unison)	21		Public objection
Jeongsun(KEWPO)	25		Public objection
Sangmyung(unison)	16		Public objection
Samdal(Hanshin)	0	33	Under progress
2009	Plan	Implemented	Remarks
Duckpyong Jeju(KOMIPO)	40		Environment issue
Daehol Jeju(unison)	18		Public objection

Remarks: Wind projects are being delayed and suspended in Korea versus are being developed very rapidly in the other parts of world.

## 4) Renewable Energy by Source

Items	2002	2003	2004	2005	2006	2007	2008
Generation (GWh)	306,474	322,451	342,147	364,639	381,181	426,647	422,355
Renewable Energy Share (%)	0.07%	1.56%	1.33%	1.08%	1.02%	1.03%	0.90%
Renewable Energy (GWh)	203	5,035	4,534	3,950	3,899	4,395	3,813
Solar	7	8	10	14	31	71	284
Bio	71	100	147	130	155	307	3
Wind	15	25	47	130	239	376	436
Hydro	111	4,902	4,329	3,674	3,468	3,632	3,070
Fuel cell	-	-	-	2	7	9	20

Source : Renewable energy statistics by kemco in 2008

# 5) Subsidy based on FIT

Items		2002	2003	2004	2005	2006	2007	2008
Solar	Generation(GWh)	7	7.8	9.9	14.4	31	71.3	284
	Support Fund(MW)			8	340	3,481	14,772	96,000
	Unit Price(VKWh)	-	-	0.81	23.61	112.29	207.18	338
Bio	Generation(GWh)	70.8	100.2	147	129.6	154.5	307.3	3
	Support Fund(MW)						16	
	Unit Price(₩/KWh)	-	-	-	-	-	0.05	-
Wind	Generation (GWh)	14.9	24.9	47.4	129.9	239	375.6	436
	Support Fund(MW)	256	300	738	3,858	5,483	7,826	
	Unit Price (₩/KWh)	17.18	12.05	15.57	29.70	22.94	20.84	-
Hydro	Generation (GWh)	110.6	4,902	4,329	3,674	3,468	3,632	3,070
	Support Fund(MW)	2,477	3,688	2,859	2,392	661	2,076	
	Unit Price (₩/KWh))	22.40	0.75	0.66	0.65	0.19	0.57	-
Fuel-cell	Generation (GWh)	-	-	-	2	6.7	8.5	20
	Support Fund (MW)	-	-	-	-	48	393	
	Unit Price (₩/KWh)	-	-	-	-	7.16		

# 6) Renewable Energy Business Sector under FIT

## • Renewable Energy

	2003 / 2004 (B won)	2009 / 2010 (B won)
Gov. Incentives	118 / 177.1	774.1 / 808.4
R & D	37 / 73	219.4 / 252.8
Subsidy / Fund	75.4 / 98.9	315.4 / 292
FIT	5.7 / 5.1	239.2 / 263.6

## • Wind

	2003 / 2004	2009 / 2010
Capacity (MW)	18 / 49	342/
Generated Energy (GWh)	25 / 47	700/
FIT(B won)	0.3/0.74	7.8(08)
Number of Generators	-	7(22)
Number of Manufacturers including parts	/12	24 /
Number of Employees	/281	2,301 / 2,668
Exports (M USD)	/58	724 / 1,273

## • Solar

	2003 / 2004	2009 / 2010
Capacity (MW)	/2.5	356/
Generated Energy (GWh)	7. 8/9.9	117/
FIT(B won)	/0.008	63.7/
Number of Generators	-	295/
Number of Manufacturers including parts	/13	61 /
Number of Employees	/170	5,587 / 7,572
Exports (M USD)	/6	1,308 / 3,381

## **7) Pros and Cons regards FIT vs. RPS**

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- **The Projects for developing the renewable energy should be viable regardless FIT or RPS.**
- **Outcome should be more effective, more generation and less subsidy.**
- **Reasonable allocation of fund to the renewable energy resources.**
- **The consideration to develop the respective industry which will contribute to the national GDP in the future.**
- **Solicited for FIT, while market mechanism for RPS.**
- **The proper definition of the renewable energy is required.**

## **8) Why has Korea changed the Strategy from FIT to RPS**

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- **The fund for subsidy has over-run while the outcome was unable to meet target.**
- **Unit price for solar energy has been recorded 10 times higher than that of wind energy as shown in later page.**
- **Businessmen have been crowded to develop the solar energy sector which has recorded more than 300 distributed generators in 2009 from nil in 2002.**
- **Unable to adjust subsidy after people's power established.**
- **To achieve the goal of reduction of de-oxide emission.**
- **To adopt the Cap and Trade system for the CO<sub>2</sub> emission later on.**

## 9) Unit Price applied under FIT

- Solar (Unit Price as of 2010 : won/KWh)

Location	Period	Less than 30KW	ab.30KW le.200KW	ab.200KW le.1MW	ab.1MW le.3MW	ab.3MW
Land	15 yrs.	566.95	541.42	510.77	485.23	408.62
	20 yrs.	514.34	491.17	463.37	440.2	370.7
Building	15 yrs.	606.64	579.32	546.52	—	—
	20 yrs.	550.34	525.55	495.81	—	—

- Wind (above 10KW)

Applicable year	Unit Price (won/KWh)
2009	10.729
2010	105.14
2011	100.98

- Mini-hydro (Less than 5MW) Unit Price (won/KWH)

	Fixed	Variable
above 1MW	66.18 ~ 86.04	SMP+5 ~ SMP+15
less 1MW	72.80 ~ 94.64	SMP+10 ~ SMP+20

# 10) RPS Target

Items	Unit	2012	2013	2014	2015	2016	2017	2018	2019	2022 (after)
TTL Power generation	TWh	490	500	509	517	527	532.7	537	545.8	553.2
Power generation applied for RPS	TWh	448	460	473.6	480	501.6	506.8	511	519	526
RPS applied factor	%	2.0	3.0	3.5	4.0	4.5	5.0	6.0	8.0	10.0
RPS required	TWh	9	13.8	16.6	19	22.6	25	30.7	41.5	52.64
Net RPS required	TWh	7.5	10	12.9	15.5	18.8	21.6	27	37.8	49

### **3. Barriers to penetrate in Wind Energy Sector (Contents)**

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- 1) A big barrier is to access to power grid network**
- 2) Another barrier is to obtain the governmental approval**
- 3) A new concept of terminology of power grid network**

A big barrier is to access to the power grid network

Items	Current Regulation	Desireable Regulation
1. Less than 20MW, Renewable power supply	To connect to 22.9KV bus of either power station or substation	To connect to the existing 22.9KV power network with the condition that any technical or commercial issue raised,ISO will evaluate and give a solution to utility and renewable power supplier simultaneously.
2. Larger than 21 MW, less than 500MW Renewable power supply	To connect to 154KV bus of either power station or substation. Acceptable to connect to the bus of 22.9KV provided capacity is less than 40MW.	To connect to 154KV bus of either power station or substation. However the off-shore wind power supplier shall connect to 154KV bus of the closer substation which ISO recommend utility to build.
3. Lager than 500MW, less than 1,000MW	To connect to bus of either 345KV or 154KV bus.	Same as above with applicable system voltage.
4. Larger than 1,000MW	To connect to the bus of 345KV or more higher voltage.	Ditto.

Note: Korea has the very excellent 220V and 22.9KV distribussion line system nationwide.

Another barrier is to obtain the government approval of the project

Items	MOG(Current Regulation)	Desirable Regulation
1.Environmental impact assesement	Ministry of Environment	One stop window within governmental organization to cover the 4 steps of approval and circulate the
2. Lanscaping review	Local government	fact of approval within 4 Ministries/local of government.
3. Development of project	Ministry of Land Transport and Maritime Affairs	
4. Renewable Energy Project itself	Minstry of Knowledge Economy	
* Procedure to abtain approval	It will take times and incur cost-up in getting through the 4 step procudure in series,	One stop service will save times and cost for promoting renewable projects.
Note: MOG;Ministry of Government		

## A New Copncept Terminology of Power Grid Network

### Conventional terminology

### New concept terminology

1.Extra-high voltage transmission line

Extra-high voltage power network

Exemple:765KV power network

345KV power network

2.High voltage transmission line

High voltage power network

Exp.:154KV power network

3.High voltage distribution line

High voltage power network

Exp.: 22.9KV power network

4.Low voltage distribution line

Low voltage power network

Exp.:220 voltage power network

5. Substation

Convert Station

Note:

1.There is no clear category between transmission and distribution, and sustation

in between transmission and distribution line since ubiquitous renewable energy is available near consumers.

2. There are many distributed generators connected to the conventional distribution line.

3. Therefore the electrical power and energy are being networked and bi-laterally been receiving or supplying.

4. Micr-grid is regarded as an independent power grid network.

## 4. Contribution from Wind Energy Source (Contents)

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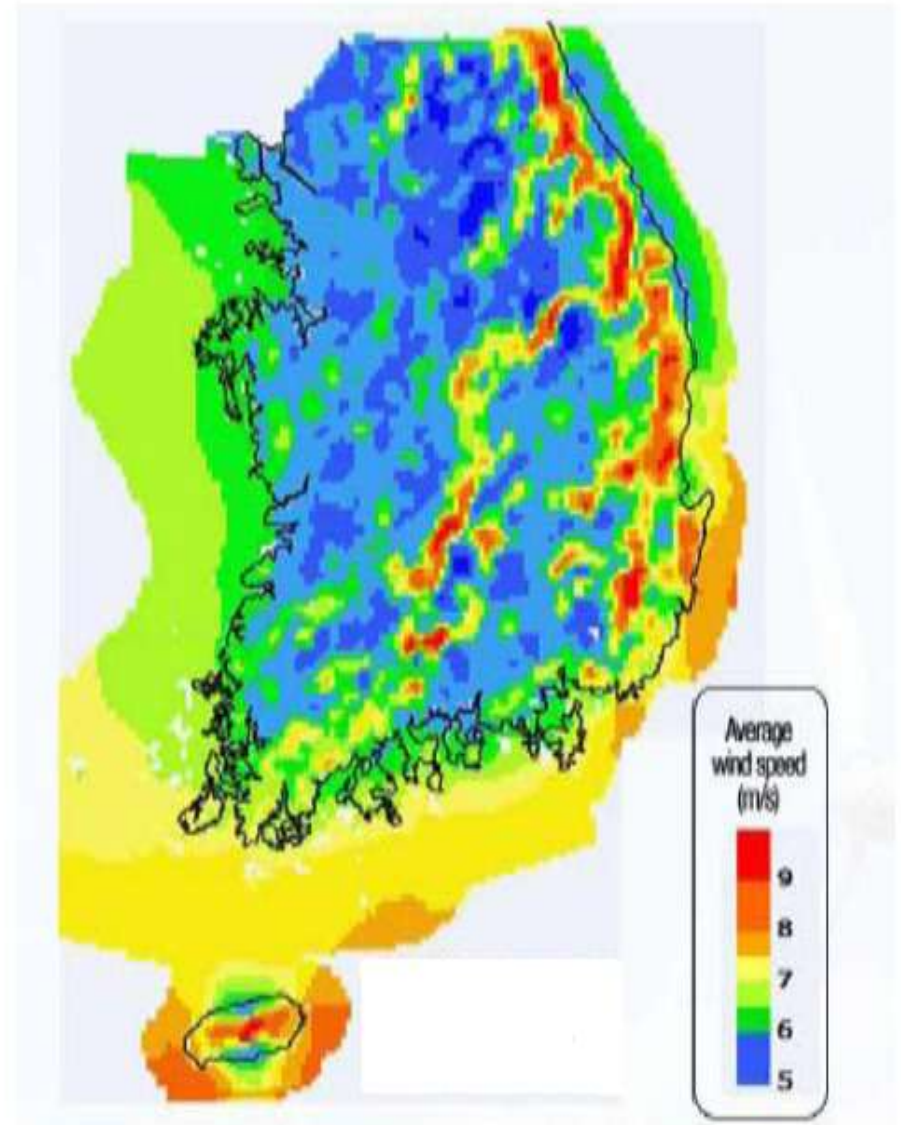
- 1) Status of Wind Energy Contribution
- 2) Forecast of Wind Energy Contribution
- 3) Wind Data Source, Resource Map
- 4) Satellite Wind Measurement

	Status of Wind Energy Cotribution						
Items			2003	2004	2005	2006	2008
Iry Energy(M TOE)			215	220	229	233	240
Renewable Energy( M TOE)			4	4.5	4.8	5.2	5.8
Ratio: RE/Iry E(%)			2.06	2.08	2.13	2.24	2.43
Wind (K TOE)			6.2	11.8	32.4	59.7	93.7
Ratio:WE/RE(%)			0.1	0.3	0.7	1.1	1.6
Renewable E.(GWh)			5,035	4,534	3,950	3,899	4,227
Wind Energy Capacity(MW)			18	68	98.7	177.6	304
Wind Energy(GWh)			25	47	130	239	430
Raio:WE/RE(%)			0.5	1	3.3	6.1	10.1

	Forecast of Wind Energy Cotribution						
Items			2010	2015	2020	2030	
Iry Energy(M TOE)			253	270	287	300	
Renewable Energy( M TOE)			8	11.7	17.5	33	
Ratio: RE/Iry E(%)			2.98	4.33	6.08	11	
Wind (K TOE)			232	1,055	2,030	4,158	
Ratio:WE/RE(%)			2.9	9.02	11.6	12.6	
Renewable E.(GWh)			6,345	13,016	21,977	39,517	
Wind Energy Capacity(MW)			1,000	5,000	9,000	14,000	
Wind Energy(GWh)			881	4,336	8,138	16,620	
Raio:WE/RE(%)			13.9	33.3	37	42.1	

# Wind Data Sources: Resource Maps

- Very coarse data for (at best) for narrowing down suitable sites
- Based on historical upper level weather data, mesoscale atmospheric modelling
- Validated using available met data
- Example:
  - Korean wind map

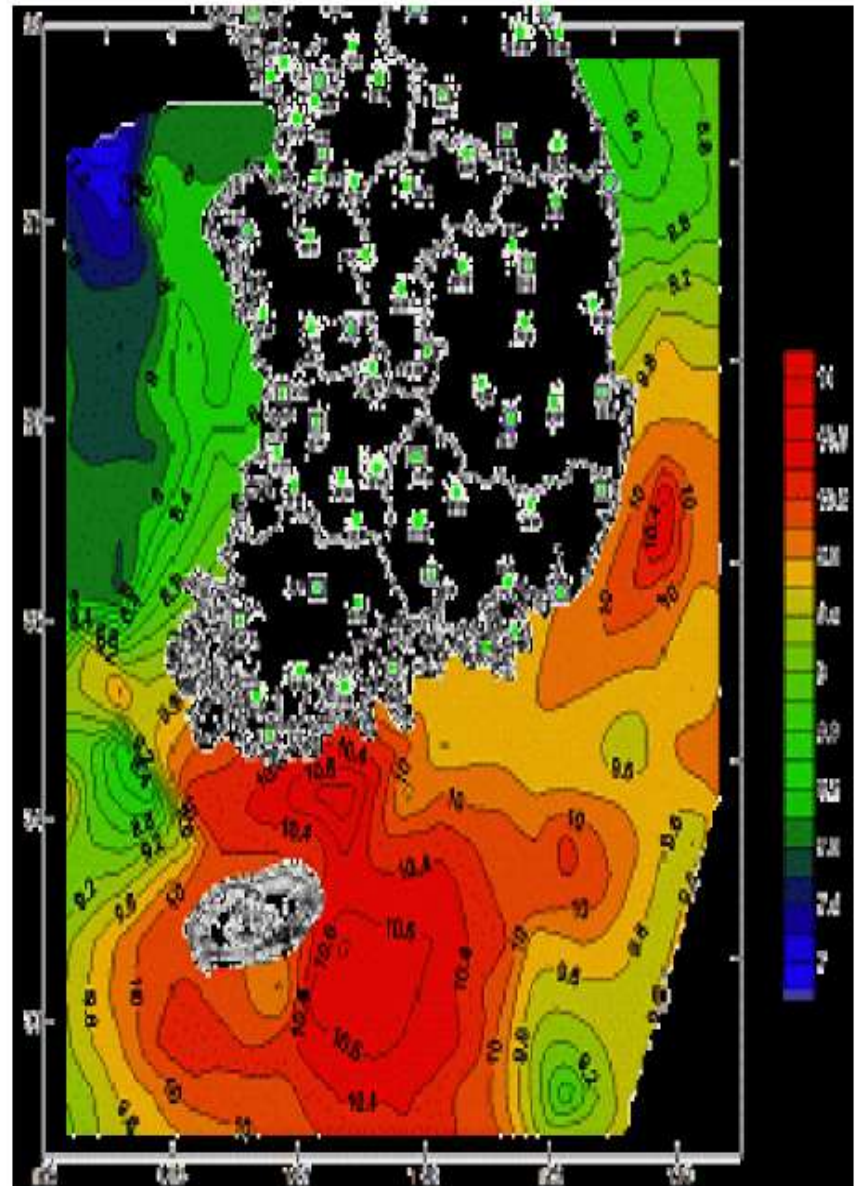


# Satellite Wind Measurement

- Based on measurements of capillary waves (small ripples on the sea surface) generated by the wind above them, calibration against offshore measurements (NASA)



- Heights: “above sea”
- Course spatial, time resolution
- Example: Map of Korean offshore winds



## **5.Dreams of Korea Wind Energy Industry Association (Contents)**

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- 1) Wind projects under consideration by private sector**
- 2) Wind projects under planning by Chonnam local government**
- 3) Status and Forecast of Wind Energy Facility of Korea**
- 4) Wind Energy Facility of Korea (Dream)**
- 5) Energy Source Mix for Generation (Dream)  
(Past-Current-Future)**

# 5. Dreams of Korea Wind Energy Industry Association

## 1) Wind projects under consideration by private sector

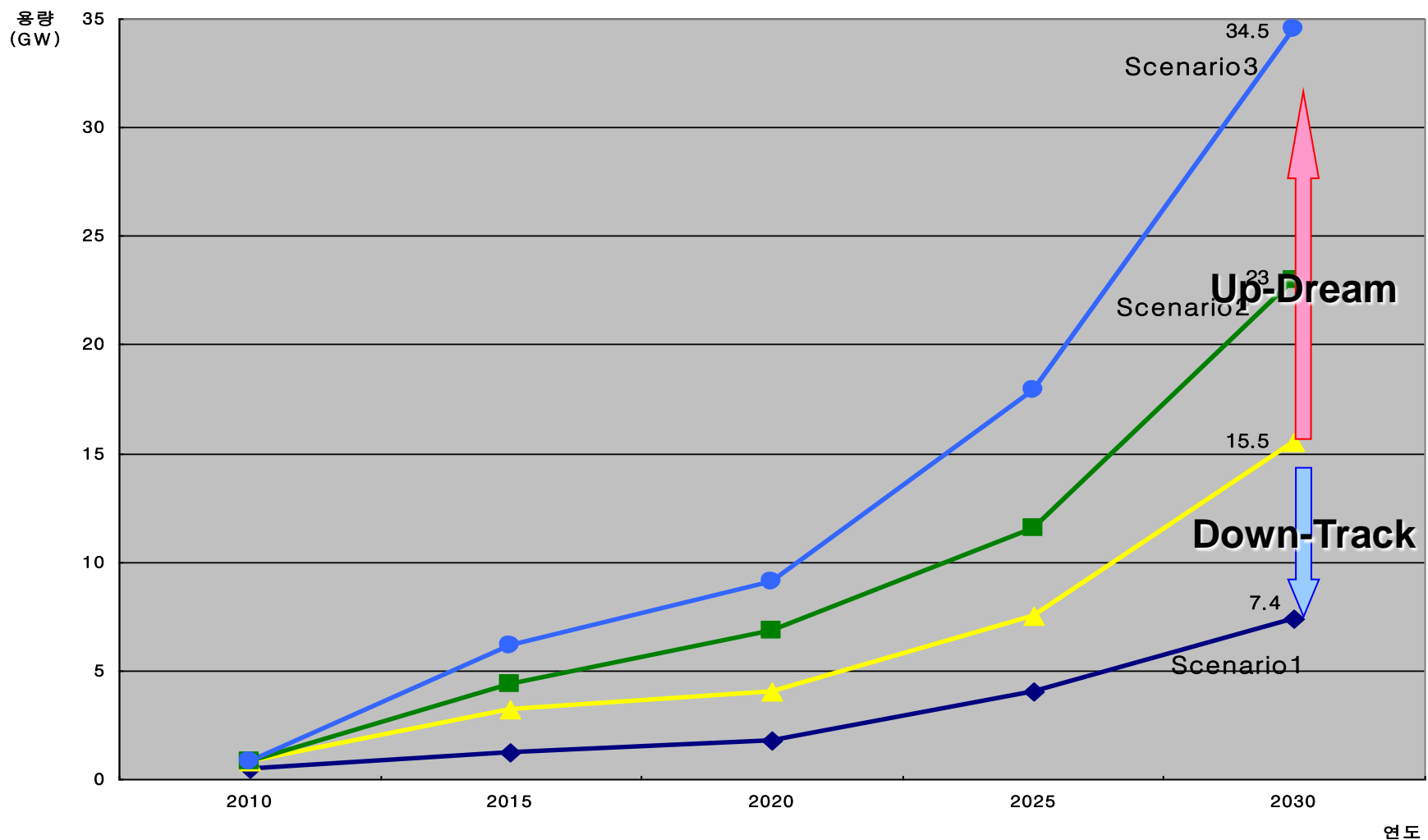
developers	Location	Capacity (MW)	Remarks
1.KNOC/HEC	Chonnam Yusu	20MW	Under design, to be completed by 2012, Est.budget: 83 B won
2. Kwmho Industry	Chonnam Yusu	100MW	
3. KOSPO	Busan off-shore	350MW(3.5MWx100ㄱ )	Target: 2020. 390W/m2, 0~30m depth, 10Km away
4. KNHC/Doosan/NCE	Jeju off-shore Hangkyung	30MW	Gov.permit in 2006, Delayed due to lack of viable ,review to start.
5. Dongkuk S&C/EWP/Yurus	Chunnam Beegwkdo	200MW	Target: 2013 / Est. budget:1.2T won
6. POSCO E&C	Chonnam Off-shore West-South	600MW	Target: 2015 / Est. budget:2.5 T won
7.POSCO E&C	Chonbuk	100MW(5MWx20)	Const. period: 2011 ~ 2015 Est. budget:0.5 T won
8. Hanwha Consortium	Off-shore Incheon	100MW (2.5MWx40ㄱ /3MWx33ㄱ )	333W/m2/7mdepth/20Km away. Start:2012, Est.budget:500 B won
9. Hanshin Energy	Jeju off-shore Gapa	50MW	Target: 2012
10. Halla Consortium	Jeju off-shore east-west	500MW	Target: 2013
11. Hanshin Energy	Samdal Ext. (onshore)	32 MW	Target: 2011
12. Accioner Korea	Kyongnam Yangyang(onshore)	500MW	60MW completed in 2009, Balance step by step
13.DMS/Enometal Ezrobot	Off-shore Taaan	100MW(3.6MWx27)	Est. budget:400 B won
14. KMIPO	Jeju Esidol(on shore)	20MW	Under design
15. Korea Gov.	Off-shore Saemangwm Dam	40MW	2MW track record build-up, Open for the new model from
16. KARICO Consortium	Chonnam Haenam	400MW	Target:2016 / Est. budget:1.2 T won
Total		3,142MW	

## 2) Wind projects under planning by Chonnam local government

	Capacity (MW)	On-shore (MW)	Off-shore (MW)	Est. budget: B won for 1 <sup>st</sup> stage
KOSEP	600	40	560	938.6
KOMIPO	300	100	200	250
KOSPO	500	100	400	460
EWP	200	50	150	181.3
KNHC	50		50	60
Fund Institute Consort.	1,000	200	800	4,400
POSCO PWR	600	200	400	2,300
LG E&S	1,000	1,000		3,000
Mitsui/Daewoo E&C	400	400		1,200
Dongkuk S&C	200		200	1,200
Acciona Korea	720	120	600	1,600
Total	5,570	2,210	3,360	15,589.9

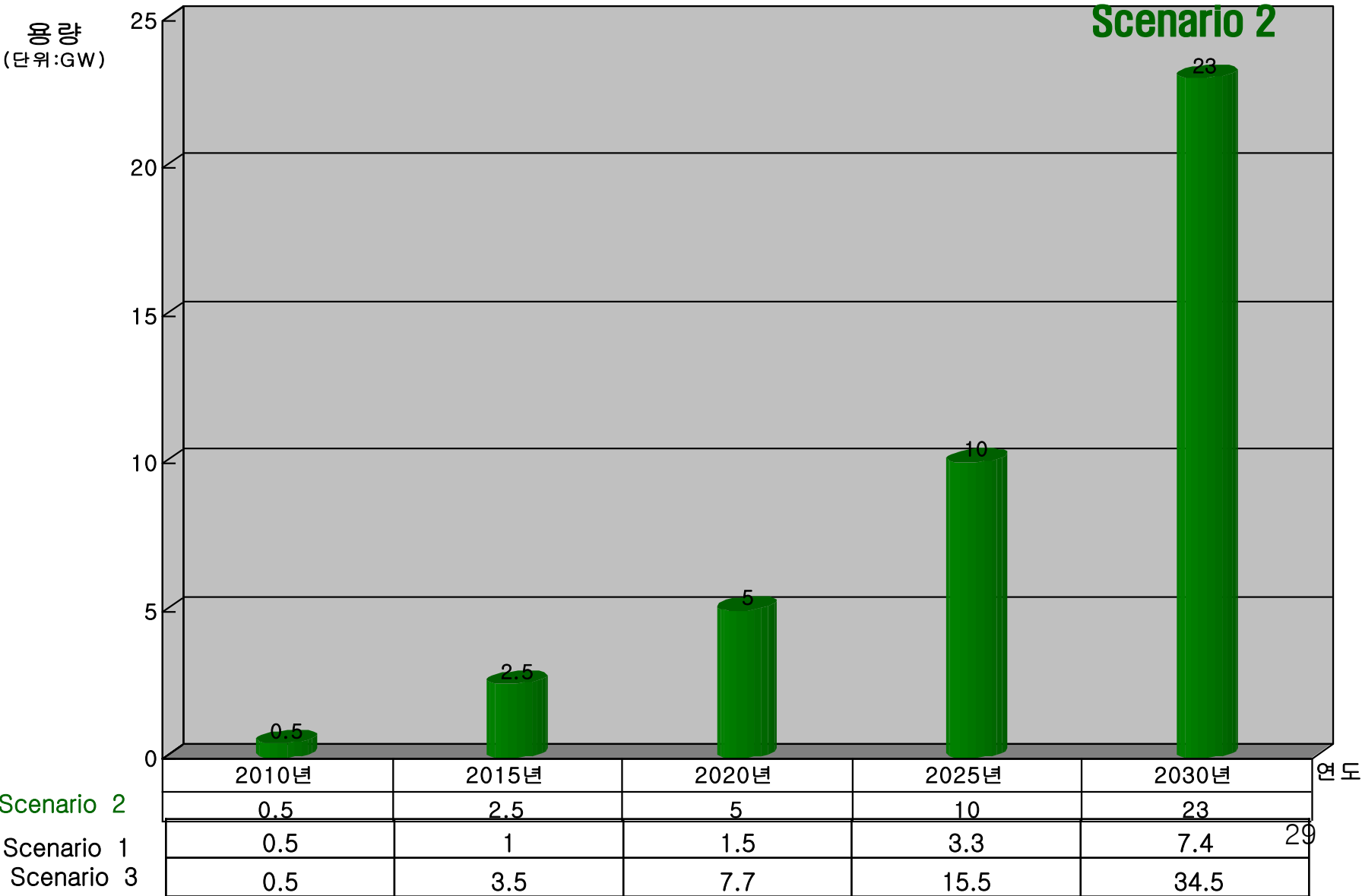
Source: Chonnam Local Gov.

### 3) Status and Forecast of Wind Energy Facility of Korea



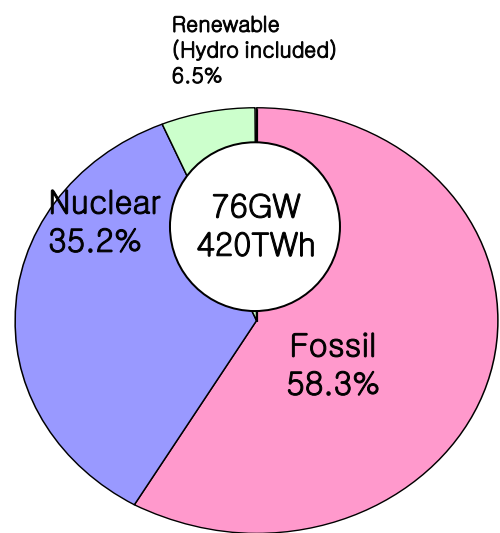
- ◆ Reviced Forecast by MKE in 2008(Scenario1)
- ▲ Reviced Forecast by MOCIE in 2003
- Dream1(Scenario2)
- Dream2(Scenario3)

# 4) Wind Energy Facility of Korea (Dream)

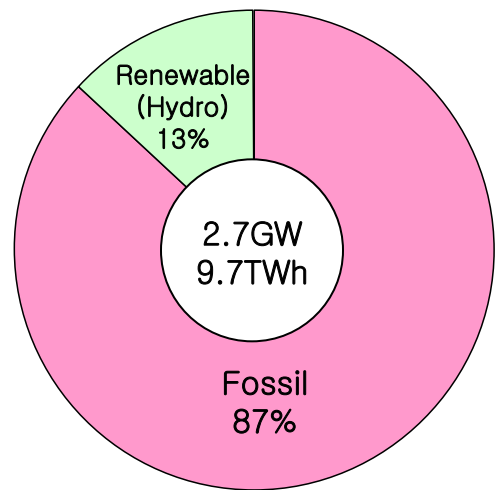


# 5) Energy Source Mix for Generation (Past-Current-Future)

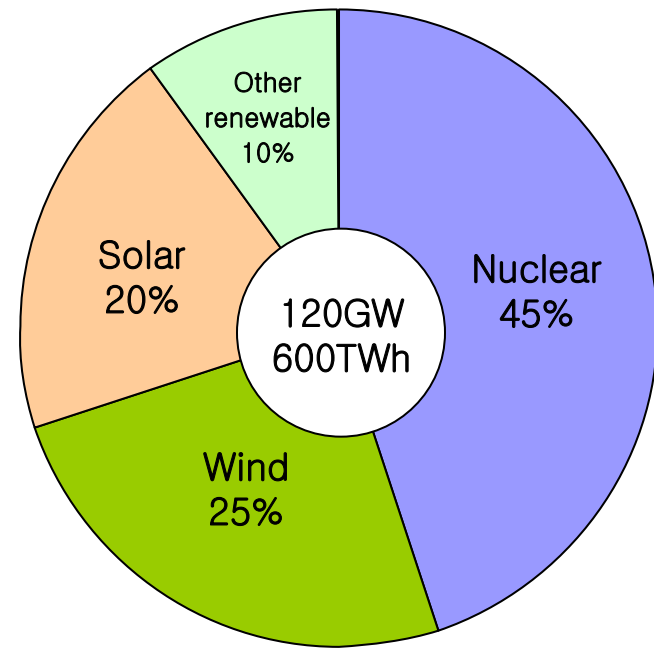
2010  
(Base)



1970  
(-40)



2050  
(+40)



# 6. Energy Comparison with World Data (Contents)

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1) EU Energy Mix in 1995 and 2007

2) EU energy Mix in 2050

3) Electric Power Generation

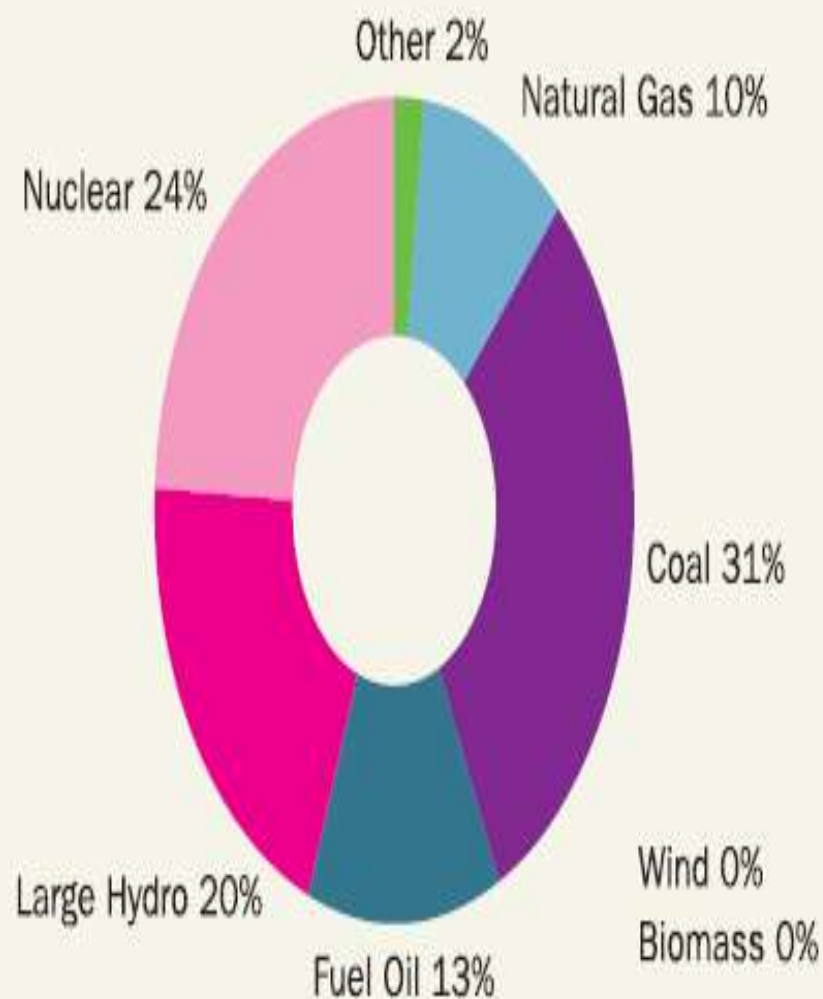
**Note: Korea marks 10th largest in the world.**

4) Wind Energy Facility installed (WWEA 2009 )

**Note: Korea marks 28th rank in the world which is comparatively low value comparing those of electric power generation.**

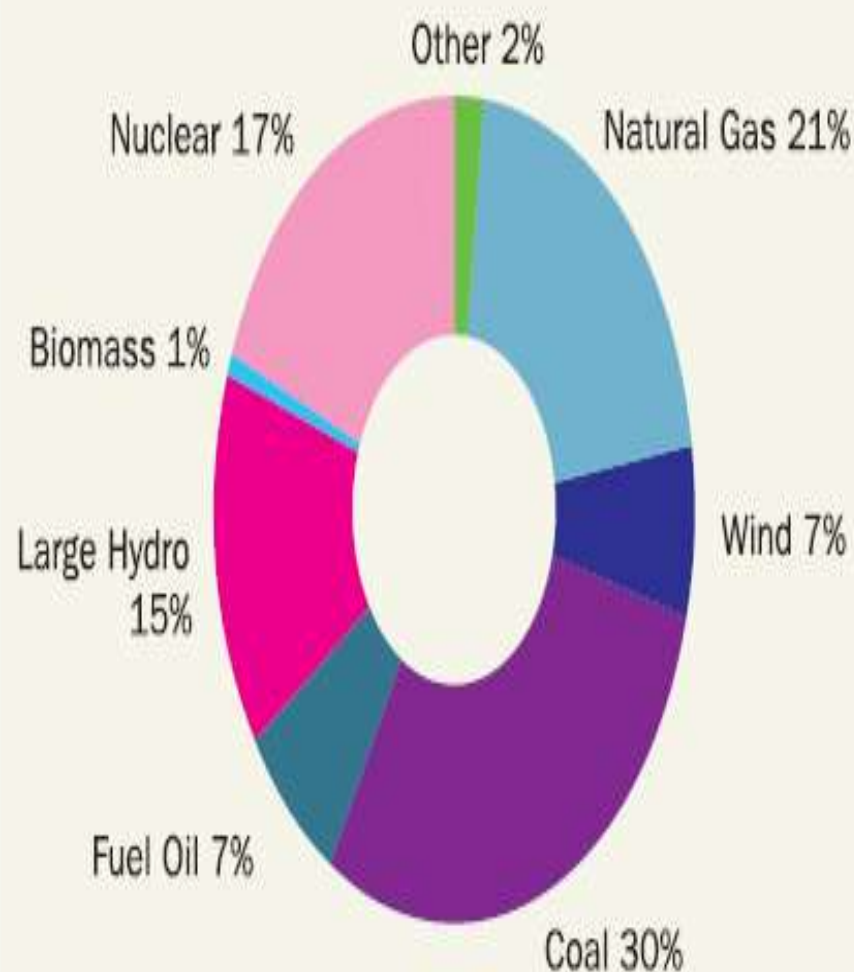
5) Wind Energy Facility of World  
(Status and Forecast)

FIG 1.3: EU Energy mix 1995 (Total 532 GW)



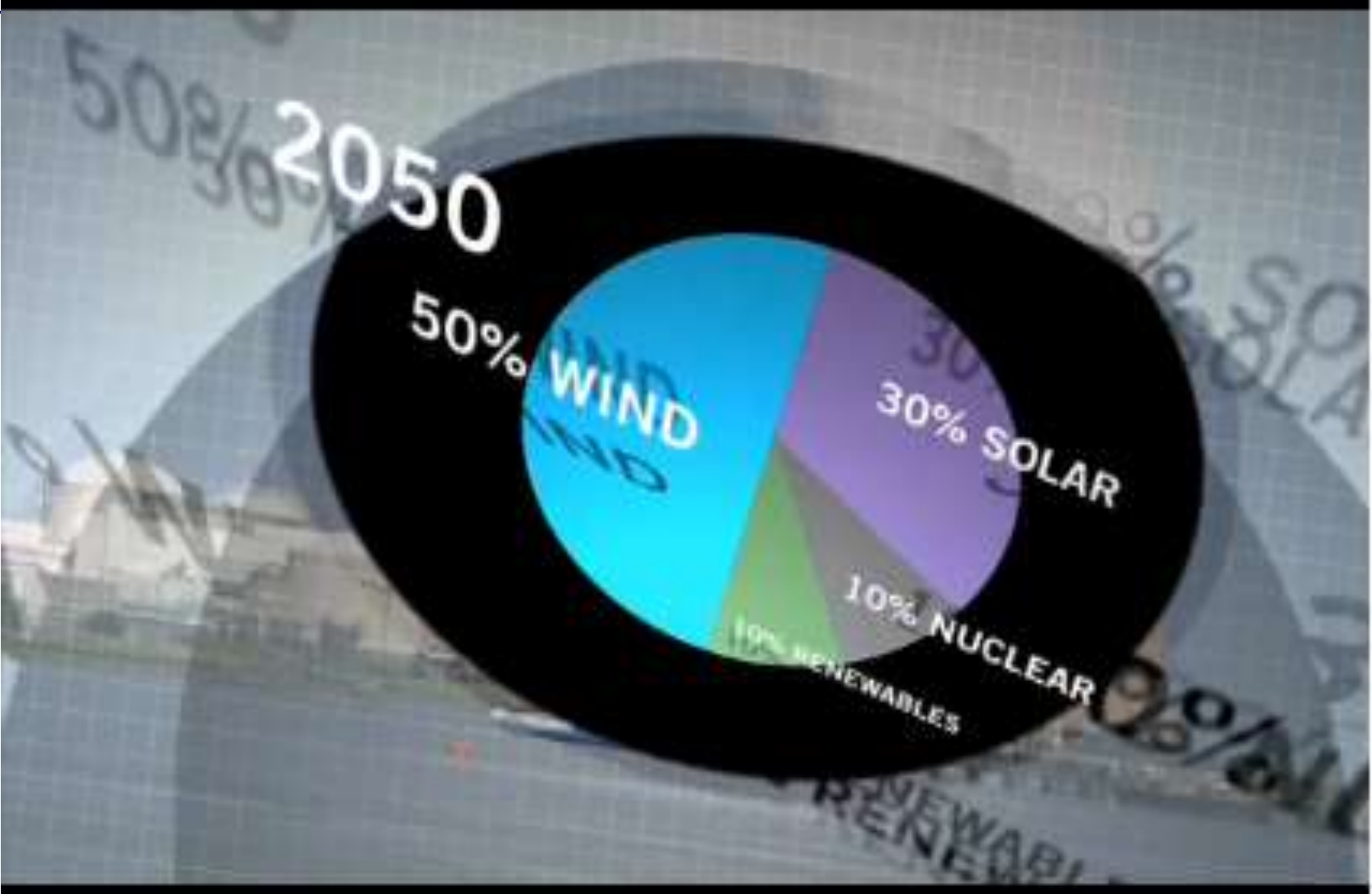
Source: EWEA and Platts PowerVision

FIG 1.4: EU Energy mix end 2007 (Total 775 GW)



Source: EWEA and Platts PowerVision

## Module 1 : 2050 Challenge



### 3) Electric Power Generation



Producers*	TW/h	% of world total
United States	4 323	21.9
People's Rep. of China	3 279	16.6
Japan	1 123	5.7
Russian Federation	1 013	5.1
India	803	4.1
Canada	640	3.2
Germany	630	3.2
France	564	2.9
Brazil	445	2.3
Korea	426	2.2
Rest of the world	6 525	32.8
<b>World</b>	<b>19 771</b>	<b>100.0</b>

2007 data

Net exporters	TW/h
France	57
Paraguay	45
Canada	25
Germany	17
Czech Republic	16
Russian Federation	13
People's Rep. of China	10
Norway	10
Ukraine	9
Spain	6
Others	47
<b>Total</b>	<b>255</b>

2007 data

Net importers	TW/h
Italy	46
Brazil	39
United States	31
Netherlands	18
Finland	13
Argentina	8
Portugal	7
Hong Kong (China)	7
Belgium	7
Austria	7
Others	71
<b>Total</b>	<b>254</b>

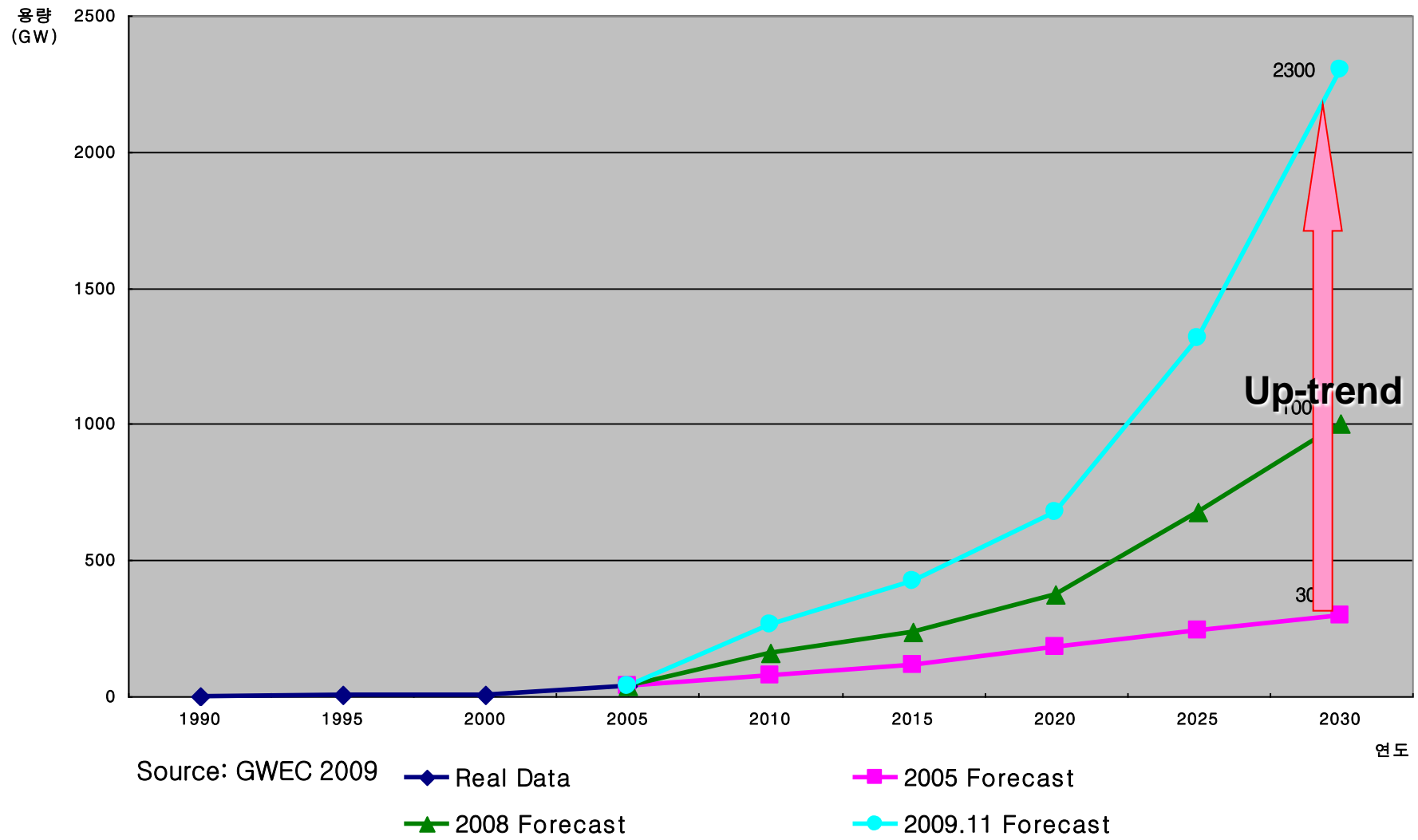
2007 data

\*Gross production minus production from pumped storage plants.

## 4) Wind Energy Facility installed (WWEA 2009 )

Position 2009	Country / Region	Total capacity end 2009	Added capacity 2009	Growth rate 2009	Position 2008	Total capacity end 2008	Total capacity end 2007	Total capacity end 2006
		[MW]	[MW]	[%]		[MW]	[MW]	[MW]
1	USA	35.159,0	9.922,0	39,3	1	25.237,0	16.823,0	11.575,0
2	China	26.010,0	13.800,0	113,0	4	12.210,0	5.912,0	2.599,0
3	Germany	25.777,0	1.880,0	7,9	2	23.897,0	22.247,4	20.622,0
4	Spain	19.149,0	2.460,0	14,7	3	16.689,0	15.145,1	11.630,0
5	India	10.925,0	1.338,0	14,0	5	9.587,0	7.850,0	6.270,0
6	Italy	4.850,0	1.114,0	29,8	6	3.736,0	2.726,1	2.123,4
7	France	4.521,0	1.117,0	32,8	7	3.404,0	2.455,0	1.567,0
8	United Kingdom	4.092,0	897,0	28,1	8	3.195,0	2.389,0	1.962,9
9	Portugal	3.535,0	673,0	23,5	10	2.862,0	2.130,0	1.716,0
10	Denmark	3.497,0	334,0	10,6	9	3.163,0	3.125,0	3.136,0
11	Canada	3.319,0	950,0	40,1	11	2.369,0	1.846,0	1.460,0
12	The Netherlands	2.240,0	5,0	0,2	12	2.235,0	1.747,0	1.559,0
13	Japan	2.056,0	176,0	9,4	13	1.880,0	1.528,0	1.309,0
14	Australia	1.877,0	383,0	25,6	14	1.494,0	817,3	817,3
15	Sweden	1.579,0	512,0	48,0	16	1.066,9	831,0	571,2
16	Ireland	1.260,0	233,0	22,7	15	1.027,0	805,0	746,0
17	Greece	1.109,0	119,0	12,0	18	989,7	873,3	757,6
18	Austria	995,0	0,0	0,0	17	994,9	981,5	964,5
19	Turkey	796,5	463,1	138,9	25	333,4	206,8	64,6
20	Poland	666,0	194,0	41,1	19	472,0	276,0	153,0
21	Brazil	600,0	261,5	77,3	24	338,5	247,1	236,9
22	Belgium	555,0	171,0	44,6	22	383,6	286,9	194,3
23	New Zealand	497,0	172,0	52,9	26	325,3	321,8	171,0
24	Chinese Taipeh	436,0	78,0	21,8	23	358,2	279,9	187,7
25	Norway	431,0	2,0	0,5	20	429,0	333,0	325,0
26	Egypt	430,0	40,0	10,3	21	390,0	310,0	230,0
27	Mexico	402,0	317,0	372,9	34	85,0	85,0	84,0
28	Korea (South)	364,4	86,4	31,1	27	278,0	192,1	176,3
29	Morocco	253,0	129,0	104,0	32	124,0	125,2	64,0

# 5) Wind Energy Facility of World (Status and Forecast)



## 7. WTG Manufacturing Technology

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\* Shift from Indigenous to International Tech.

### 7-1. Indigenous Technology Developers:

- 1) Hyosung:
  - 750KW and 2MW(Under test operation)
  - 5MW(Under developing)
- 2) Unison: 750KW and 2MW(Under test operation)
- 3) Doosan: 3MW(Under test operation)
- 4) Hanjin: 1.5MW(Under test operation)

# 7. WTG Manufacturing Technology

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## 7-2. International Technology Inducement:

- 1) Hyundai Heavy Industry(AMSC Wintec,USA):
  - 1.65MW(under mass production, to supply domestic market and Pakistan )
  - 5MW(Under developing for offshore project)
- 2) Samsung Heavy Industry(UK):
  - 2.5MW(under mass production for onshore project)
  - 5MW(under development for offshore project)
- 3) Daewoo Shipbuilding and Marine(Dewind,USA)
  - 750KW,1.5MW,2MW(under production in USA)
  - Ship for offshore WTG erection(Client: RWE)
- 4) STX Heavy(Harakosan,Netherland)
  - 2MW, 3MW(under production in Netherland)

## 8.Component Producing Industry

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- 1) Dongkuk S&C: Tower(Client:Vestas)
- 2) CS Wind:Tower(Client:Siemens,Vestas,GE)
- 3) Taewoong:Main shaft,Flange,Forged or molded materials(Client:Vestas,Siemens,GE)
- 4) PMS Pyongsan:Flange, Gear ring,distance plate, lock plate, rotor shaft, gear box for 1.5MW(Client:Vestas,Siemens,GE,Gamesa)
- 5) KM: Blades for 2MW, 3MW
- 6)Hyunjin Source Material:Main shaft, tower flange,Forged materials.
- 7) Korea Tech.: Rotor hub,Bed Plate

## 9. Smart Grid Promotion

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- 1) Electrical Power and Energy Deal at SMP between Supplier and Consumers.
- 2) Automatic measuring watt-hour meter will be installed through IT system.
- 3) Renewable Energy Sources are enhanced to develop within Power Grid System.
- 4) Electrical Storage System such as Battery Station will be installed and added.
- 5) Electrical Vehicles are enhanced to use.
- 6) Effective usage and save of Energy will be achieved.
- 7) Jeju island has been nominated as a trial territory to apply the Smart Grid System.

To be presented more details by Professor Moon in another session.

# Abbreviation & Reference

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## 1. Abbreviation:

- K:Kilo,1,000times (KWh)
- M:Mega,1,000times of K(MWh)
- G:Giga,1,000times of M(GWh)
- T:Tera, 1,000times of G(TWh)
- TOE: Tonnage of oil equivalent
- FIT: Feed-in Tariff
- RPS: Renewable Energy Portfolio
- REC: Renewable Energy Certificate
- SMP: System Marginal Price

## 2. Reference:

- Data of MKE (Ministry of Knowledge Economy)
- For FIT and RPS.
- Data of KEPCO for access to grid power network(2010.4)
- 박종배교수, REC시장 및 가격
- Off-shore wind farm projects by Jullanamdo
- .노상양 실장,에너지관리공단,해상풍력 시책 및 활성화 방안(2010.4)
- IEA Annual Report 2009.
- WVEC Annual Report 2009.

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# Thanks for Your Kind Attention

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