

Le fonti rinnovabili e l'energia eolica nei contesti: globale, europeo e nazionale

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Obiettivi del corso on-line

1. Fornire alcuni dati circa l'incidenza delle fonti rinnovabili (in particolare eolica) a livello europeo e nazionale.
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EU power mix

FIGURE 2.3: EU POWER MIX 2000

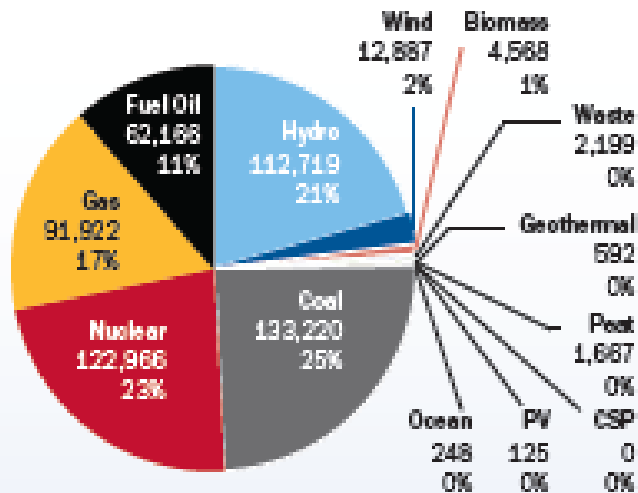
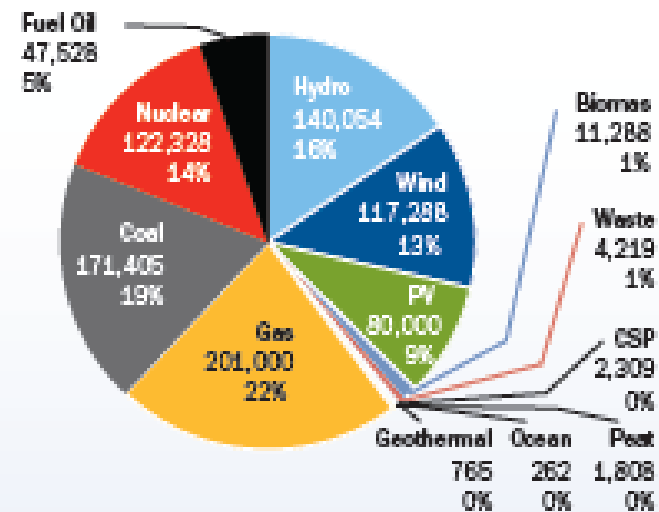


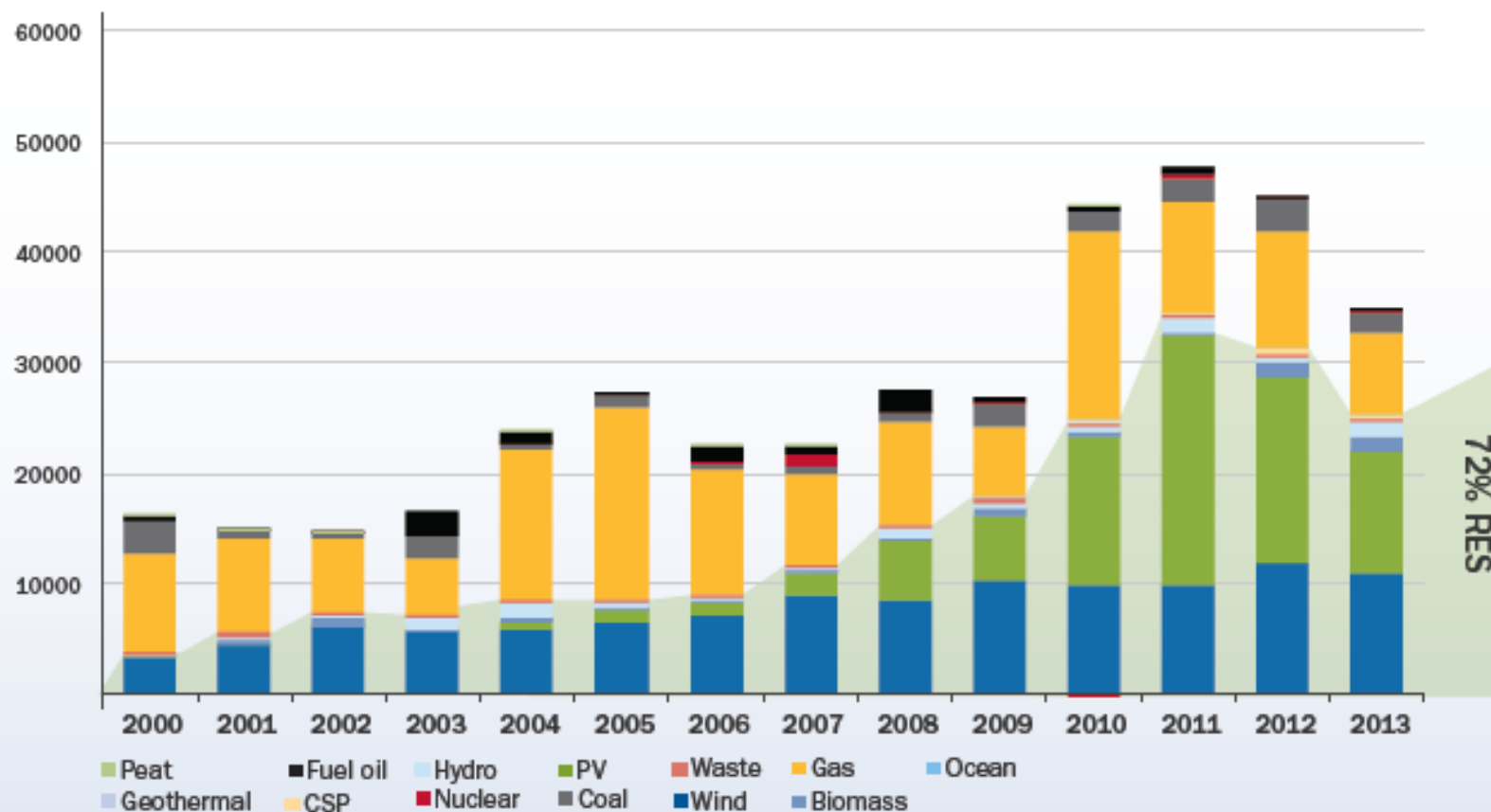
FIGURE 2.4: EU POWER MIX 2013



CSP: *Concentrating Solar Power*, Peat: torba

Le “rinnovabili” nel contesto europeo

FIGURE 2.1: INSTALLED POWER GENERATING CAPACITY PER YEAR IN MW AND RENEWABLE ENERGY SHARE (%)



Le “rinnovabili” nel contesto italiano

- L' idroelettrico, che fornisce la quota più rilevante, è caratterizzato da una forte fluttuazione da attribuire a fattori di idricità;
- la geotermia mostra un contributo relativamente costante, che nel periodo considerato oscilla intorno a 1.4 Mtep;
- per quanto riguarda le altre rinnovabili, si evidenzia nel 2008 il buon incremento della produzione eolica (+20%) e la sorprendente crescita dei biocombustibili (+227%). Meno marcati invece gli aumenti di biomassa legnosa (+5%) che si attesta su valori ancora lontani da quelli tipici dei Paesi europei, dei rifiuti (+3%) e dei biogas (+11%);
- molto bene inoltre le produzioni da fonti solari quali il solare termico (+44%) e il fotovoltaico (quasi quattro volte rispetto al 2007). Fonte ENEA

Fonti energetiche	2000	2005	2006	2007	2008
Idroelettrica ¹	9.725	7.935	8.139	7.219	9.157
Eolica	124	515	654	888	1.069
Solare fotovoltaico	4	7	11	26	99
Solare termico	11	21	29	39	56
Geotermia	1.248	1.384	1.429	1.438	1.427
Rifiuti ²	461	1.501	1.672	1.734	1.784
Legna ed assimilati ³	2.344	3.153	3.328	3.710	3.883
Biocombustibili	95	172	155	174	567
Biogas	162	343	383	415	459
Totale	14.173	15.033	15.798	15.641	18.501
di cui non tradizionali ⁴	2.046	4.556	4.964	5.334	6.210

¹ Solo energia elettrica da apporti naturali valutata a 2200 kcal/kWh.

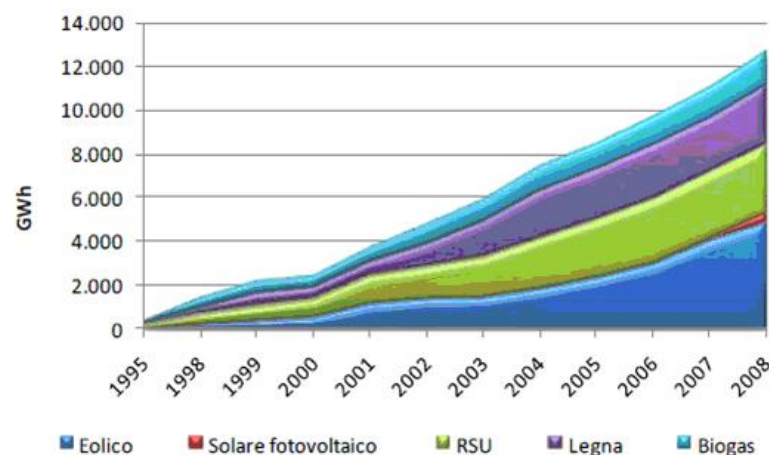
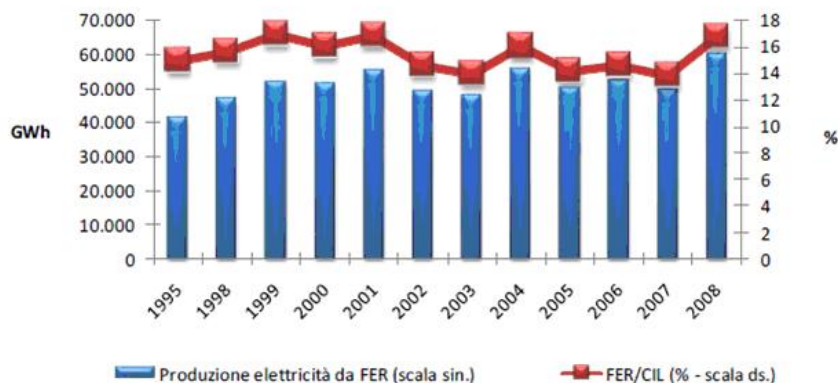
² Inclusa la parte organica.

³ Non include risultato indagine ENEA sul consumo di legna da ardere nelle abitazioni.

⁴ Eolico, solare, rifiuti, legna (esclusa la legna da ardere), biocombustibili, biogas.

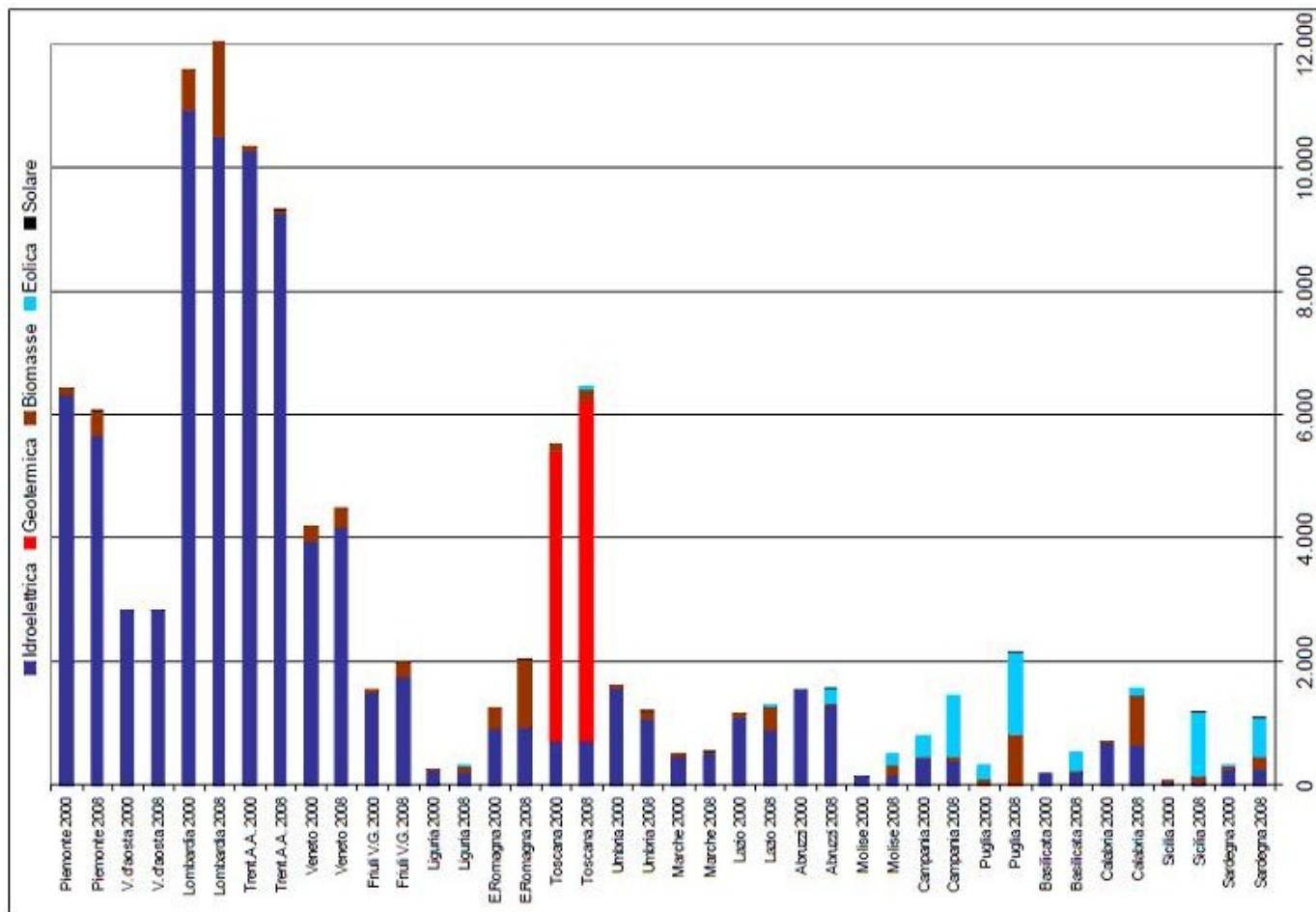
* Dati provvisori.

Energia elettrica da FER



- Italia: produzione di energia elettrica da fonti rinnovabili (anni 1995-2008)
- Italia: energia elettrica da fonti rinnovabili non tradizionali (anni 1995-2008, GWh)

Il contesto regionale



Produzione di energia elettrica da fonti rinnovabili nelle regioni per fonte (anni 2000 e 2008/ GWh)

La fonte eolica



Da dove proviene l'energia eolica?

- Tutte le fonti rinnovabili (ad eccezione dell'energia maremotrice e geotermica) hanno origine dal sole. Il sole irradia 174,423,000,000,000 kilowatt ora di energia verso la terra ogni ora. In altre parole, la terra riceve 1.74×10^{17} watts di potenza dal sole.
- Si stima che circa il 1-2% dell'energia proveniente dal sole sia convertita in energia eolica.

Energia eolica: vantaggi

- Il vento è una fonte rinnovabile:
 - pulita,
 - inesauribile.

Energia eolica: svantaggi

- La fonte eolica è intermittente;
- L'impatto visivo non è trascurabile nelle aree antropizzate;
- La densità di potenza è bassa.

HAWT da 6,5 MW

Turbina Francis da 700 MW



Impatto ambientale sull'avifauna

Causes of bird mortality	Annual bird mortality estimate
Buildings/windows	550 million
High tension lines	130 million
Cats	100 million
Vehicles	80 million
Pesticides	67 million
Communication towers	4.5 million
Wind turbines	28.5 thousand
Aeroplanes	25 thousand

Source: Erickson W., Johnson, G. and Young, D. (2005)

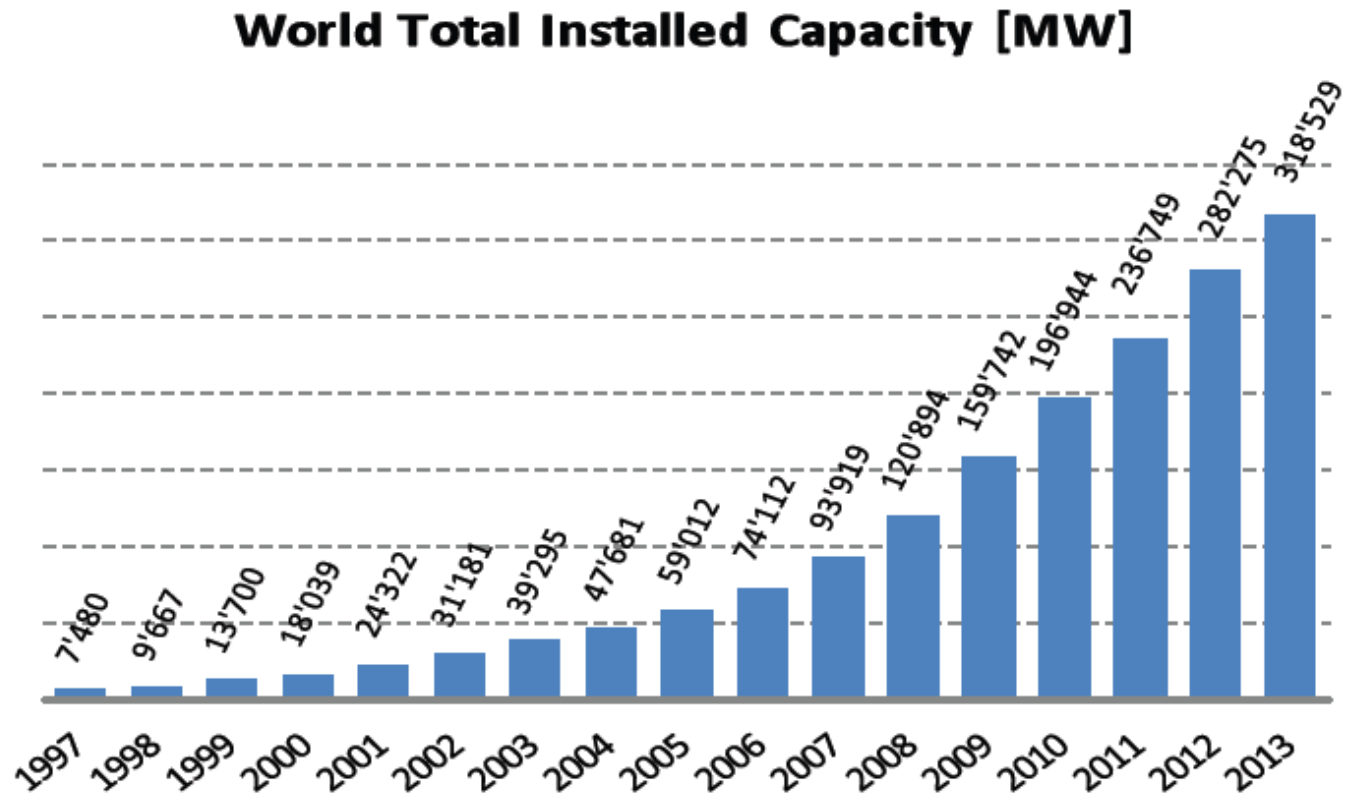
Impatto acustico

Comparative noise for common activities

Source/activity	Indicative noise level (dB)
Threshold of hearing	0
Rural night-time background	20-40
Quiet bedroom	35
Wind farm at 350m	35-45
Busy road at 5km	35-45
Car at 65km/h at 100m	55
Busy general office	60
Conversation	60
Truck at 50km/h at 100m	65
City traffic	90
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

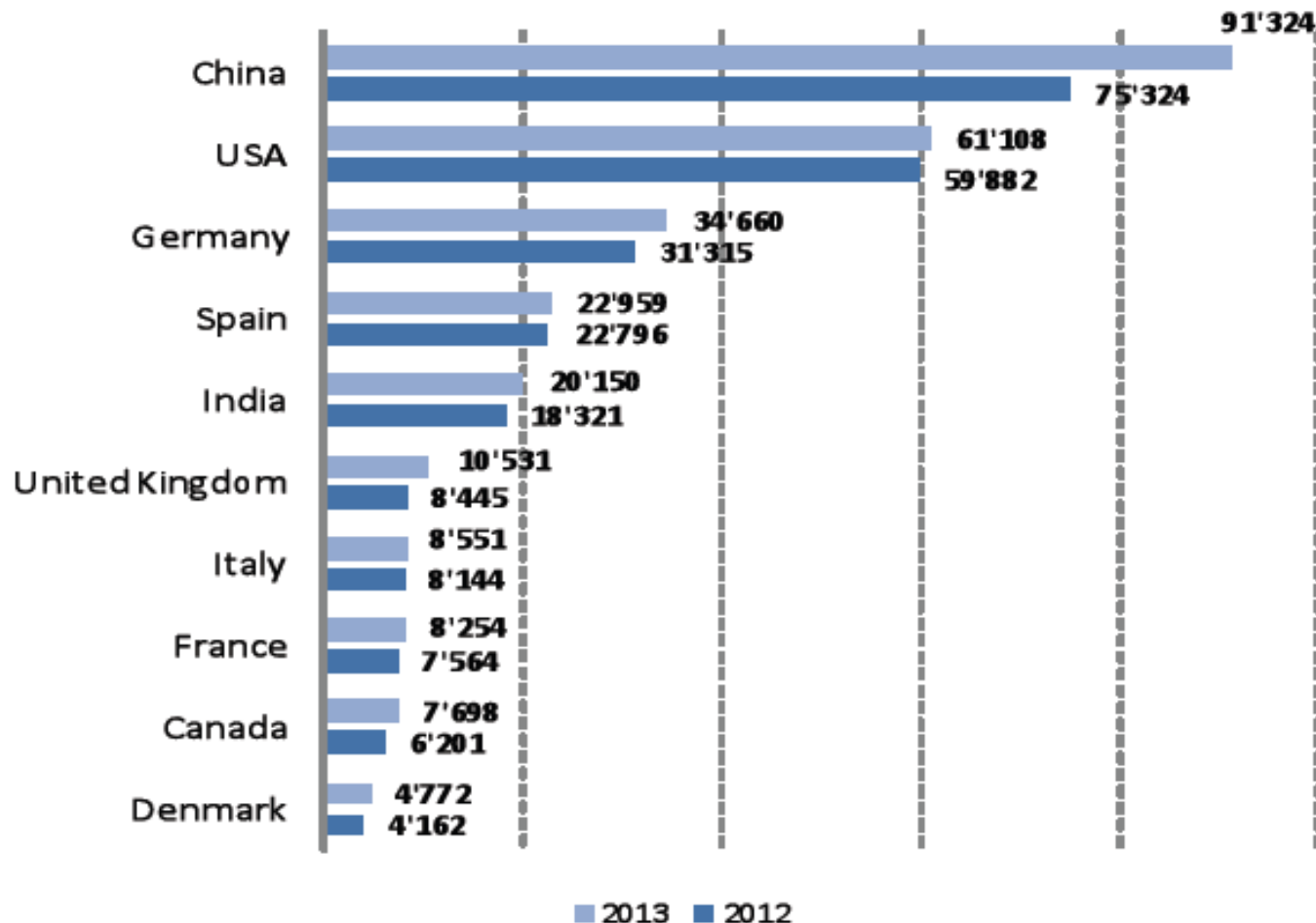
Source: CIEMAT

Potenza eolica installata nel mondo 1997-2013

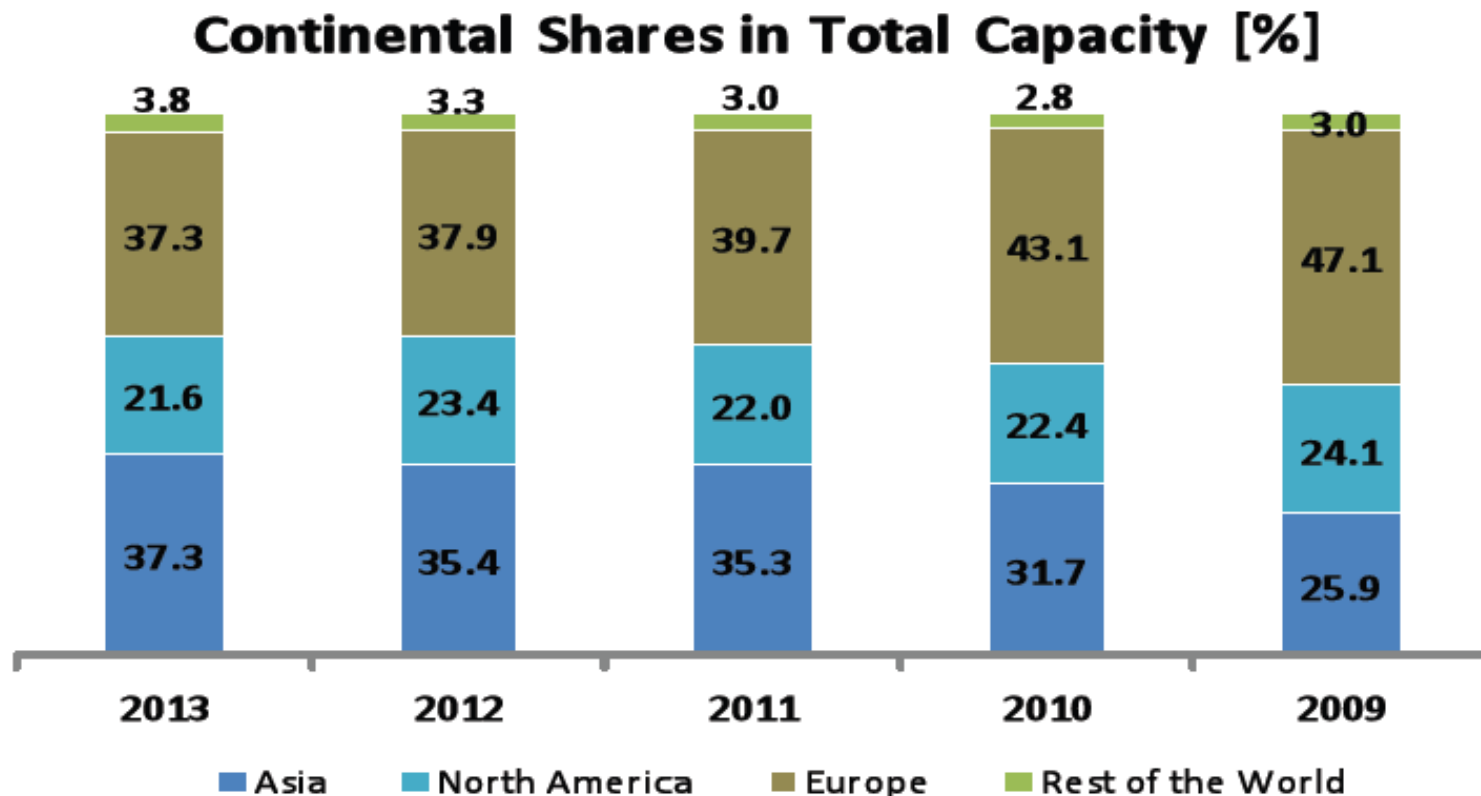


Capacità installata (cumulativa)

Top 10 Countries by Total Capacity [MW]



Distribuzione su scala planetaria della potenza eolica installata



Alcune cifre circa la fonte eolica nella EU

1/3 (fonte EWEA)

1. 11,159 MW of wind power capacity (worth between €13 bn and €18 bn) was installed in the EU-28 during 2013, a decrease of 8% compared to 2012 installations.
2. EU wind power installations for 2013 show the negative impact of market, regulatory and political uncertainty sweeping across Europe. Destabilised legislative frameworks for wind energy are undermining investments.
3. Wind power is the technology which installed the most in 2013: 32% of total 2013 power capacity installations - five percentage points higher than during the previous year.
4. Renewable power installations accounted for 72% of new installations during 2013: 25 GW of a total 35 GW of new power capacity, up from 70% the previous year.

Alcune cifre circa la fonte eolica nella EU

2/3 (fonte EWEA)

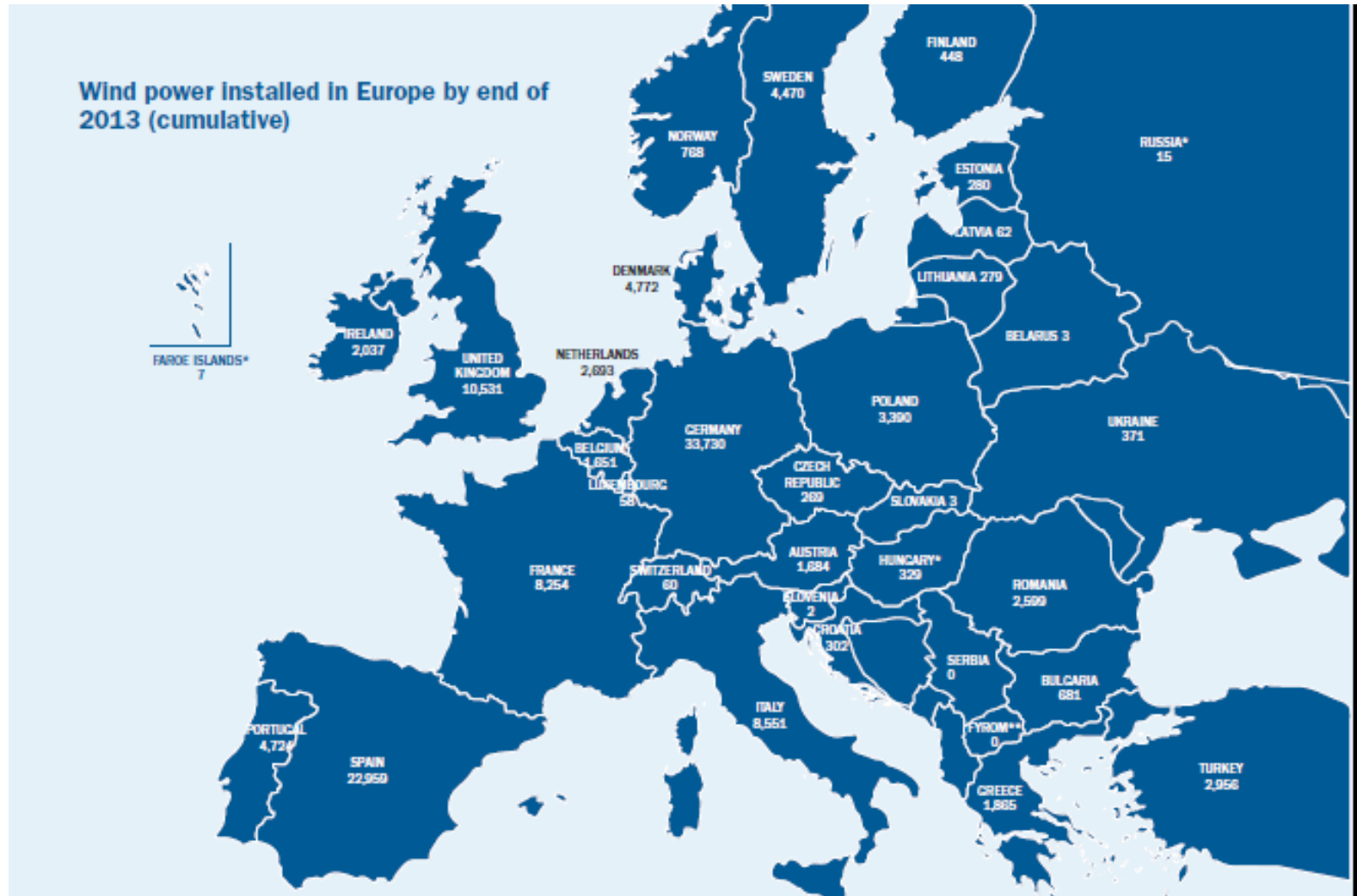
1. There are now 117.3 GW of installed wind energy capacity in the EU: 110.7 GW onshore and 6.6 GW offshore.
2. The EU's total installed power capacity increased by 13 GW net to 900 GW, with wind power increasing by 11.2 GW and reaching a share of total installed generation capacity of 13%, up one percentage point compared to the previous year.
3. Since 2000, over 28% of new capacity installed has been wind power, 55% renewables and 92% renewables and gas combined.
4. The EU power sector continues its move away from fuel oil and coal with each technology continuing to decommission more than it installs.

Alcune cifre circa la fonte eolica nella EU

3/3 (fonte EWEA)

1. Annual installations of wind power have increased over the last 13 years, from 3.2 GW in 2000 to 11.2 GW in 2013, a compound annual growth rate of 10%.
2. A total of 117.3 GW is now installed in the European Union, an increase in installed cumulative capacity of 10% compared to the previous year.
3. Germany remains the EU country with the largest installed capacity followed by Spain, the UK and Italy. Fifteen EU countries have more than 1 GW of installed capacity, including two newer EU countries (Poland and Romania), and eight EU countries have more than 4 GW of installed capacity.
4. The volatility across Europe has contributed to 46% of all new installations in 2013 being in just two countries (Germany and the UK), a significant concentration compared to the trend of previous years whereby installations were increasingly spread across healthy European Markets. This is a level of concentration that has not been seen in the EU's wind power market since 2007 when the three wind energy pioneering countries (Denmark, Germany and Spain) together represented 58% of all new installations that year.
5. A number of previously healthy markets such as Spain, Italy and France have seen their rate of wind energy installations decrease significantly in 2013, by 84%, 65% and 24% respectively.
6. Offshore saw a record growth in 2013 (+1.6 GW); the outlook for 2014 and 2015 is stable, but not growing.
7. The wind power capacity installed by the end of 2013 would, in a normal wind year, produce 257 TWh of electricity, enough to cover 8% of the EU's electricity consumption – up from 7% the year before.

Il panorama europeo (1/2)



Il panorama europeo (2/2)

	Installed 2012	End 2012	Installed 2013	End 2013
EU Capacity (MW)				
Austria	296	1,377	308	1,684
Belgium	297	1,375	276	1,651
Bulgaria	158	674	71	681
Croatia	48	180	122	302
Cyprus	13	147	0	147
Czech Republic	44	260	9	269
Denmark	220	4,162	657	4,772
Estonia	86	269	11	280
Finland	89	288	162	448
France	814	7,623	631	8,254
Germany	2,297	30,989	3,238	33,730
Greece	117	1,749	116	1,865
Hungary*	0	329	0	329
Ireland	121	1,749	288	2,037
Italy	1,239	8,118	444	8,551
Latvia	12	60	2	62
Lithuania	60	263	16	279
Luxembourg	14	58	0	58
Malta	0	0	0	0
Netherlands	119	2,391	303	2,693
Poland	880	2,496	894	3,390
Portugal	155	4,529	196	4,724
Romania	923	1,905	695	2,599
Slovakia	0	3	0	3
Slovenia	0	0	2	2
Spain	1,110	22,784	175	22,959
Sweden	846	3,582	724	4,470
United Kingdom	2,064	8,649	1,883	10,531
Total EU-28	12,102	106,454	11,159	117,289
Total EU-15	9,879	99,868	9,402	108,946
Total EU-13	2,224	6,586	1,757	8,343

European Union: 117,289 MW

Candidate Countries: 2,956 MW

EFTA: 830 MW

Total Europe: 121,474 MW

	Installed 2012	End 2012	Installed 2013	End 2013
Candidate Countries (MW)				
FYROM**	0	0	0	0
Serbia	0	0	0	0
Turkey	506	2,312	646	2,956
Total	506	2,312	646	2,956
EFTA (MW)				
Iceland	0	0	1,8	1,8
Liechtenstein	0	0	0	0
Norway	166	703	110	768
Switzerland	4	50	13	60
Total	170	753	125	830
Other (MW)				
Belarus	0	3	0	3
Faroe Islands	2	2	5	7
Ukraine	125	276	95	371
Russia*	0	15	0	15
Total	127	297	100	397
Total Europe	12,906	109,816	120,030	121,474

* Provisional data or estimate.

** Former Yugoslav Republic of Macedonia

Note: due to previous year adjustments, 372 MW of project de-commissioning, re-powering and rounding of figures, the total 2013 end-of-year cumulative capacity is not exactly equivalent to the sum of the 2012 end-of-year total plus the 2013 additions.

Installazioni EU (fine 2013)

FIGURE 3.1: ANNUAL WIND POWER INSTALLATIONS IN EU (GW)

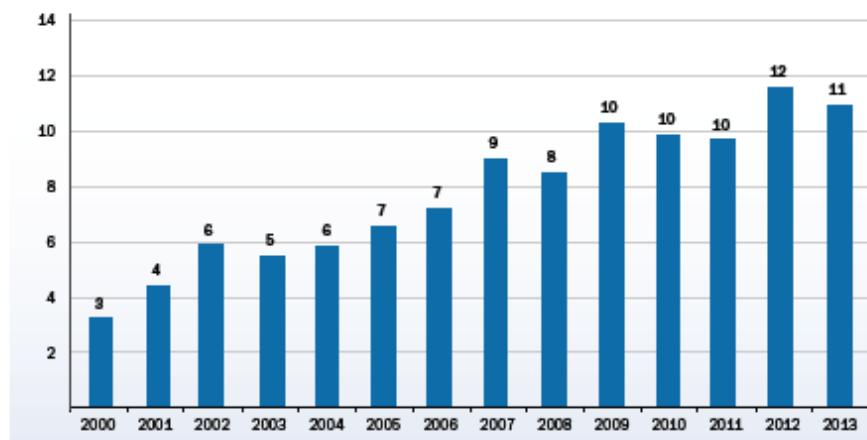
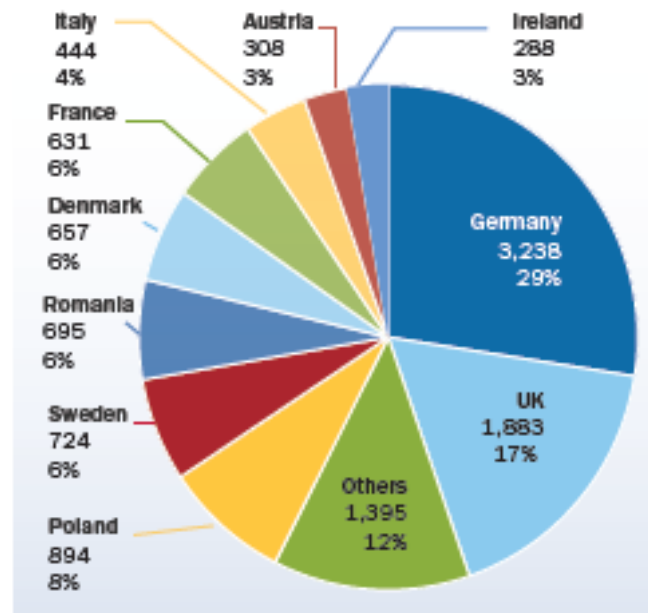


FIGURE 1.1: EU MEMBER STATE MARKET SHARES FOR NEW CAPACITY INSTALLED DURING 2013 IN MW. TOTAL 11,159 MW



Dato cumulativo EU fine 2013

FIGURE 3.4: CUMULATIVE WIND POWER INSTALLATIONS IN THE EU (GW)

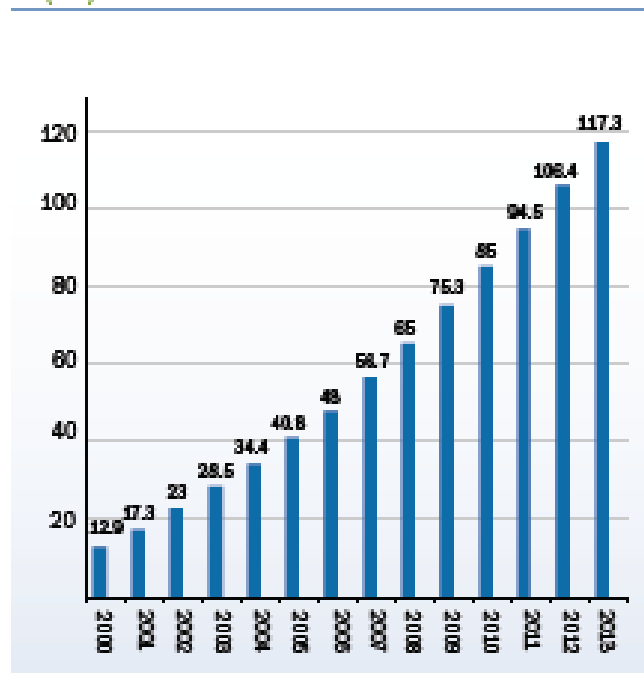
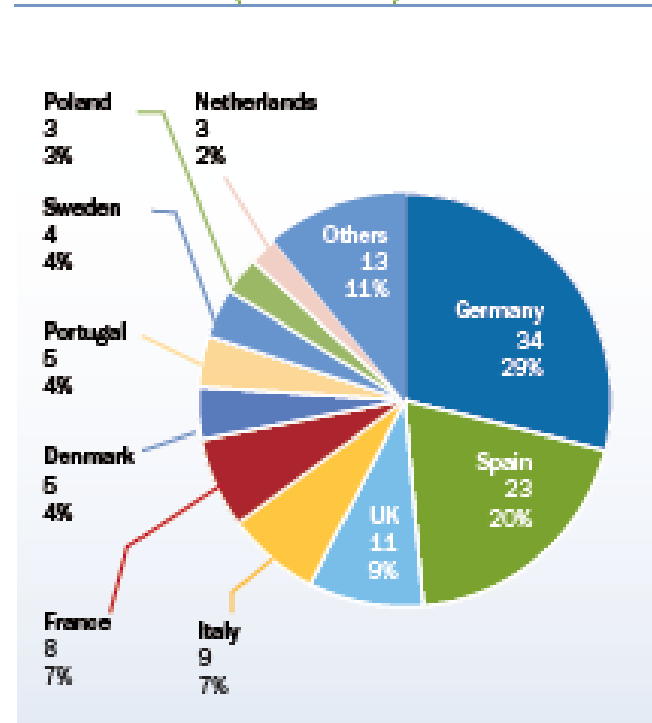


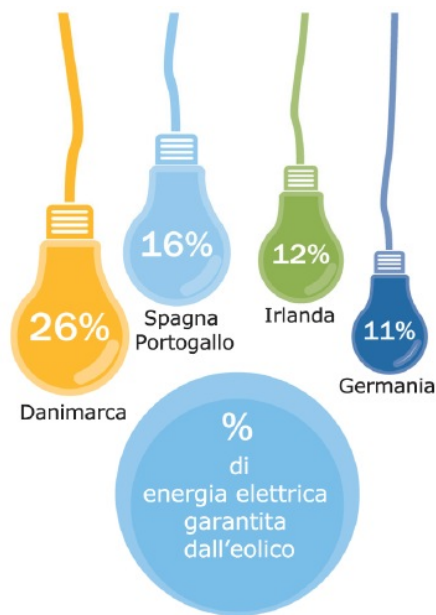
FIGURE 3.5: EU MEMBER STATE MARKET SHARES FOR TOTAL INSTALLED CAPACITY (TOTAL 118 GW)



Produzione elettrica da WE in EU

TABLE 1: WIND ENERGY SHARE OF EU ELECTRICITY CONSUMPTION

Total EU electricity consumption	Onshore wind energy production	Offshore wind energy production	Share of EU consumption met by onshore wind	Share of EU consumption met by offshore wind	Share of EU consumption met by wind
3,280 TWh	233 TWh	24 TWh	7.1%	0.7%	7.8%

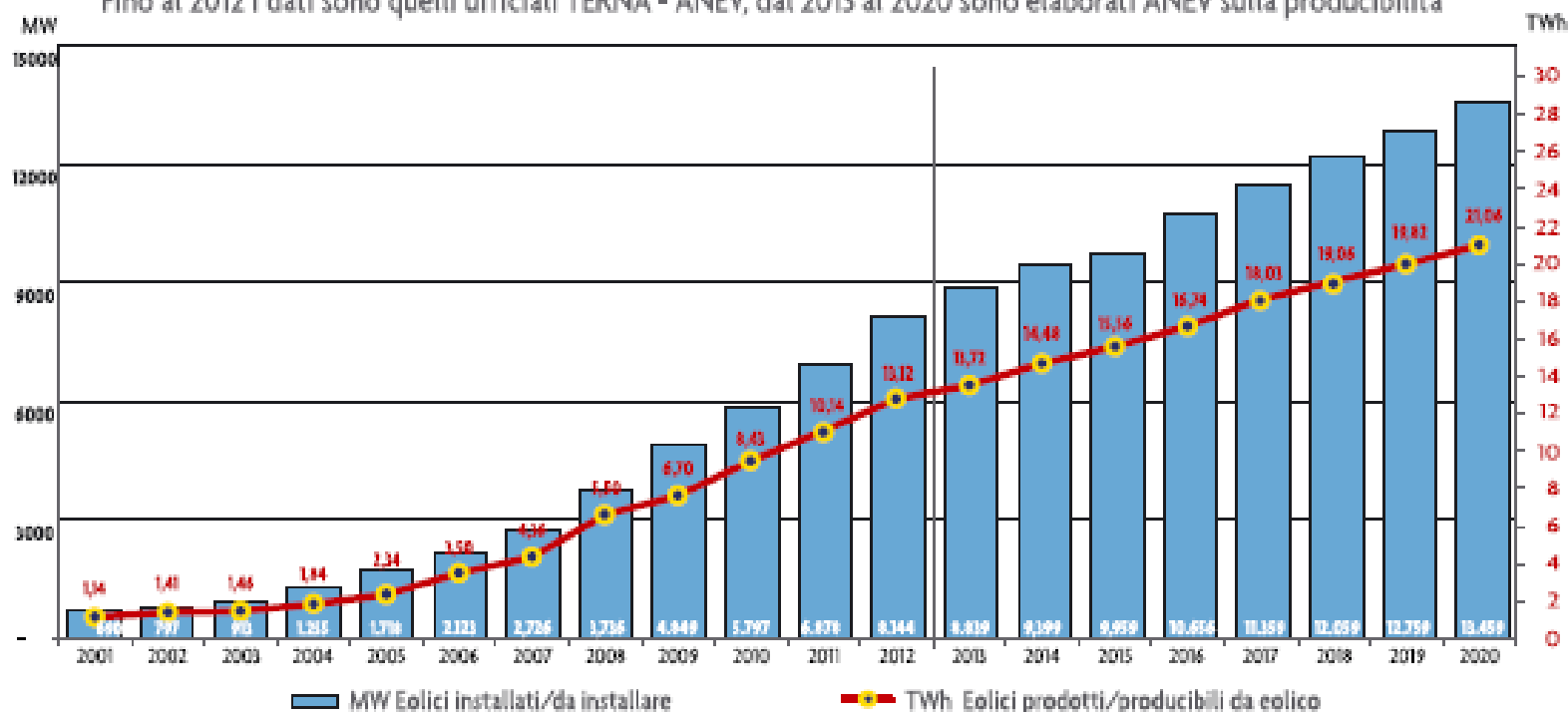


Il quadro italiano

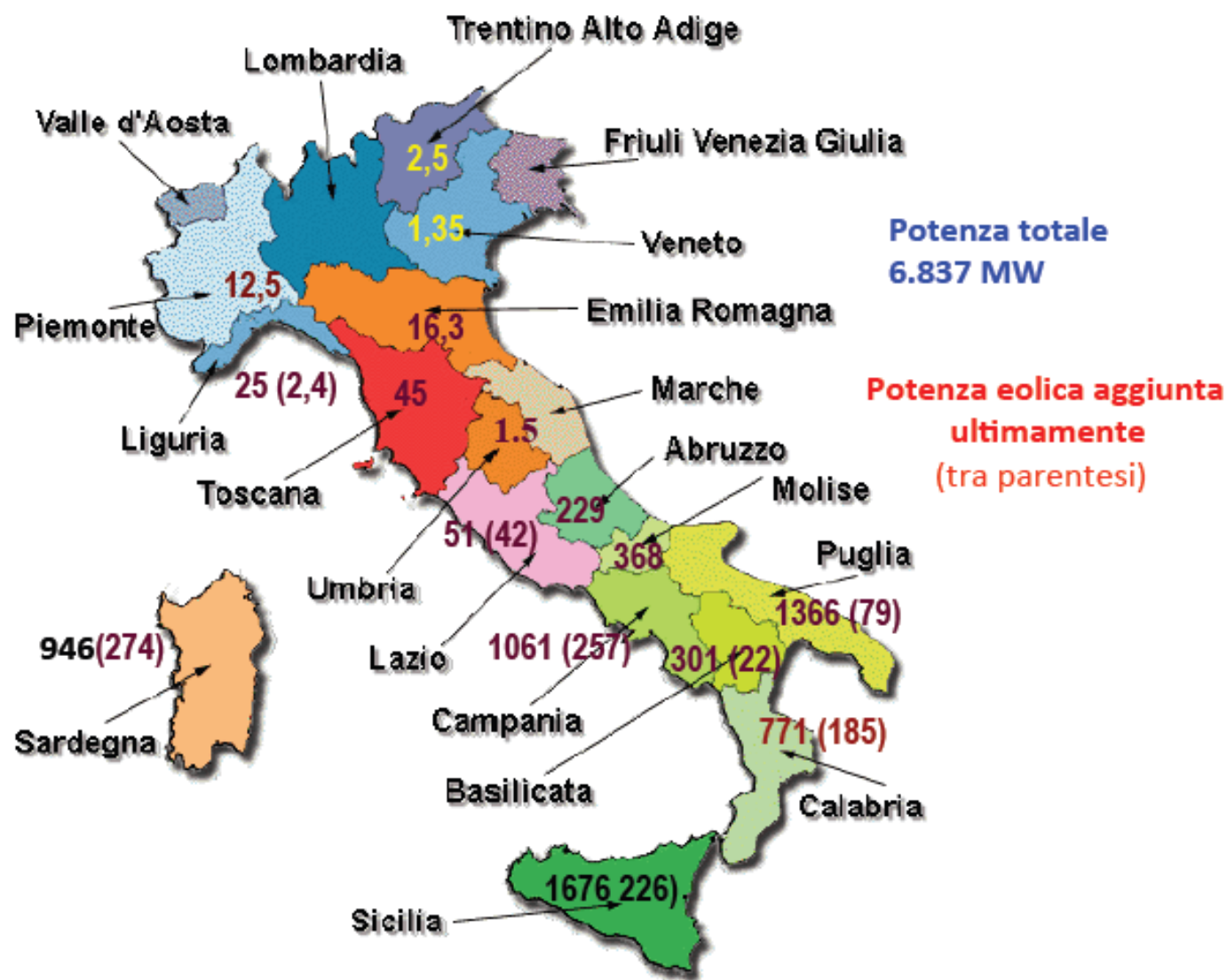


Prospettive di crescita dell'eolico sulla base degli impegni dell'Italia in sede Comunitaria

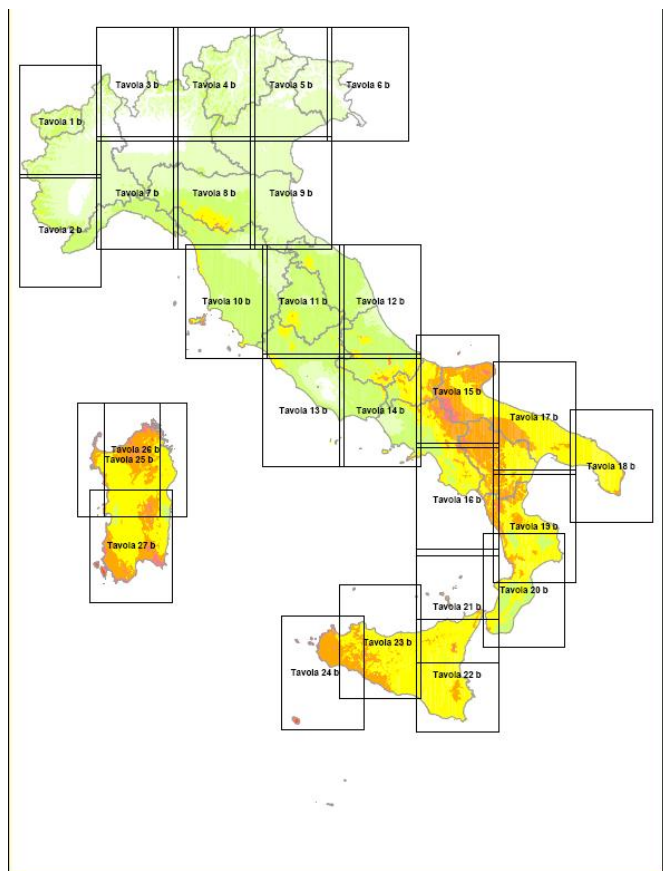
Fino al 2012 i dati sono quelli ufficiali TERNA - ANEV, dal 2013 al 2020 sono elaborati ANEV sulla producibilità



Potenza eolica regionale inizio 2012(MW)



Dislocazione dei parchi eolici



Mapa elaborata da CESI in collaborazione con il Dipartimento di Fisica dell'Università di Genova nell'ambito della Ricerca di Sistema.
Per una corretta interpretazione si veda il testo dell'Atlante di cui questa mappa fa parte.



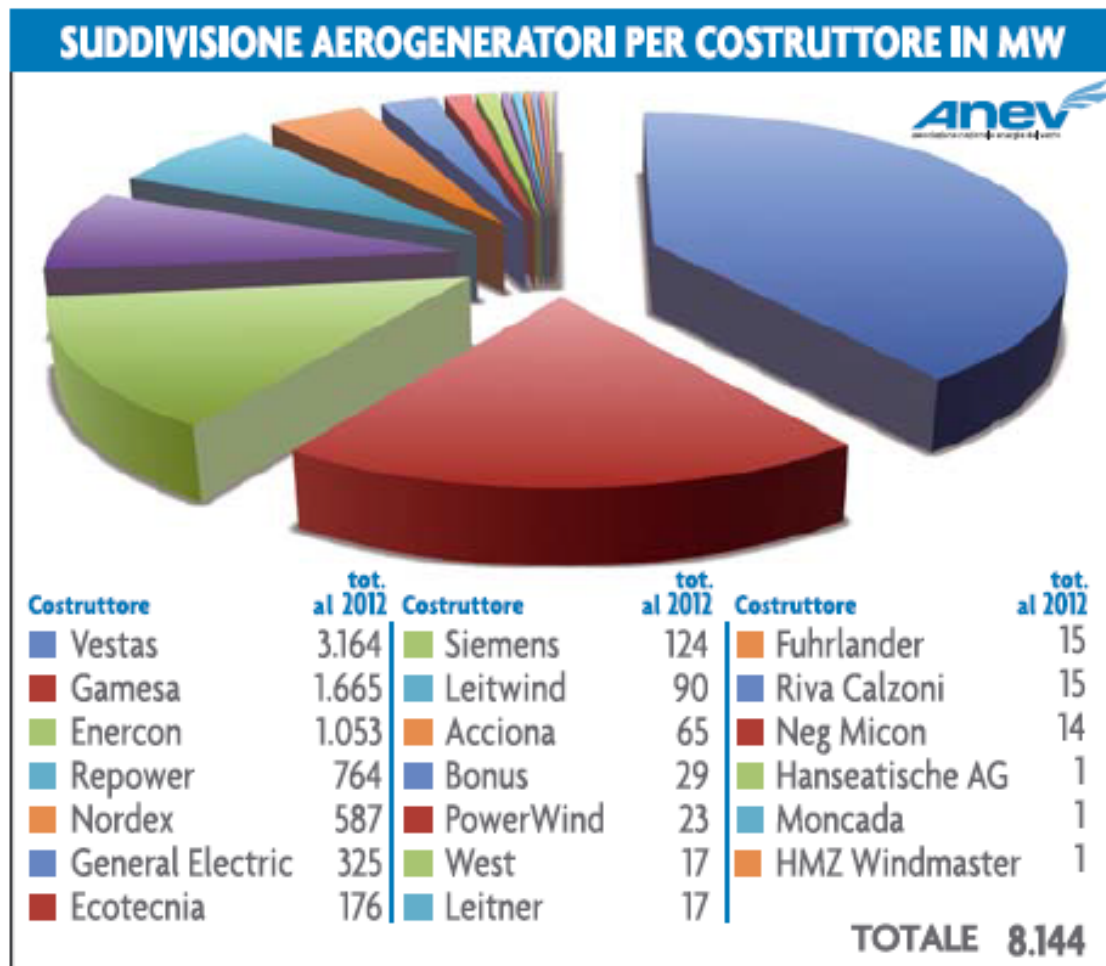
Regione	MW installati	Regione	MW installati
Puglia	1.992	Liguria	47
Sicilia	1.746	Emilia Romagna	16
Campania	1.208	Piemonte	13
Sardegna	1.015	Trentino Alto Adige	3
Calabria	996	Valle d'Aosta	3
Molise	372	Umbria	2
Basilicata	360	Veneto	1
Abruzzo	236	Marche	-
Toscana	84	Friuli Venezia Giulia	-
Lazio	51	Lombardia	-
TOTALE		8.144	

Il contesto regionale italiano

ITALIA							
REGIONE	AEROGENERATORI		POTENZIALE AL 2020		CRESCITA % 2012 RISPETTO AL 2011	KW PER ABITANTE	KW PER KM²
	MW	N°	MW *	OCCUPATI **			
PUGLIA	1.992	1.358	2.070	11.714	45,9%	0,488	102,918
SICILIA	1.746	1.480	1.900	7.537	4,2%	0,346	67,925
CAMPANIA	1.208	966	1.915	8.738	14,1%	0,207	88,871
SARDEGNA	1.015	724	1.750	6.334	7,1%	0,607	42,144
CALABRIA	996	558	1.250	4.484	30,0%	0,496	66,039
MOLISE	372	307	635	2.289	0,0%	1,161	83,758
BASILICATA	360	300	760	2.675	19,2%	0,611	36,009
ABRUZZO	236	285	900	3.166	4,5%	0,176	21,892
TOSCANA	84	61	600	2.114	88,5%	0,023	3,668
LAZIO	51	36	900	3.741	0,0%	0,009	2,959
LIGURIA	47	41	280	1.061	88,8%	0,029	8,705
EMILIA ROMAGNA	16	20	200	771	20,9%	0,004	0,722
UMBRIA	2	2	1.090	3.868	0,0%	0,002	0,177
ALTRE	19	11	1.750	7.518	0,0%	0,001	0,186
OFFSHORE	0	0	200	1.000	0,0%	0,000	0,000
TOTALE	8.144	6.149	16.200	67.010	18,5%	0,135	27,026

* Studio ANEV ** Studio UIL - ANEV

Aziende produttrici di aerogeneratori (2012)





Fonti

- Il materiale didattico presentato è stato “prevalentemente” tratto dalle seguenti fonti:
 1. [Danish wind industry association web site](#)
 2. Direzione Studi e Ricerche ENEL. Come nasce l'energia eolica. I quaderni dell'Energia Vol. 17.
 3. Patel M.R. (1999) Wind and Solar Power Systems CRC press ISBN: 0-8493-1605-7
 4. Leishman J. Gordon (2006) Principles of Helicopter Aerodynamics (Cambridge Aerospace Series) Cambridge University Press; 2 edition ISBN-10: 0521858607 ISBN-13: 978-0521858601

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 6. [UIUC Airfoil Coordinates Database](#)
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 2. [Danish Wind Industry Association Guided Tour](#)
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[Illustrated history of wind power development](#)
 2. Elenco dei [produttori di turbine eoliche](#)
 3. [EMD International A/S](#) produttore del software WindPro
 4. [Aerodynamics Index](#) NASA Glenn Research Centre
 5. [Aerodynamics for students](#)
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6. Office of Energy Efficiency & Renewable Energy
 7. European Wind Energy Association
 8. American Wind Energy Association
 9. German Wind Energy Association
 10. Ricerca di Sistema
 11. <http://www.renewableenergyfocus.com/>
 12. <http://www.risoe.dk/>
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14. http://en.wikipedia.org/wiki/Wind_turbine_design
 15. [Wind Power Monthly](#)
 16. [Associazione nazionale Energia del Vento](#)
 17. [Qualenergia](#)
 18. [Il portale italiano dell'energia eolica](#)
 19. <http://www.energies-renouvelables.org/>
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