

# **GLOBAL ENERGY TRANSITION: YES, BUT HOW, WHICH SPEED, WHICH SOCIAL COSTS**

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# **INDEX**

**Environmental issues are leading energy strategies/programs**

**The primary energy resources**

**The electricity sector with explosive RES**

**EU and Variable Renewables Energy Sources (VRES)**

**Some hidden costs for VRES integration**

**A serious and sophisticated holistic approach is needed for an effective and stable energy transition**

**COMMENTI ADDIZIONALI SU ITALIA,SUA SEN ED EU**

# Environmental issues are leading energy strategies/programs

"The United Nation Conference on Environment and Development" of 1992 in Rio has posed the necessity to substitute with alternative energy resources the fossil fuels considered responsible of global warming.

From the 1997 following Kyoto Protocol up to the 2016 Parigi Accord and the last Nov 2017 Conference in Bonn a series of declared of outstanding engagements for decarbonization from many countries/regions

EU in Bonn has brought a declaration of EU Parliament for full decarbonization in 2050

# The primary energy consumptions

OIL (39%)+COAL(29%)+ GAS(24%) now 85% share compared to 92% in 2005

RES now 10% from 6.8% in 2005 :hydro is at 6.6% and wind and PV even with an explosive growth are together at 2.5%

There is no scarcity of fossil fuels :the ratio Actual Reserves/Present Consumption

150 years for coal,50 years for conventional gas ,55 years for conventional oil  
But huge potential for shale gas and oil (see US explosion)

The key problem is burning effect of fossil fuels ;concerns also on some of their important reserves of oil and gas located in critical areas

Great change from 2000; **consumption of primary resources in non OCSE countries are increasingly higher than those in OCSE**

ASIA(led by China) now the great actor with an AAG in last 10 years of around 4% close to ME;  
AAG -0.4% in EU and -0.2 % in North America

### In 2017 CO2 emissions

- non OCSE 62.5 % (AAG 3.4% in 10 years)
  - OCSE 37.5% with AAG -1%
  - EU (including UK ) 10.4% with -2% AAG

Germany (37% of electricity production with lignite and coal) 2.3% world CO2 share, UK 1.2%, Italy 1%, France and Poland 0.9%, Spain 0.8%

Decarbonization is global and it is/will be mainly dependent on non OCSE countries (China has a 27.3 % share of CO<sub>2</sub>) but US is at 17.5% followed by India 6%, Russia 4.4%, Japan 3.2%, Germany 2.3%, Iran 1.8%, S.Korea/Canada/S.Arabia 1.6-1.7% and Indonesia/ S.Africa at 1.4%

The EU contribution is always more marginal and in 2030 without UK it should be around 6%

Fossil fuels according to the majority of scenarios will have a non negligible role up to 2050 in primary energy consumption worldwide

# The electricity sector with explosive VRES.

The **electricity sector** is the one that has seen in the last 15 years the major changes

- privatizations and new market rules
- explosive **development of RES** ,mainly wind and solar
- decentralization of production
- pervasive application of **ICT** at all the levels

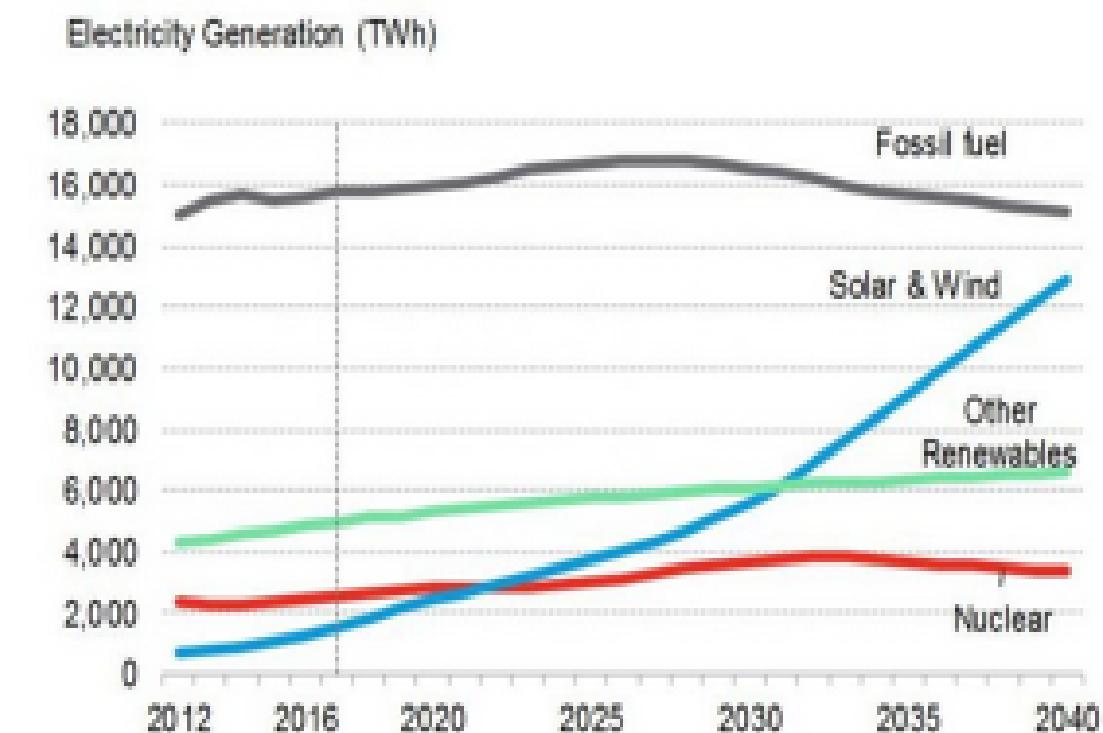
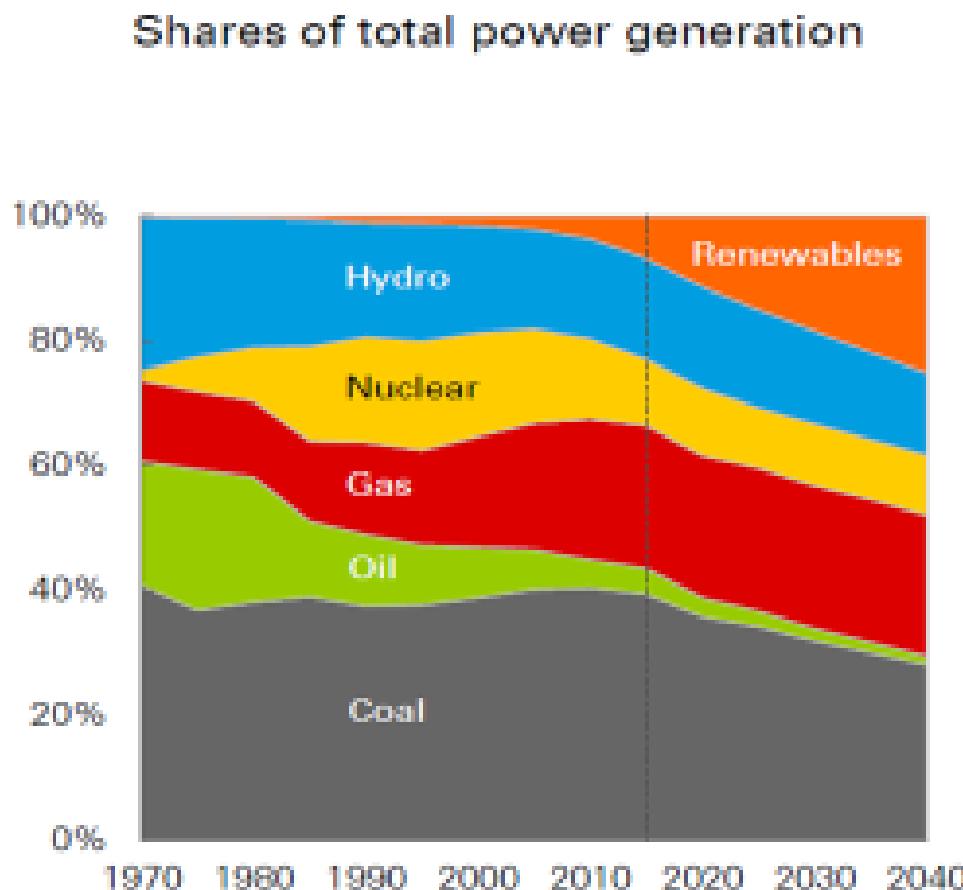
	<b>2001</b>	<b>2016</b>
Coal	38.7%	37.5%
Oil	7.4% FF 64.7%	4.0% FF 65.1%
Gas	18.6%	23.6%
Nuclear	17.1%	10.5%
Hydro	16.5%	16.4%
Biomasses	1.1% RES 18.2	2.3% RES 24.4%
Other Renewables	0.6%	5.7%

**Contribution by the different sources to the 2001 and 2016 *global gross electricity production***

*Elaborations from IEA*

# Projected development of electricity generation up to 2040

- FOR BP IN 2040 FOSSIL SHARE 53% (27% COAL ,24% GAS, 2% OIL) ,RES 38% (13% IDRO AND 25% OTHERS MAINLY PV AND WIND) AND NUCLEAR 9%-COAL STILL THE FIRST PRIMARY SOURCE FOR ELECTRICITY
- FOR BLOOMBERG IN 2040 FOR THE GLOBAL 38000 TWH PRODUCTION, RES SHARE IS 51% (2/3 FROM PV AND WIND) ,FOSSIL AT 40% AND NUCLEAR AT 9%-



Source: Bloomberg New Energy Finance, New Energy Outlook 2017

# Variable Renewables Energy Sources (VRES) and challenges for their integration

EU has been (but now no more) the leader in VRES and still keeps very ambitious goals: new agreement at 32% of final energy consumption in 2030

According to WEC VRES integration study, the first 5 countries (and 8 over the first 10) are in EU for the highest % of VRES capacity with respect to peak load

An high % of VRES, apart from initial generous incentives reverted on client bills, creates challenges and costs for a smooth integration in the power system due to their non programmable output:

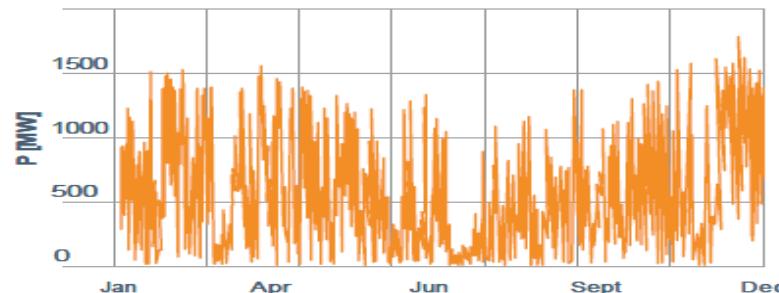
- Larger spinning reserve and flexible (steep ramps)
- Investments in T&D systems
- Integration of storage systems
- A capacity market to assure security of supply,
- Balancing costs etc

**VARIABLE NATURE OF WIND AND SUN:Ireland great variability of wind and no wind for all the month of July 2023**

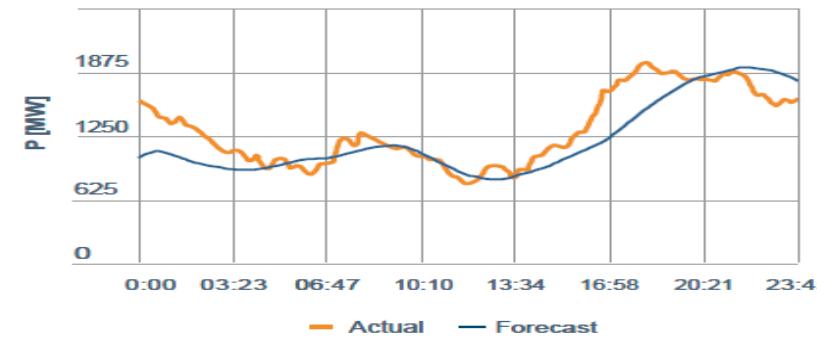
In Florence PV system in a sunny day of Dember 1/3 of energy than a sunny day of July

### YEARLY AND DAILY VARIABILITY IN IRELAND OF GLOBAL WIND FLEET POWER PRODUCTION

YEARLY

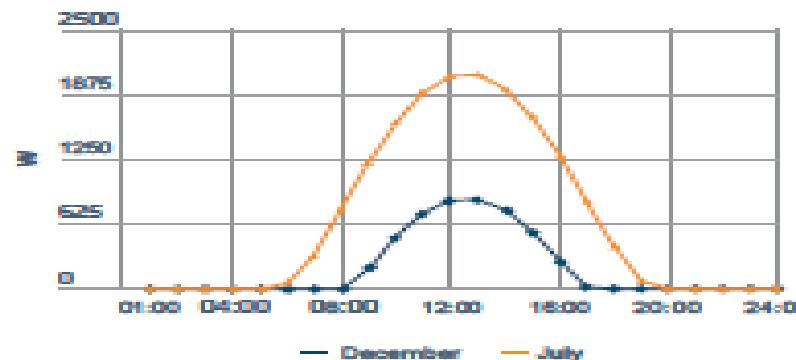


DAILY

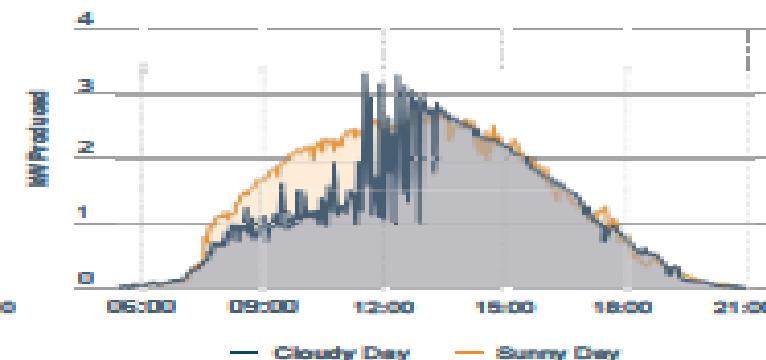


### SEASONAL AND DAILY VARIATION OF THE POWER GENERATION FOR A SMALL PV PLANT IN CENTRAL ITALY

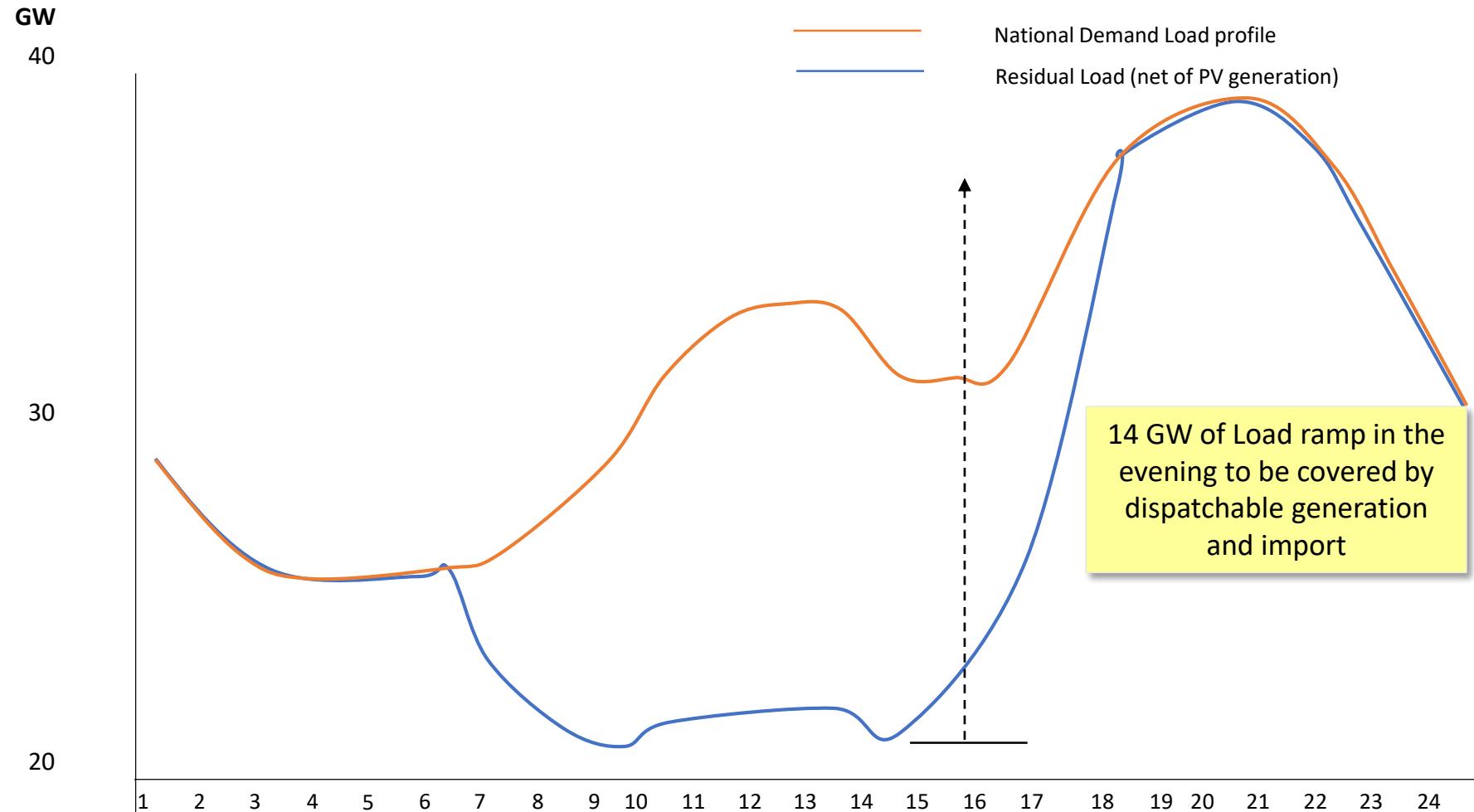
SEASONALITY



DAILY



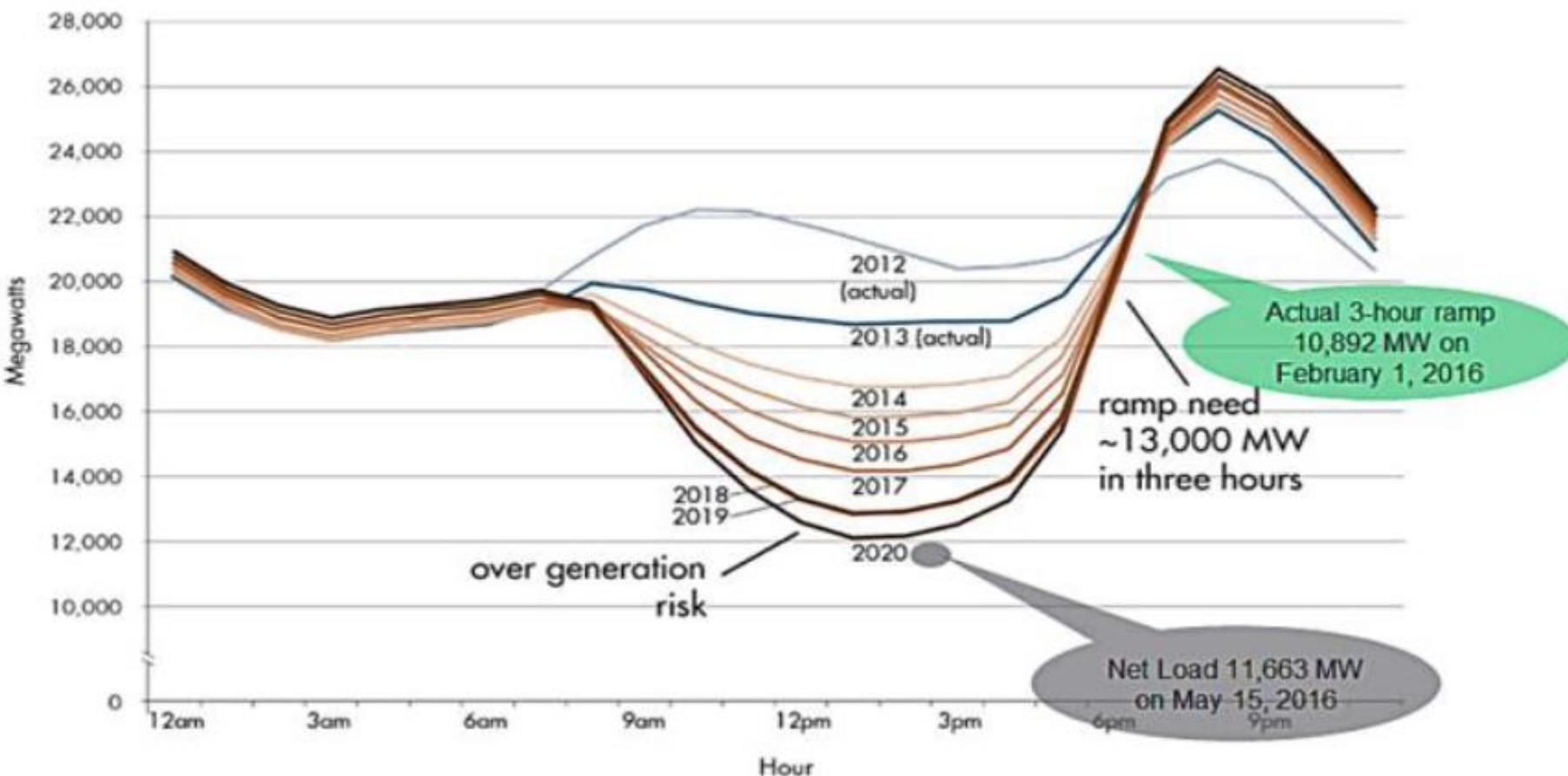
# Sharp variation of RES generation (e.g. Italy)



Source: Terna

# Forti ram① Increased ramping requirements (“duck curve”)

California Load Curve (MW) Net of Wind and Solar production



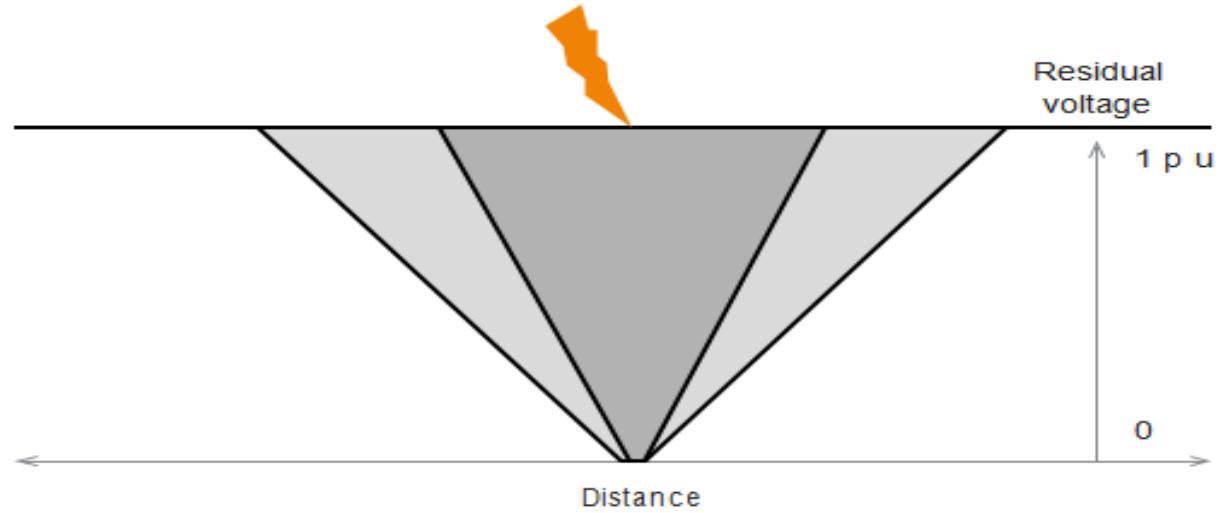
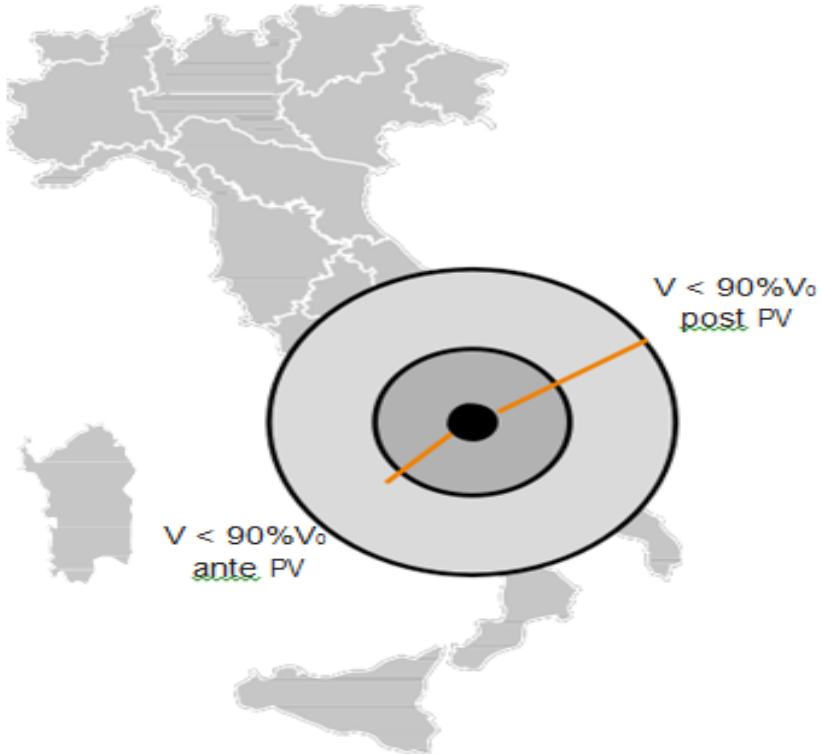
Source: CAISO

**CESI**

"Variable renewable energy sources integration in electricity systems – How to

Milano - 21/11/2017

# Voltage drops caused by a fault

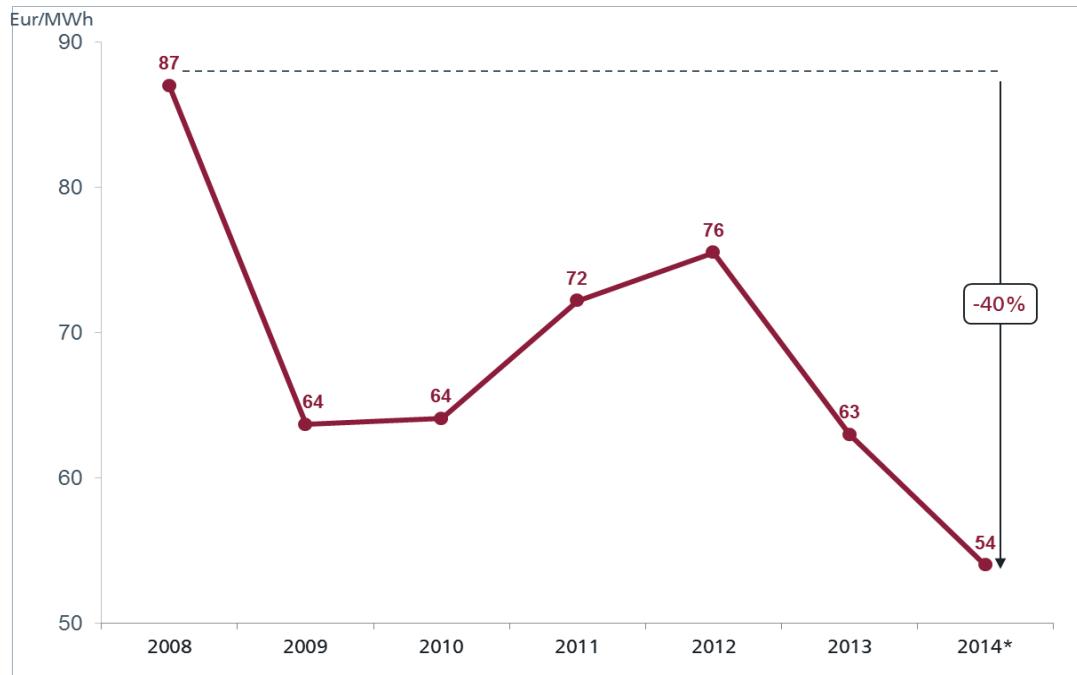


Due to reduction of rotating machines connected to Transmission grid, there is less Shortcircuit-Power available and therefore voltage dips generated at T-level have larger impact. (In this simulation the spatial distribution of DG has been assumed homogenous.)

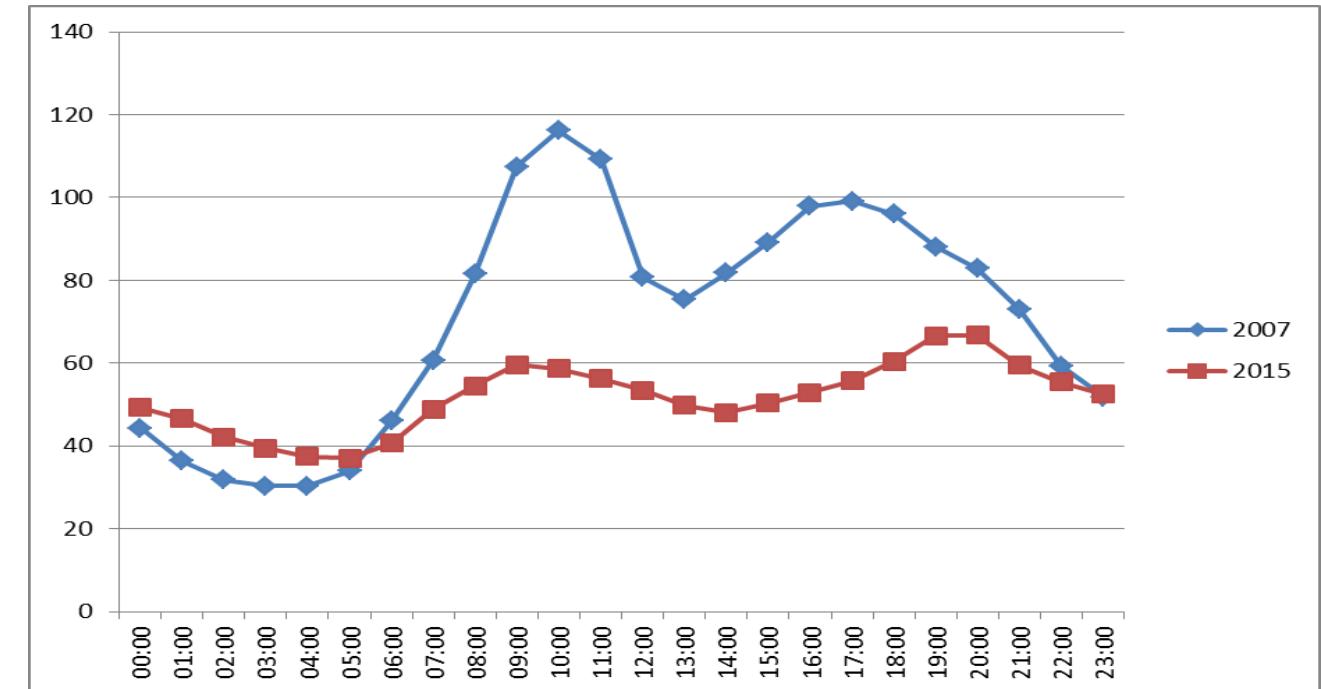
## Max Daily Price in the Evening after Sunset – Italy

Growing volumes of VRES combined with gas price reduction resulted in a drastic collapse of PUN (national average pool price)

Average

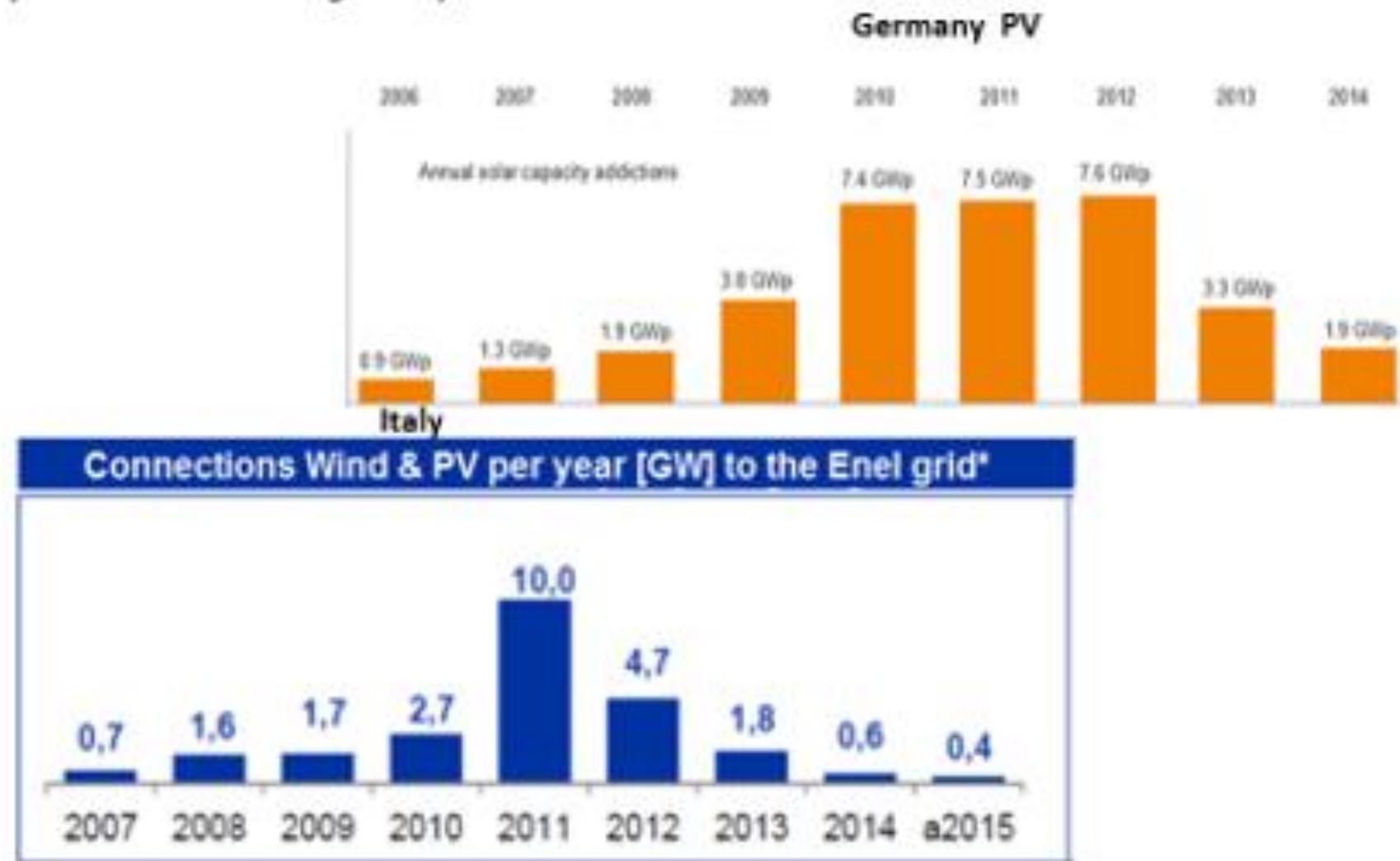


Daily



## BUBBLES CREATED BY TOO GENEROUS INCENTIVES FOR WIND AND SOLAR

(Source: WEC RES Integration)



# VRES ;exceptional cost reductions

Combination of technology / construction developments, volumes and auctions have driven down CAPEX and OPEX costs of VRES to values in some countries (UAE,S.Arabia, Chile) unimaginable :around 20\$/MWh-

Extrapolation of low auction values should be done with caution, as the low prices are based on countries with high wind and solar load factors and low local cost and special financing-  
In EU the values are now at around 50 €/MWh but in Germany auctions, some off shore wind plants have quoted at no surcharge on pool price (now around 35 €/MWh)

So far DSO's and TSO's have been able to manage electric power systems without an impact on reliability even with high % of VRES.

VRES a pathway for climate change mitigation, but they also reduce dependence on imported fuel (security of supply), improve air quality, promote economic development and jobs creation

VRES have contributed to the reduction of electricity pool prices(whole sale price) but for some categories of clients increase of retail prices due to initial strong incentives still valid for around 8 years :in 2016 reverted on client bills in Germany FV production incentive costs of 250 €/MWh and in Italy of 295 €/MWh

# Some hidden costs for VRES integration

The incentives of production cost of VRES reverted to clients amount to hundreds of €/t CO<sub>2</sub> avoided- For the average 360 t CO<sub>2</sub>/GWh of the Italian electricity production ,the 295 €/MWh in Italy for FV correspond to more than 800 €/t CO<sub>2</sub> avoided-If one substitutes coal generation you get 350 €/tCO<sub>2</sub> avoided.....compared to an ETS value of 5-6 €/tCO<sub>2</sub> and recently 10-13- This is relevant to past ineffective regulations.....but now

the off shore wind in Germany in recent auctions is claimed to be in “grid parity” with no surcharge on pool price(now average 35 €/MWh);but this in the Baltic/North sea at place of production-

The cost of connections of 7500 MW from off shore to mainland and for the 3 underground +/- 500 kV DC 250 km systems for specific transmission to the loads in central South Germany is on the shoulders of the TSO's and reverted on the bills of clients: more than 80 €/MWh to be added to the so called grid parity and without all the other additional costs to the system in order to take care of variability of RES (balancing,storage,capacity market etc)

# A serious and sophisticated holistic approach is needed for an effective and stable energy transition

Energy transition should promote a socio economical development ,respecting the environment and keeping country competitiveness in a global market where sustainable energy costs of industrial, commercial and residential clients are an asset.

A holistic approach is essential ,taking care and evaluating on a country base both positive and negative externalities:

- reduction of emissions
- creation/elimination(eg closure of coal plants) of jobs
- reduction of imported TEP with relevant increased security of supply
- additional government incomes for taxes for increased activities
- additional costs connected to the various investments such as those created by VRES as above mentioned

Etc

**A quantitative evaluation of externalities (a range for each of them) is essential for final cost /benefit analyses and this should be the initial step.**

**The environmental objectives should be reached with the minimum cost alternatives with appropriate sharing of investments in power generation ,transports and energy efficiency**

**An ideological pushing for a fast energy transition (e.g great expansion of RES and e-vehicles) without detailed analyses on the costs and on who is paying for them, it could lead to bubbles as already seen ;and this killing on the cradle or strongly reduce an effective and stable transition as needed-**

**A too fast decarbonization may imply in specific countries higher energy costs to final clients, stranded energy infrastructures, stranded primary resources assets, stranded labour forces to be requalified –**

**Final clients must be involved to become conscious of environmental problems and to have their contribution :spread communication and information**

**LET US WORK TOGETHER FOR AN  
EFFECTIVE TRANSITION WITH SERIOUS  
APPROACHES AND WITH THE CONFORT OF  
THOUGHT, WITHOUT A PASSVE  
ACCOMPLISHMENT TO PREVAILING AND  
FASCINATING IDEOLOGIES THAT HOWEVER  
HAVE THE MERIT TO PUSH FOR INNOVATION**

# ADDITIONAL SLIDES

# **EMISSIONI GHG ITALIA 2015 in Mt CO<sub>2</sub> eq**

## **(RAPPORTO ISPRA 2017)**

<b>TOTALI</b>	<b>435</b>
<b>USI ENERGETICI</b>	<b>355 (circa 1% di globali mondiali)</b>
trasporti	106
prod.elettricità/calore	80
civile (2/3 resid.)	75
industrie manif./costr.	52
raffinerie e manif.combust.	25
agricoltura ed altro	17
<b>USI NON ENERGETICI</b>	<b>80</b>

# Confronto Italia –Germania per emissioni nel 2016

- Italia secondo ARERE **35 TWh** di produzione linda **da carbone** per emissioni CO2 di circa **28Mt** ( **7,6%** di emissioni italiane per usi energetici )
- Germania da dati ministeri **262 TWh** da lignite e carbone(**150 TWh** da lignite e **112** da carbone) per totali emissioni CO2 valutabili in **240 Mt** e quindi pari ad oltre **8 volte** le emissioni da elettricità da carbone per l'Italia-Corrispondono al **31,5%** delle globali emissioni tedesche per usi energetici
- Germania non proclama uscita dal carbone ma l'Italia sì e nel 2025 e nel contempo prevede al 2030 addizionali **67 TWh** da fotovoltaico ed eolico che corrispondono rispettivamente ad **ulteriori 32 GW** e **18** portando la potenza in servizio di fotovoltaico a **52 GW** e di eolico a quasi **28 GW** per totali **80GW** di produzione volatile e con carichi previsti variare tra **25 e 65 GW**.**QUALI COSTI EFFETTIVI?CHI LI PAGA?**

•

# La situazione nel settore elettrico domestico italiano: esempio di storture ideologiche e costose al paese molto più di altre soluzioni con i medesimi risultati ambientali

attuali clienti domestici, circa 30 milioni;  
consumo elettrico domestico, 22 % del totale;  
prosumers totali, circa 600.000 e supponendoli tutti domestici sono responsabili di 0,44% dei totali consumi elettrici con tasso di crescita del 7% all'anno nonostante incentivi al CAPEX, riduzione su pagamento degli oneri di sistema e vantaggio di scambio sul posto;  
nel 2030, se mantenuti gli incentivi e tasso di sviluppo, i prosumers domestici rappresenterebbero meno dell' 1% dei consumi elettrici Italiani;  
i clienti domestici che potrebbero installarsi il loro micro- impianto FV non sono molti in Italia (grande maggioranza di famiglie in case con vari appartamenti);  
costo unitario di un « impianto micro» singolo FV installato in Italia per 3-5 kW di potenza nominale è tra 2000 e 3500 €/kW, in funzione di ubicazione casa e oneri di installazione su tetto esistente.

- considerando orientamento della casa esistente ed inclinazione del tetto, l'efficienza è ben inferiore a quella di un impianto a terra; il costo del kWh prodotto da un «impianto mini» di 500 kW a terra vicino ad una cabina secondaria e capace di alimentare circa 100 utenti costerebbe 1/3 di quello prodotto da «impiantino micro» singolo;
- l'Italia ha un sistema capillare di distribuzione dell'elettricità evoluto ed automatizzato e che serve anche le zone più isolate del paese;
- nel campo della mobilità il concetto di proprietà sta evolvendosi verso il car sharing, car pooling, car renting; e nel settore elettrico il sig Brambilla deve sentirsi orgoglioso di possedere il suo impiantino FV (pagato in gran parte dalla comunità), che fa costare almeno 3 volte il kWh prodotto al paese rispetto ad un impianto mini che aggrega gli interessi di un centinaio di clienti distribuendo l'energia sugli assets esistenti di distribuzione che verrebbero valorizzati?
- ha senso ed è democratico che l'Italia incentivi tale «distributed solution» dove la signora Maria di una casa popolare contribuisca sia agli incentivi in conto capitale pagati per l'impianto FV di una bella villa con piscina e sia agli oneri di sistema non pagati ed i vantaggi dello scambio sul posto?

# **ENERGY TRANSITION :SI ....MA « ADELANTE PEDRO CON JUICIO»**

**OCCORRE UN APPROCCIO SERIO ED OLISTICO CHE  
COMPRENDA IL GLOBALE SISTEMA PAESE E VALORIZZI LE  
ESTERNALITA' POSITIVE E NEGATIVE( AMBIENTALI E NON)  
PER SCEGLERE IL MIX OTTIMALE DI INTERVENTI PER  
RAGGIUNGERE GLI OBIETTIVI, MANTENENDO UNA  
INDISPENSABILE COMPETITIVITA' IN UNA ECONOMIA  
GLOBALE.**

**ED I COSTI ENERGETICI PAGATI DA IMPRESE E CITTADINI  
INFLUENZANO FORTEMENTE LO SVILUPPO PAESE E  
DEVONO ESSERE CHIARAMENTE EVIDENZIATI ED ESSERE  
CONDIVISI AL FINE DI EVITARE FORTI REAZIONI CHE  
PRECLUDEREBBERO UNA EFFICACE E DURATURA  
TRANSIZIONE .**

CABINA DI REGIA INTERGOVERNATIVA PER RIPARTIZIONE SEMI  
OTTIMALE DEGLI INTERVENTI NEI VARI SETTORI CON VALUTAZIONE DEI  
COSTI REALI E DI CHI LI PAGA SULLA BASE DI RANGE DI VALORI  
ECONOMICI PER LE ETERNALITA' POSITIVE E NEGATIVE ,DERIVANTI DA  
SERIE ANALISI TECNICHE/ECONOMICHE E SOCIALI-

NON SLOGAN MA NUMERI RAGIONATI, DATI E FATTI

**IL SAPER FARE DEVE PREVALERE SUL FAR SAPERE**

REGOLAZIONE TALE DA ATTIRARE INVESTIMENTI MA ANCHE FLESSIBILE  
PER TENER CONTO DEGLI SVILUPPI TECNOLOGICI

RENDERE ED OTTI I CITTADINI CHE LA TRANSIZIONE COSTA PER AVERE  
UN MONDO MIGLIORE PER I LORO FIGLI E FUTURE GENERAZIONI E  
DEVONO QUINDI ACCETTARE I RELATIVI ONERI.

**IMPORTANZA DI CAPILLARE ED EFFICACE COMUNICAZIONE**

# Emissioni di CO2eq. in Mt da combustione di combustibili fossili (ora circa 34000 Mt a livello mondiale)

## STIME 2017 (AGORA) MONDO

China	8,796
United States	5,112
India	2,088
Russia	1,560
Japan	1,096
Germany	744
Iran	610
South Korea	588
Canada	564
Saudi Arabia	555
Indonesia	470
South Africa	454

## DATI CONSOLIDATI 2016 DA BP PER EU +UK

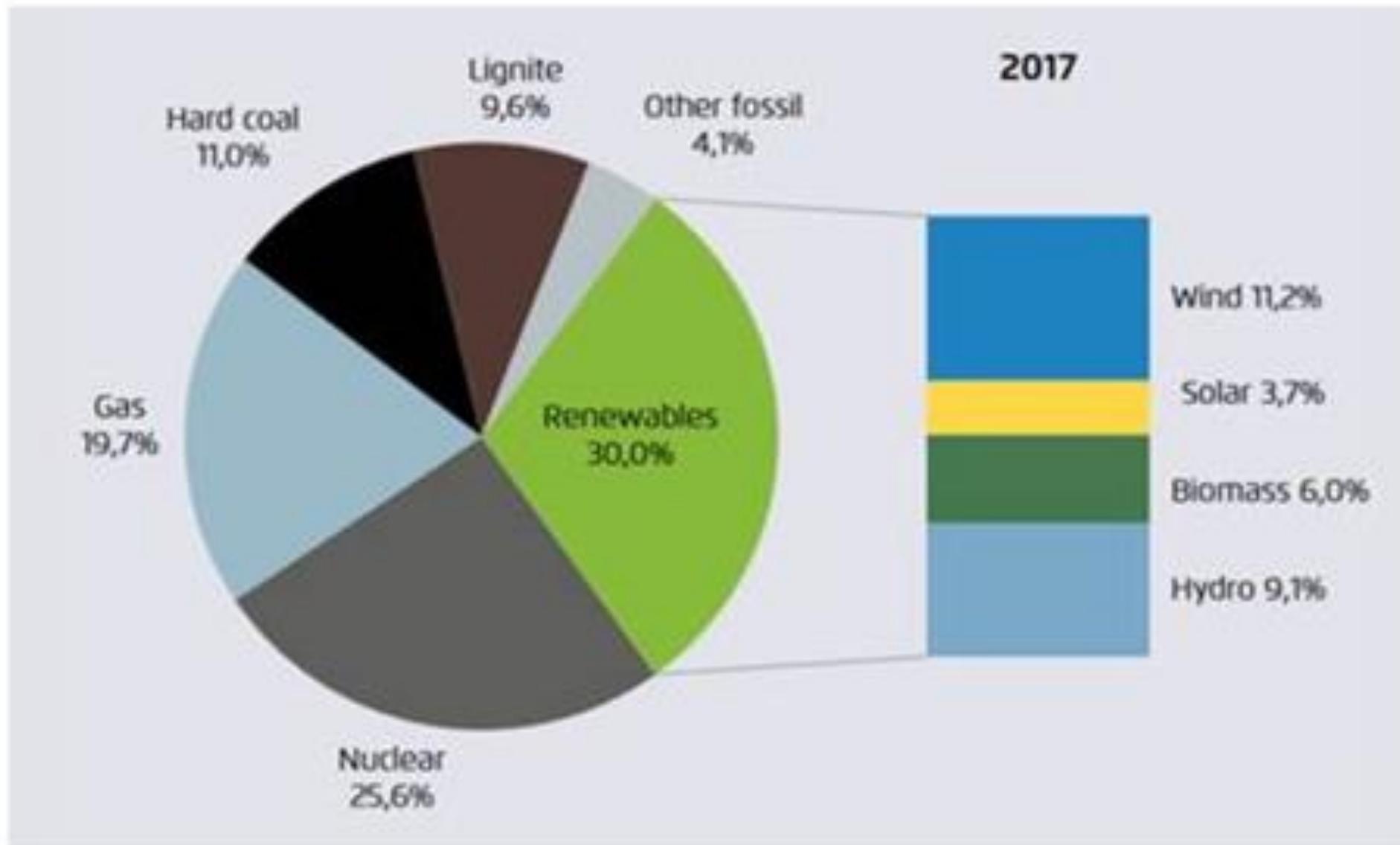
	CO2 Mt	TWh prodotti
Germania	761	648
UK	406	338
Italia	337	286
Francia	316	553
Polonia	300	167
Spagna	282	274
Olanda	212	115
<b>MONDO</b>	<b>33432</b>	<b>24816</b>

## World global power capacity additions and energy production by source 2004-2016

Source	Installed Capacity 2004 [GW] and (%) share	Installed Capacity 2016 [GW] and (%) share	Average Annual Growth Rate (%)	2016 Production [TWh] and (%) share		Average Equivalent Operating Hours [h]
Hydro	715GW 18.80%	1,096 GW 16.3%	4%	4,023TWh 16.2%		3,671
Wind	48GW 1.30%	487GW 7.3%	21%	960TWh 3.9%		1,971
Biomass	39GW 1.00%	112GW 1.7%	9%	468TWh 1.9%		4,179
Solar	3GW 0.10%	303GW 4.5%	47%	333TWh 1.3%		1,099
Geothermal	9GW 0.20%	13GW 0.2%	3%	94TWh 0.4%		7,231
Total Renewables	814GW 21.4%	2,017GW 30.1%	8%	5,878TWh 23.7%		2,914
Total Conventional (Oil, Gas, Coal) and Nuclear	2,986GW 78.6%	4,690GW 69.9%	4%	18,938TWh 76.3%		4,038
TOTAL	3,800GW 100%	6,707GW 100%	5%	24,816TWh 100%		3,700

Source: CESI based on REN21

## EU 2017 ELECTRICITY PRODUCTION BY SOURCES (From AGORA ENERGIEWENDE)



(fonte Agora ENERGIEWENDE)

Hard coal and lignite as percentage of national electricity production

Figure 24



EUROSTAT data to 2015, 2016 and 2017 are own calculations; LT, LU, CY, EE, LV, PL, SE not included due to lower data quality



