MILANO 11 MAGGIO 2017-AIEE MEGALIA

Variable Renewables Electricity Systems Integration: how to get it right

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Shaping a Better Energy Future

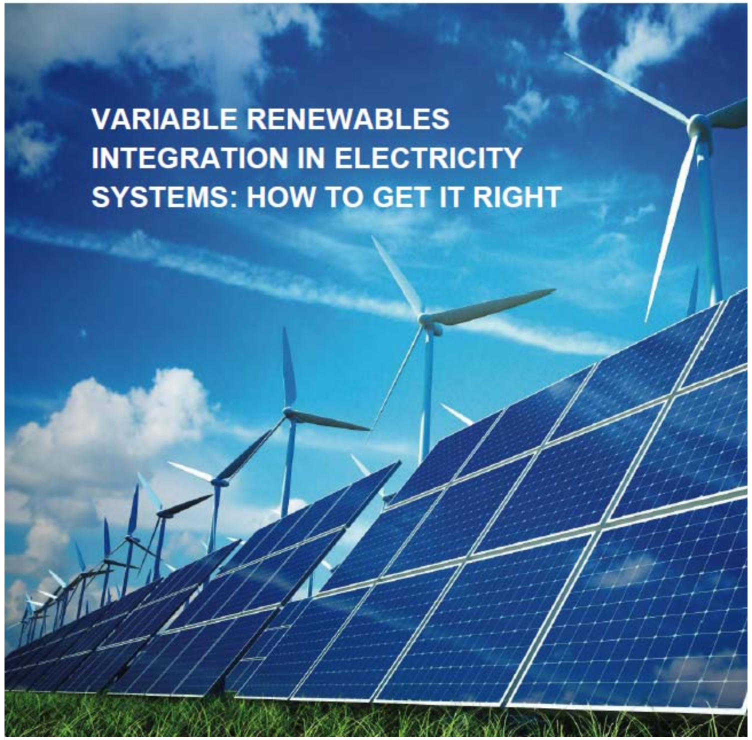
VARIABLE RENEWABLES INTEGRATION IN ELECTRICITY SYSTEMS: HOW TO GET IT RIGHT

Report from WEC Study Group “RES Integration” launched after 2 years of activities in September 20th 2016- Work supported by WEC Global Partner CESI ,Italy

WORLD ENERGY COUNCIL

World Energy Perspectives

Renewables Integration | 2016



1. CURRENT STATUS OF VRES

2. LESSONS LEARNED FROM THE CASE STUDIES

2.1 Power mix of the 32 country case studies

2.2 RES regulations, policies and economics

2.3 Impacts of VRES on the electrical power system

- Impacts on traditional fleets
- Impacts on the electricity market
- Impacts on the transmission and distribution grid
- Impacts on consumers

3. MEASURES FOR A SMOOTHER VRES INTEGRATION

Technologies

Market redesign

4. KEY MESSAGES

ANNEX 1 - EXAMPLES OF COSTS OF WIND AND SOLAR PV SYSTEMS AND RESULTS OF RECENT AUCTIONS

ANNEX 2 - COUNTRY CASE STUDIES SUMMARIES

32 COUNTRY CASE STUDIES

1. Algeria
2. Brazil
3. China
4. Colombia
5. Denmark
6. Ecuador
7. Mexico
8. Egypt
9. France
10. Germany
11. India
12. Indonesia

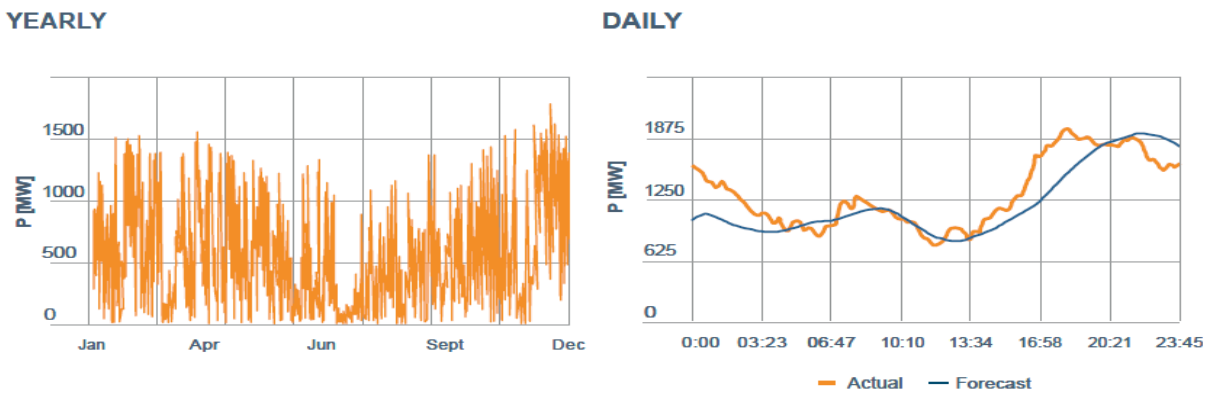
12. Ireland
13. Italy
14. Japan
15. Jordan
16. Kazakhstan
17. Korea (Rep.of)
18. Mexico
19. New Zealand
20. Nigeria
21. Philippines
22. Poland
23. Portugal

24. Romania
25. Russian Federation
26. South Africa
27. Spain
28. Thailand
29. Tunisia
30. United Kingdom
31. United States of of America
32. Uruguay

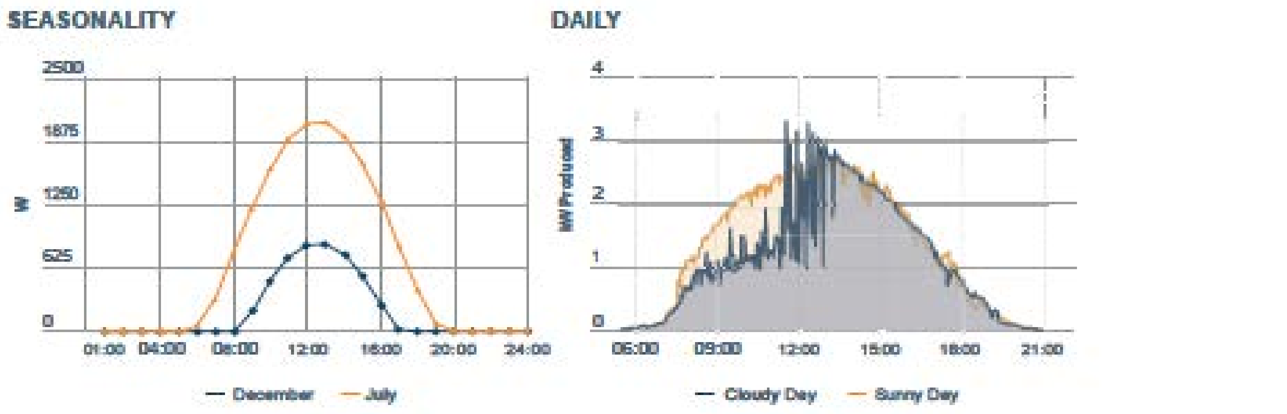
- **89% of total installed VRES generating capacity**
- **87% of VRES electricity production**

Variable Nature of Wind and Sun

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



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



ESI

enewables in the Global Energy System

rld global power capacity additions and energy production by source 2004-2014 (in 2016 Wind +54GW giving global installed 48
- 75 GW giving global installed 302 GW)

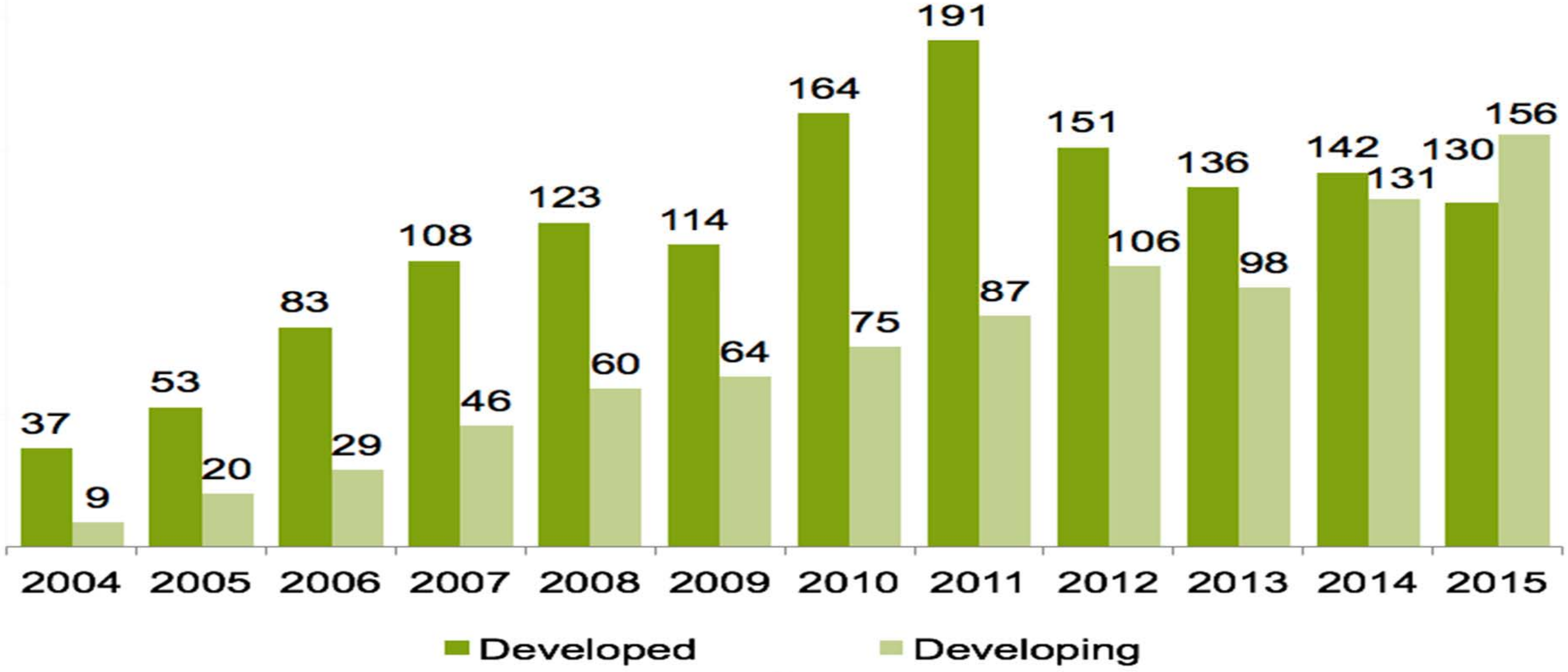
Source	Installed Capacity 2004 [GW] and (%) share		Installed Capacity 2014 [GW] and (%) share		Average Annual Growth Rate (%)	2014 Production [TWh] and (%) share		Average Equivalent Operating Hours [h]
Hydro	715GW	18.8%	1,055 GW	17.1%	4%	3,898TWh	16.6%	3,694
Wind	48GW	1.3%	370GW	6.0%	23%	728TWh	3.1%	1,967
Biomass	39GW	1.0%	93GW	1.5%	9%	423TWh	1.8%	4,545
Solar	3GW	0.1%	181GW	2.9%	51%	211TWh	0.9%	1,168
Geothermal	9GW	0.2%	13GW	0.2%	4%	94TWh	0.4%	7,225
Total Renewables	814GW	21.4%	1,712GW	27.7%	8%	5,353TWh	22.8%	3,127
Total Conventional (Oil, Gas, Coal) and Nuclear	2,986GW	78.6%	4,468GW	72.3%	4%	18,127TWh	77.2%	4,057
TOTAL	**3,800GW**	**100%**	**6,180GW**	**100%**	**5%**	**23,480TWh**	**100%**	**3,799**

ESI, based on REN21 (2015)

lobal new investment in RES excluding Idro plants larger tha
0 MW- – Developed vs developing countries,(USD billion

3-In 2016 reduction of 18% with respect to the 2015 billion $286-Less impact on installed capacity for price uctions per kW installed

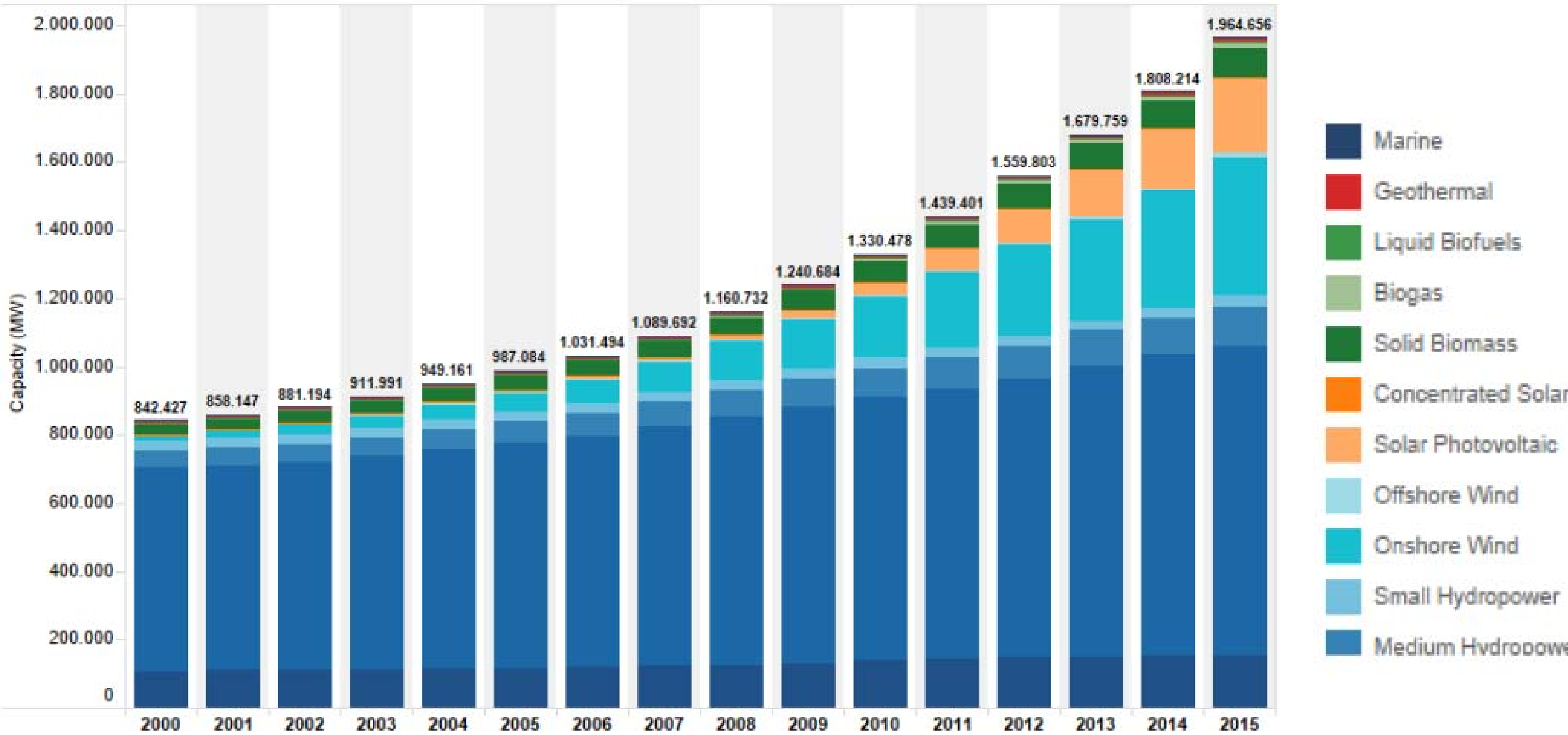
EU is loosing its leading position to ASIA. China accounts 36% of the total RES investments



(46) (73) (112) (154) (183) (178) (239)(278) (257) (234) (273) (286)

ource: BNEF, 2015

RENEWABLE CUMULATIVE INSTALLED RENEWABLES CAPACITY BY TECHNOLOGY IN THE PERIOD 2001–2015



ource: IRENA, 2016

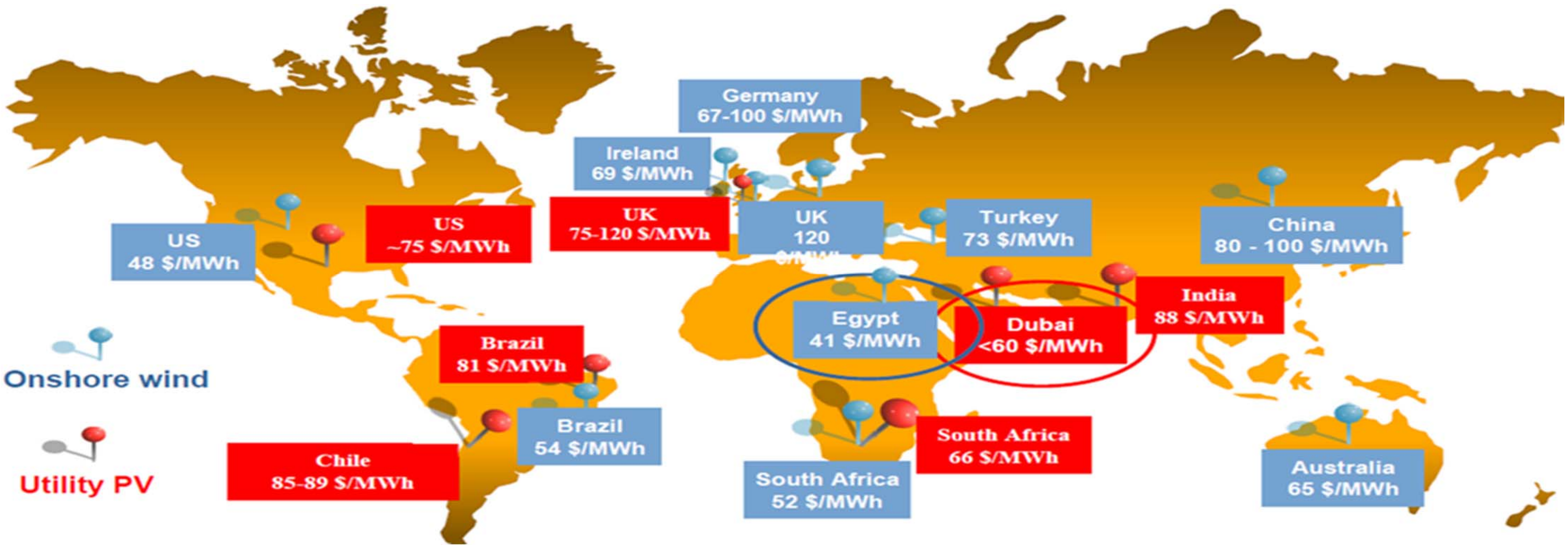
WIND AND SOLAR PV CUMULATIVE INSTALLED CAPACITY DEVELOPMENT FROM 2011-2015. EUROPE HAS FACED A DRASTRICAL DECLINE

		2011	2012	2013	2014	2015
	Europe	52	70	81	88	96
SOLAR PV	**World total**	69	100	139	181	222
	EU	**75%**	70%	58%	49%	**43%**
	Europe	95	108	119	131	144
WIND	**World total**	239	283	318	370	432
	EU	**40%**	38%	37%	35%	**33%**
	Europe	147	178	200	219	240
TOTAL	**World total**	308	383	457	551	654
	EU	**48%**	46%	44%	40%	**37%**

ource: BNEF, 2015

Wind and solar PV reach new lows ;June 2015 IEA

Long-term contract prices (e.g. auctions and FITs)



- Rapid reduction in capital costs due to high volume of RES investments and fast technology development.
- Solar PV show the greatest reduction of prices, by 50% between 2010 – 2014 in OECD and even greater in non-OECD countries
- In some countries solar PV power plants with capacity above a few MW the minimum EPC contract value is around 1,000 USD/kW.

ource: IEA, 2016

Wind and solar PV reach new lows

- **The above prices are old after only 1 year**.

  At May 2016 ,auctions:

  -**Morocco wind 28 $/MWh** **-UAE PV 30 $/MWh**

  And at February 2017,auctions

  PV in UAE and Mexico 24$/MWh

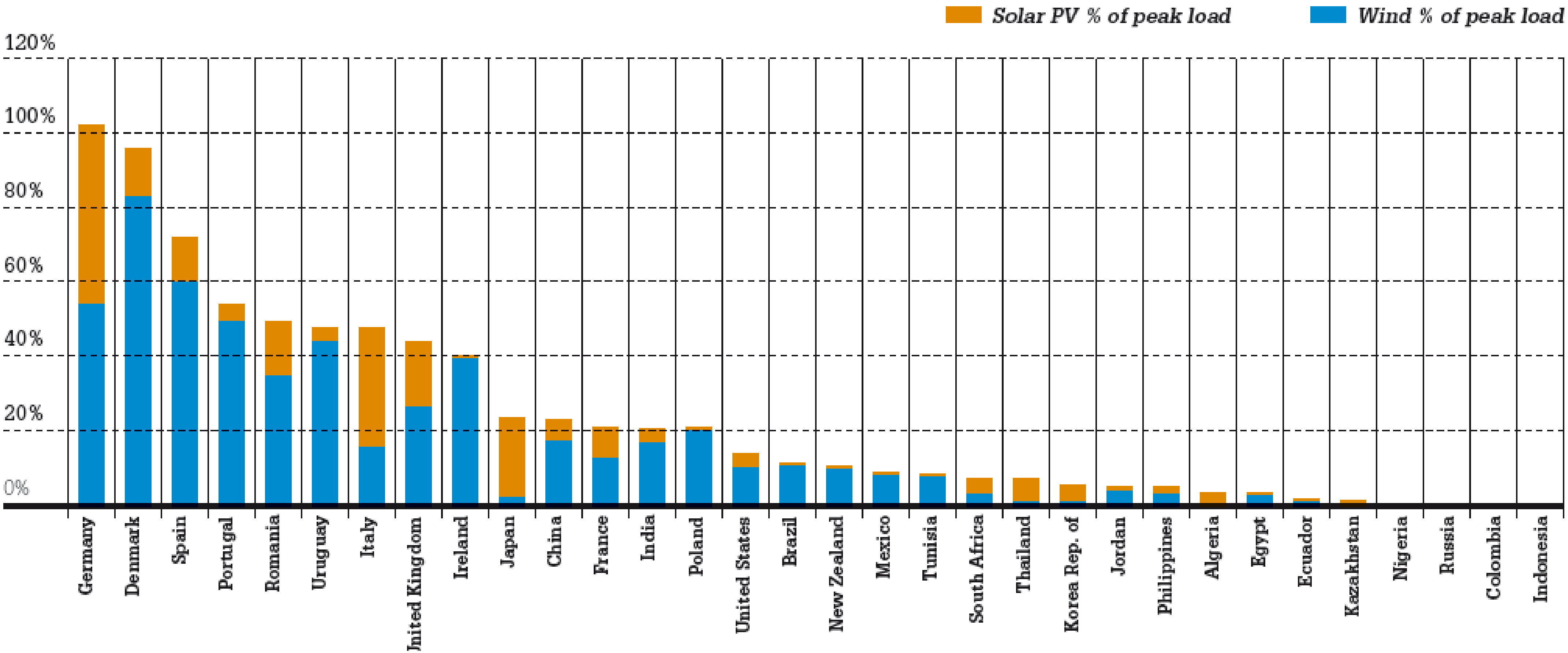
- **Cannot be used as average values**, since they are affected by the local costs and load factor values for wind and solar plants and by type of auction.
- **Morocco high wind load factor close to 60%** (the average in Italy is 18-24%).
- Solar PV plants in Dubai and Mexico have load factors which are **more than double of those in the UK**

Leading countries in wind and power in 2015

	1	2	3	4	5
Capacità installata eolica	Cina [145 GW]	Stati Uniti [73 GW]	Germania [45 GW]	India [25 GW]	Spagna [23 GW]
Capacità installata fotovoltaica	Cina [43 GW]	Germania [40 GW]	Giappone [33 GW]	Stati Uniti [26 GW]	Italia [19 GW]
Capacità installata fonti rinnovabili non programmabili (FRNP)	Cina [188 GW]	Stati Uniti [98 GW]	Germania [85 GW]	Giappone [36 GW]	India [30 GW]
Contributo percentuale di FRNP su produzione nazionale	Danimarca [52%]	Portogallo [24%]	Irlanda [23%]	Spagna [23%]	Germania [20%]
Percentuale di FRNP su domanda di picco	Germania [102%]	Danimarca [96%]	Spagna [72%]	Portogallo [54%]	Romania [49%]

VRES INSTALLED CAPACITY HAS SIGNIFICANT PROPORTION ON THE DEMAND IN VARIOUS COUNTRIES

VRES cumulative installed capacity by Country in percent of the national peak load



EC Report

Regulation policies and economics

- VRES regulation and policies present differences in the 32 Countries, but VRES enjoy priority of dispatch in most of them.
- The use of various support and incentive schemes has a strong impact on the VRES development and success.
- Financial incentives have been widely used for promotion of VRES. The most popular form is Feed in Tariffs (FIT) that are in used in many countries and are fixed for specified time periods (e.g. 20 years in Germany and Italy).

Regulation policies and economics

- **Brazil** Country-wide **auctions for all types of power sources** for long term contracts (Power Purchasing Agreements). **In 2015, wind power was the cheapest** electricity **source with 50 USD/MWh**.
- **Egypt Bilateral agreements**. RES equipment and spare parts are **exempted from custom duties and sales taxes.**
- **Germany The FIT has been the basic incentive**. The **reduction of PV feed-in has resulted in reduced capacity additions** in recent years. Moreover**, a cap on the installed PV capacity of 52 GW** has been introduced. Once this cap is reached, new PV units will no longer be supported by the feed-in tariff. **In 2014 auctions for PV have been introduced for plants above 6 MW each**; auctions also **for wind** plants will be introduced **in 2017.**
- **Italy** Incentives for VRES in Italy used to consider **Green Certificates, FIT, FI premium tariff. PV incentives** were introduced **in 2005 with high FI premium tariff of 450 €/MWh;** impressive growth in new installations. **As soon as the incentives** for both wind and PV **were drastically reduced or withdrawn**, the annual growth of **VRES decreased from more than 10 GW in 2011 to around 0.5 GW of new capacity additions in 2015**. **Now** there are **only auctions for very reduced global yearly capacity of large plants and tax deductions for small plants**.

Regulation policies and economics

- **Japan Feed in tariff** for wind and solar falls in the range **between 300–350 USD/MWh and now up to 450** to push VRES development **considering nuclear concern** and strong reduction in its production.
- **New Zealand A unique market arrangement based on a carbon price which avoids incentives to RES, combined with a nodal price that takes into account eventual additional costs on the T&D (e.g. losses and congestion) due to plants localization**.
- **South Korea Additional green certificates** are **added to utilities which install wind power plants combined with Energy Storage Systems.**
- **USA Differences for different utilities and regions**: incentives are **Federal** (Tax Credit and Production Tax Credit), **State** (e.g. Net metering) and **Loca**l (rebate and financing options, green power rates).

Impacts of VRES on the electrical power system

1. Traditional fleets
2. The electricity market
3. Transmission and Distribution grid
4. Consumers

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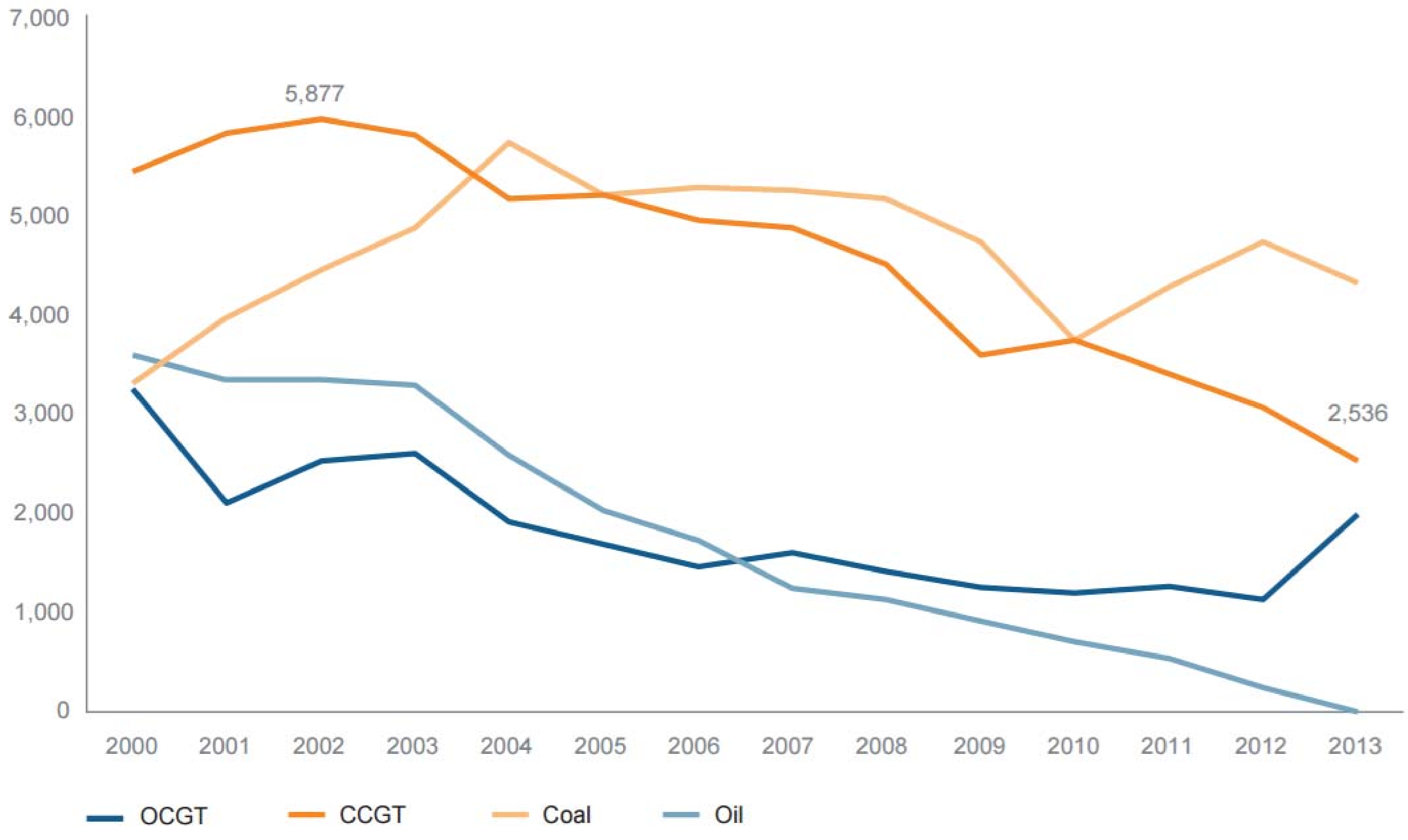
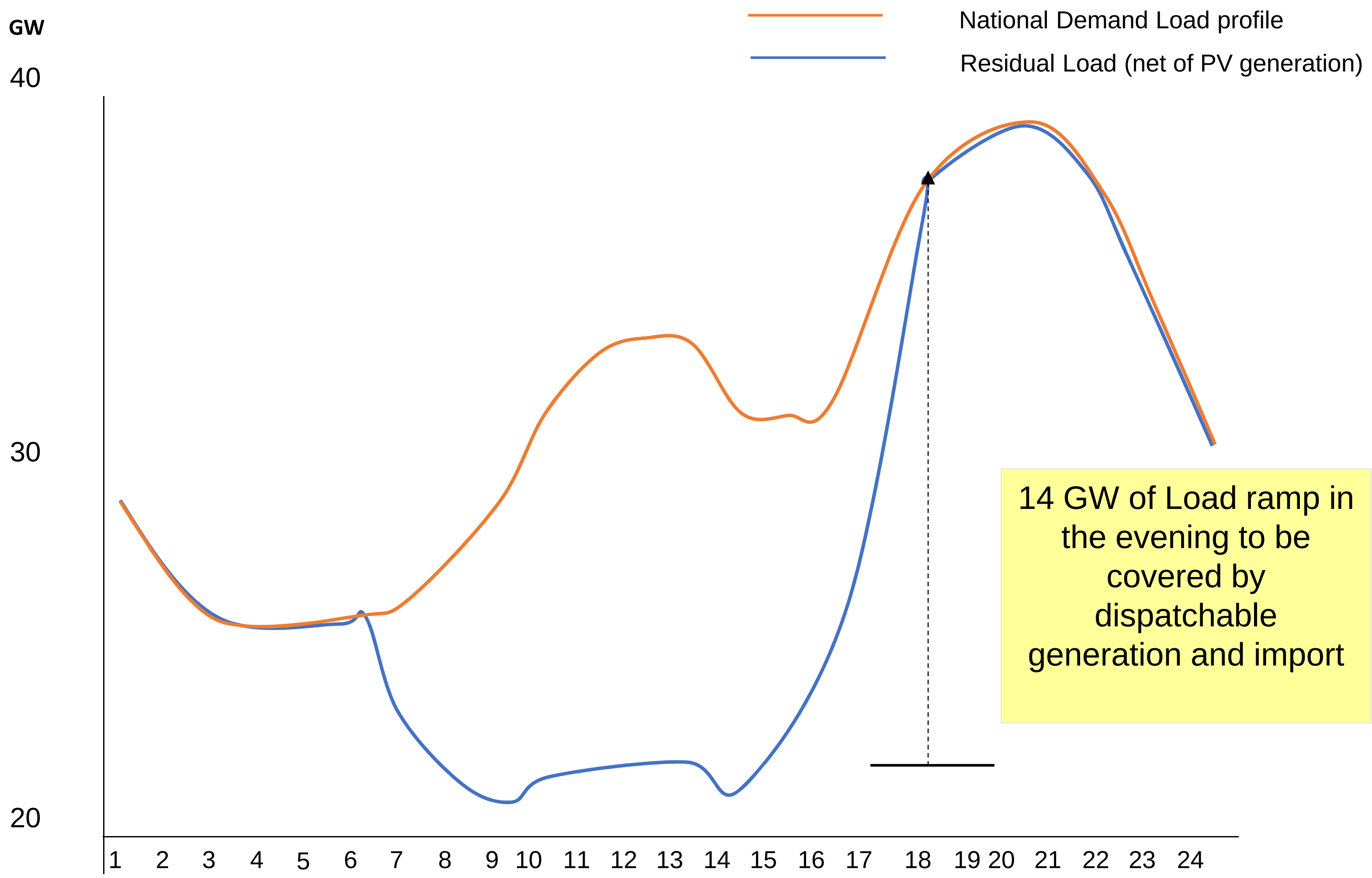
Shrinking operating hours of CCGT plants (eg. Italy)



ource: AEEGSI

Sharp variation of RES generation (eg. Italy)



Source: Terna

Impacts of VRES on the electrical power system

1 Traditional fleets

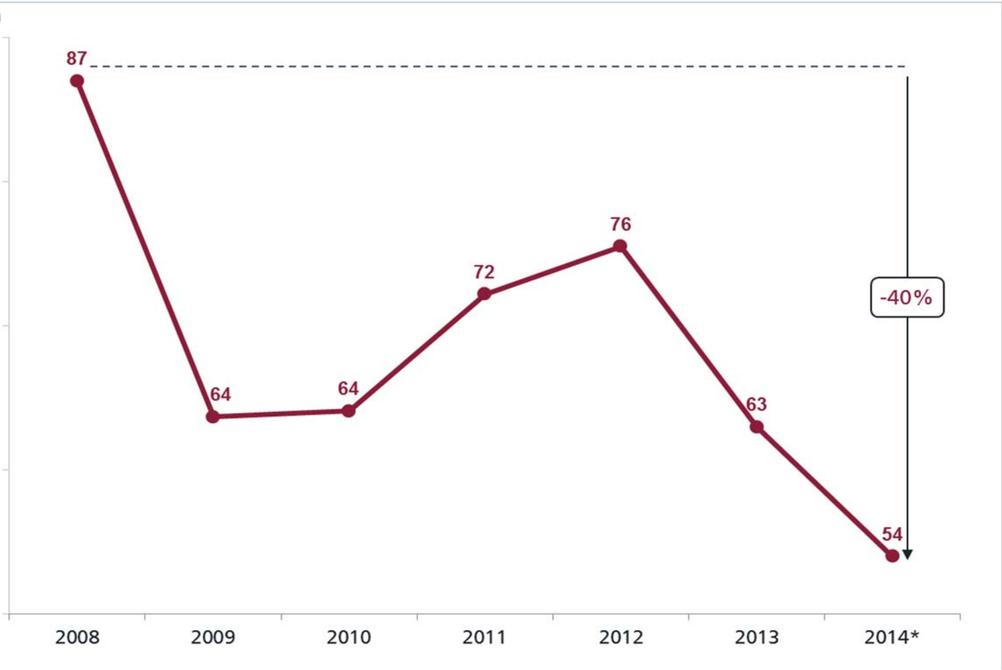
2 The electricity market

3 Transmission and Distribution grid

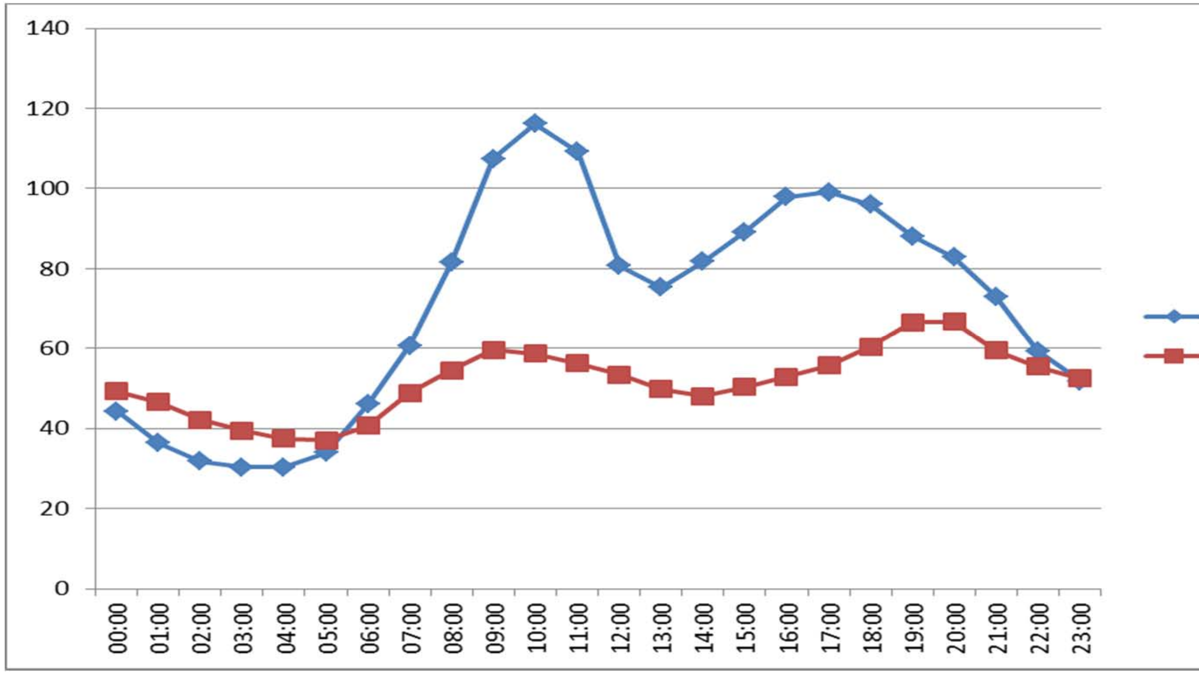
4 Consumers

VRES has caused a drastic collapse of PUN (national average pool price) combined also with gas price reduction- Max daily price in the evening after sunset –Italy case

Average

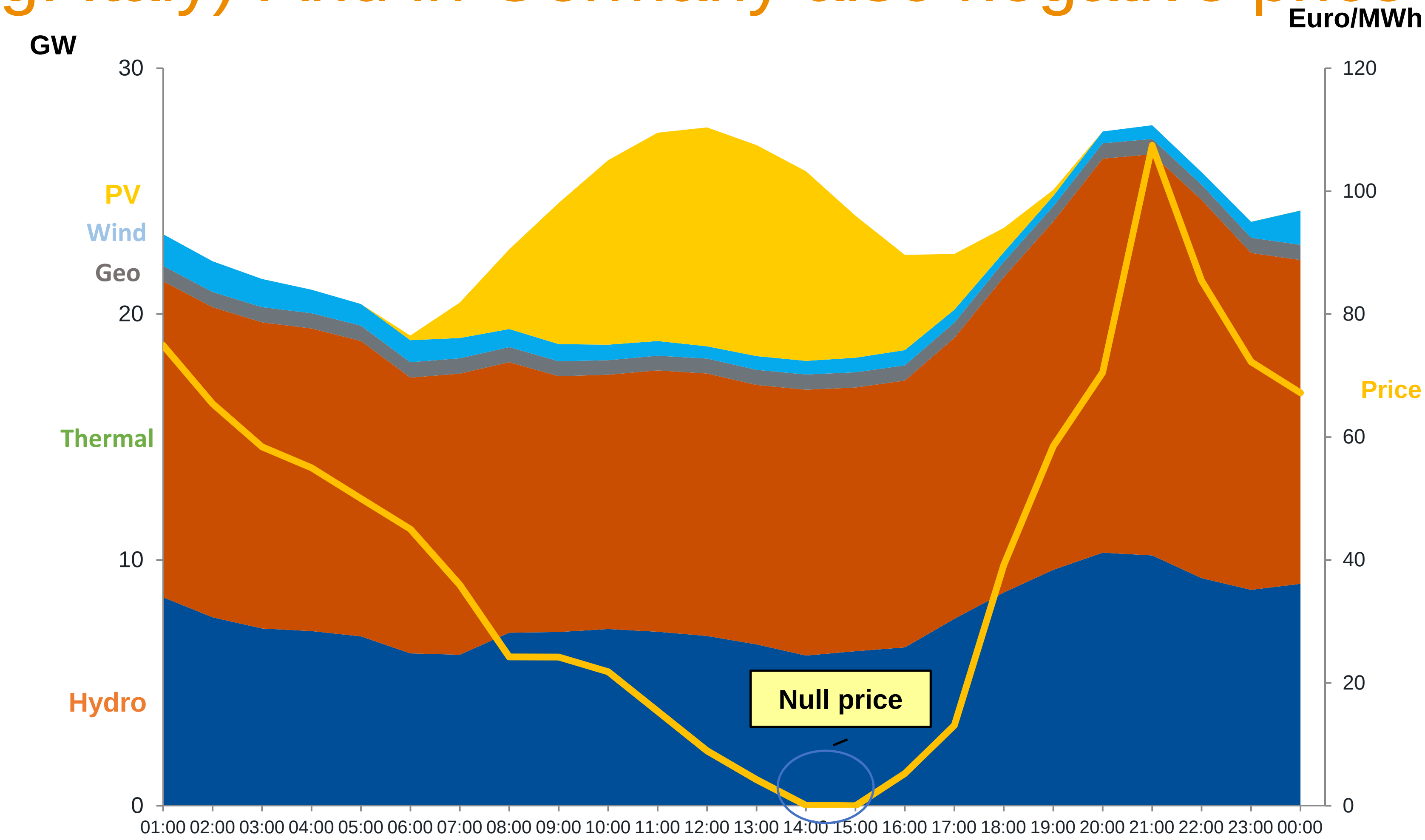


Daily



Source: GME

A null price on the day-ahead market on a sunny summer day (eg. Italy)-And in Germany also negative price



Source: Terna, GME

Impacts of VRES on the electrical power system

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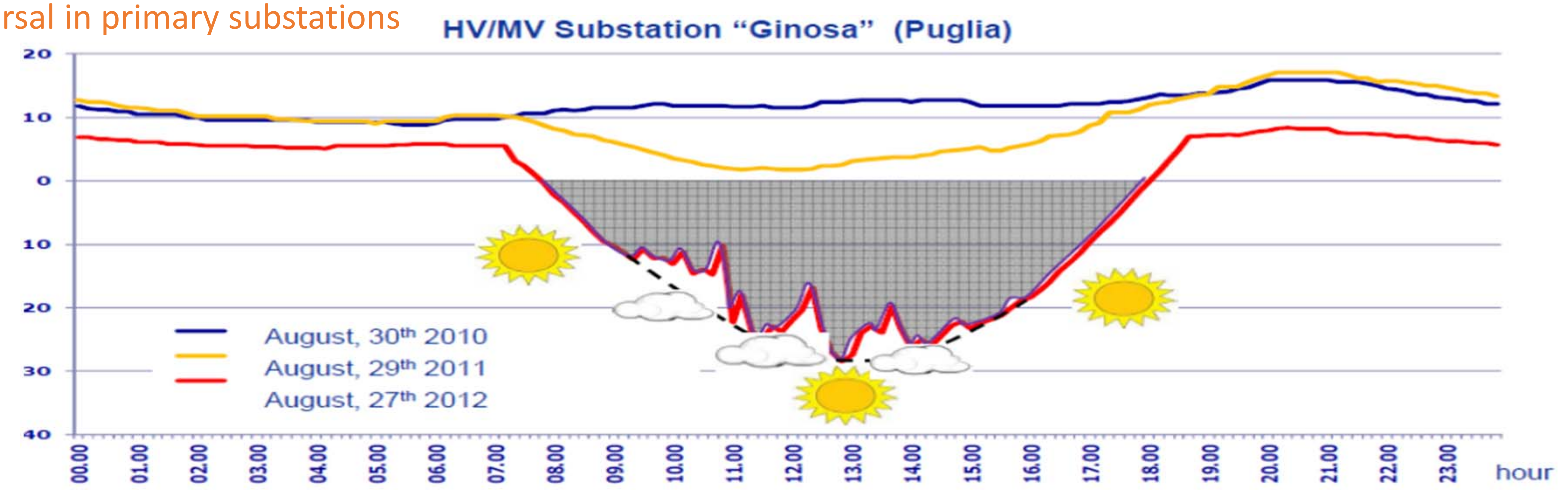
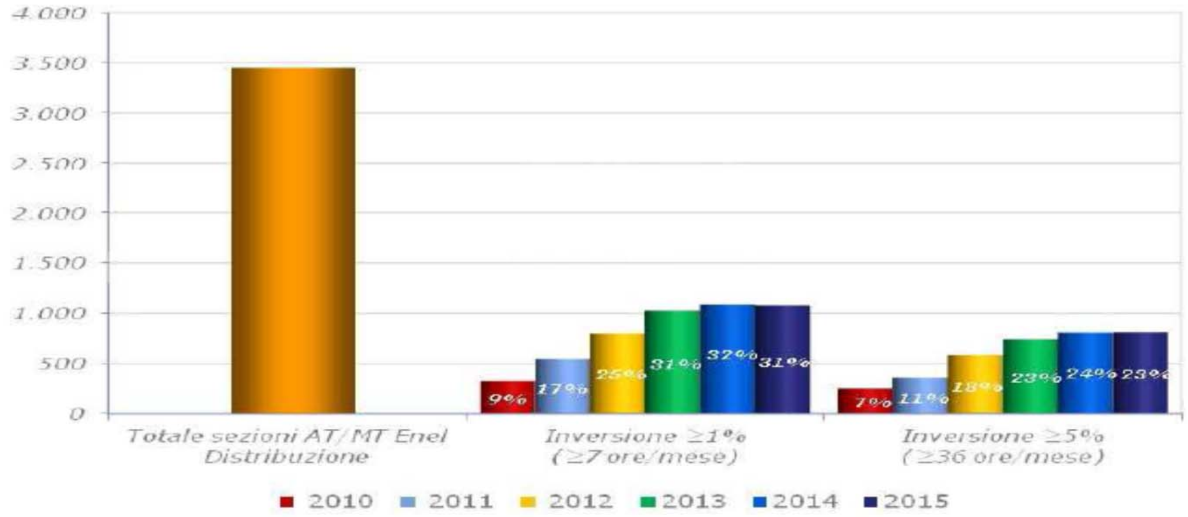
The increase in the number of primary substations with power flow inversion impacts the existing measuring and protection systems-Example of Italy

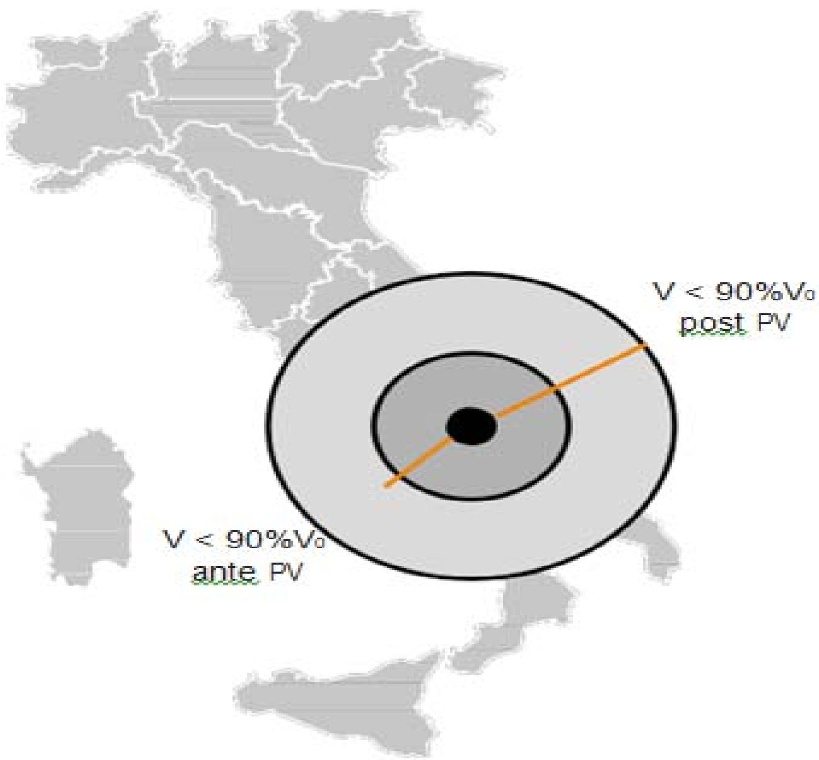
Power flow reversal in primary substations

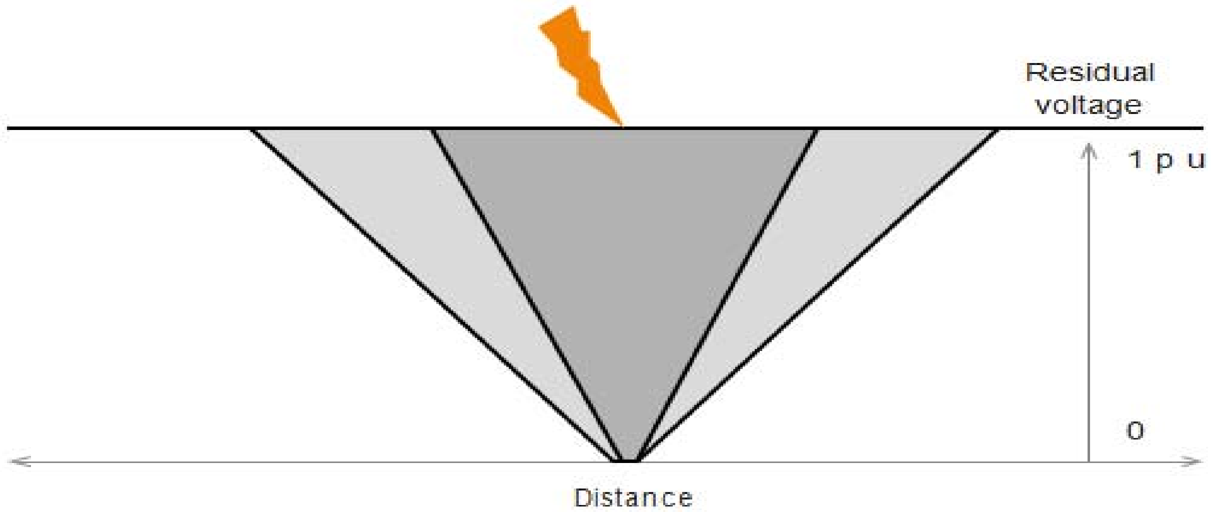




ource: ENEL Distribuzione

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.)

ource: Terna

Impacts of VRES on the electrical power system

1. Traditional fleets
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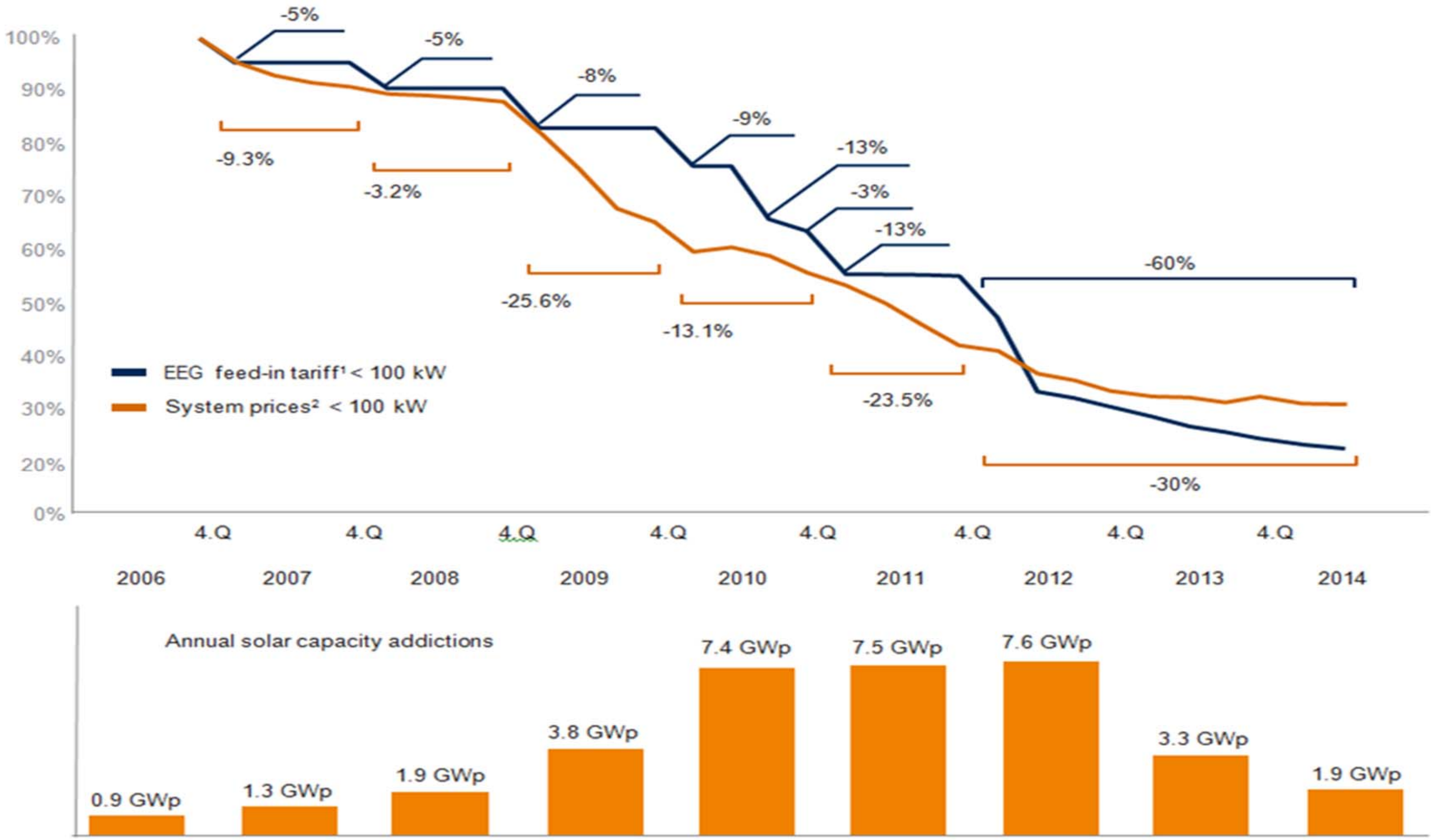
Development of PV feed-in tariffs, module costs and capacity additions (eg. Germany)



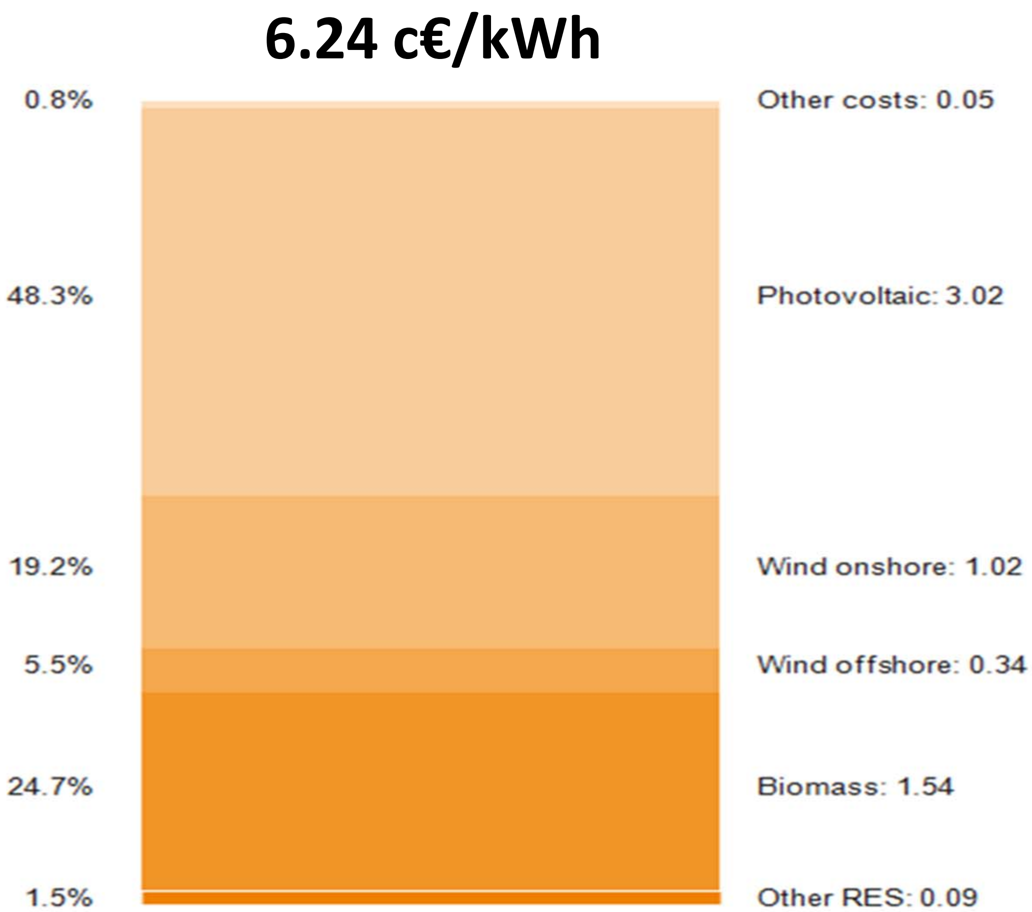
1 The EEG compensation: the compensation classes were in the second quarter 2012 brought in line with the amended EEG law. Previously until the end of the first quarter 2012, PV installations with the output of 30–100 kWp were included.

2 System prices: the average price paid by the end user for fully installed roof panels without USt.

ource: BSW-Solar, Beta

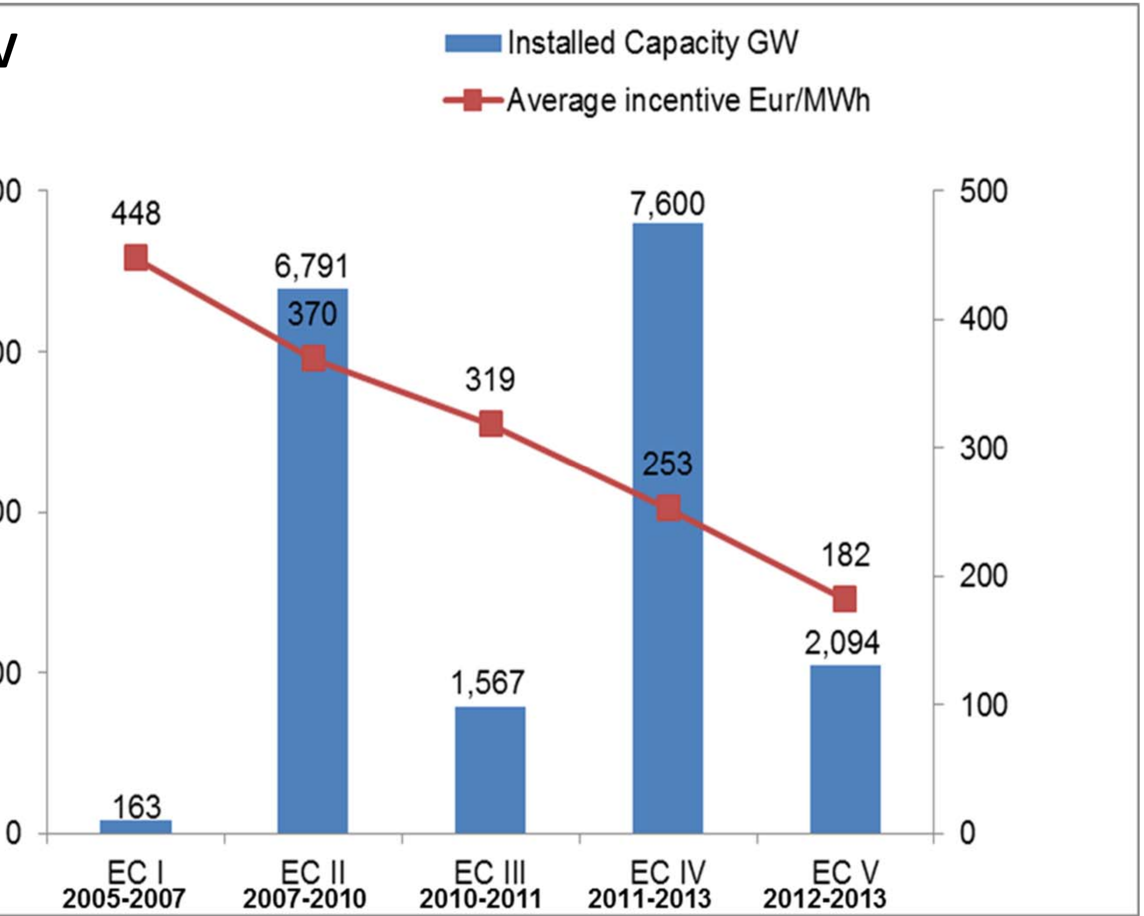
EEG-levy 2014 is ca. 6.24 c€/kWh (eg. Germany)

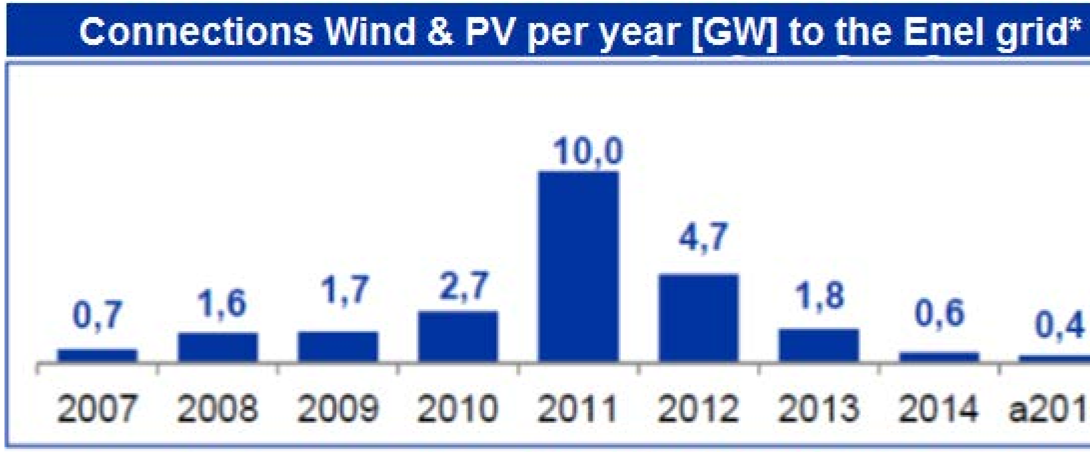
The proceeds from the introduction of EEG in 2014 totalled 23.6 billion Euros and will be used to 100% for the promotion of renewables. 97.4% go directly to the operators of the EEG plants, 1.8% to direct marketing of the EEG power and 0.8% to cover the necessary administrative costs.

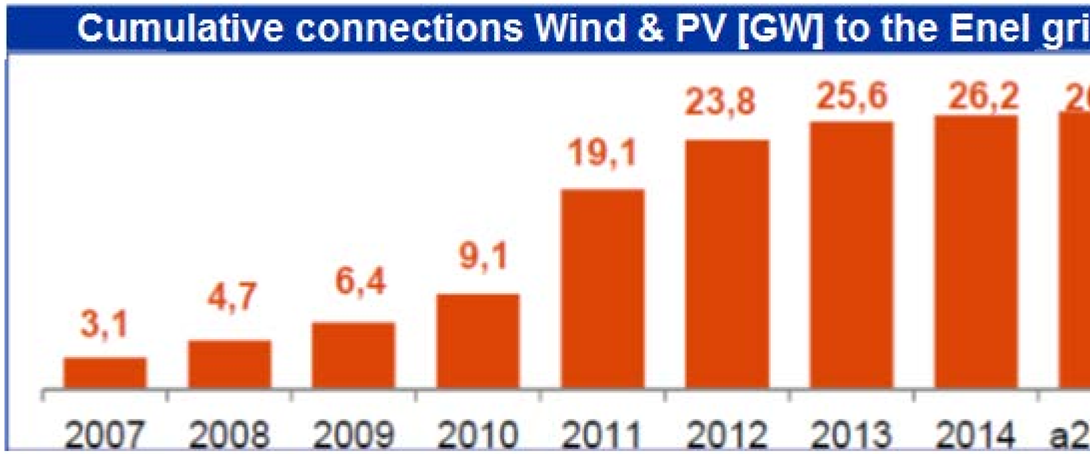


ource: BDEW

Evolution of the PV incentives with different feed-in scheme and connections (Wind & PV) to the Enel distribution system in Italy







ource: BDEW

*Enel DSO covers more than 85% of the Italian distribution grid

Measures for a smoother VRES integration

TECHNOLOGIES

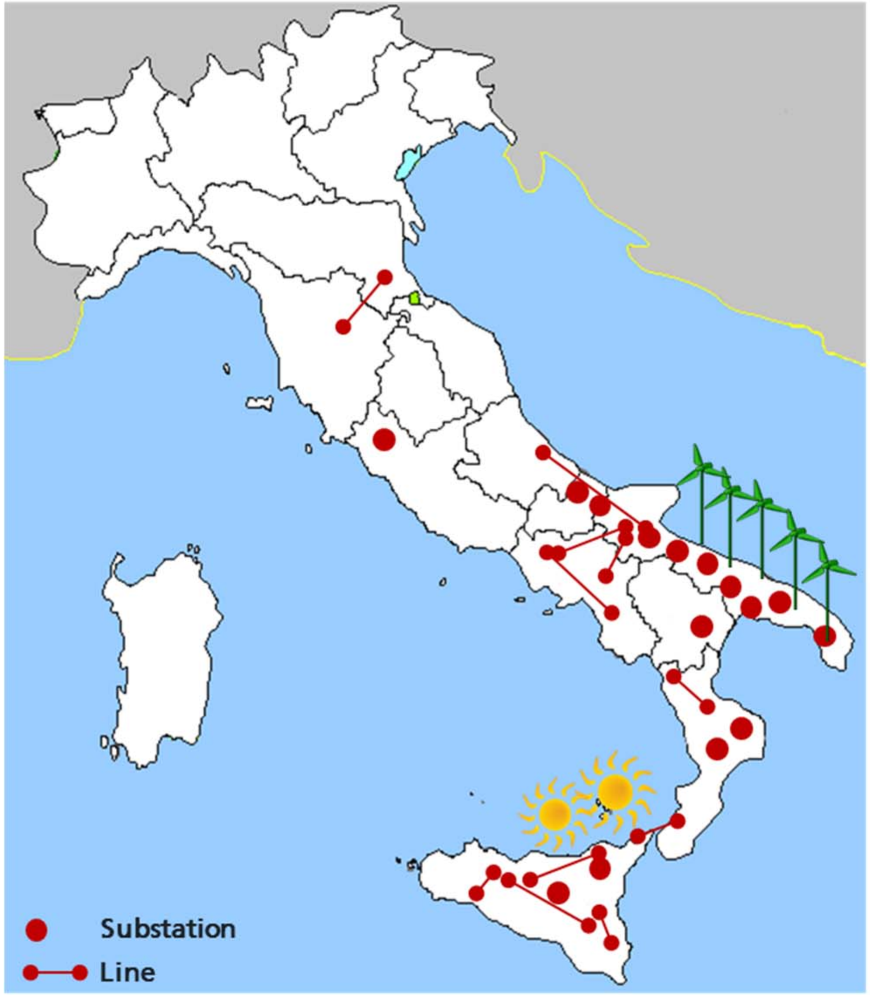
- Improved forecasting
- Optimisation of operating reserve
- Greater flexibility of conventional generation
- Dynamic transfers
- Expansion of local transmission and distribution grids
- Cross-border interconnections
- Energy storage systems
- Demand response

MARKET DESIGN

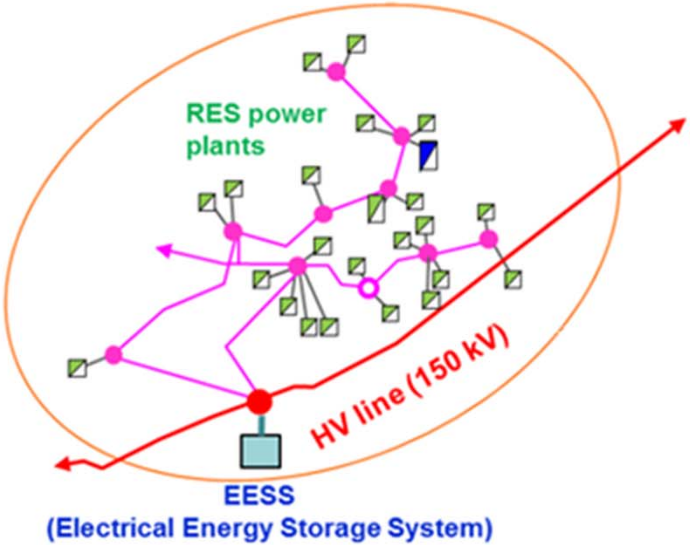
- Revision of emissions trading schemes
- Capacity market
- Sub-hourly market closures
- Negative market prices
- Nodal pricing
- Larger balancing areas
- Aggregate bids of RES power plants
- Green energy transmission corridors
- TSO /DSO’s coordination rules
- Role of private investors

TECHNOLOGIES MARKET DESIGN

Local congestion in South of Italy calls for 8 bn Euro of investments in grid reinforcement and expansion in the next decade



Local generation exceeds sub-transmission capacity



Source: Terna

TECHNOLOGIES MARKET DESIGN

Italian Transmission system operator storage pilot projects

Power Intensive

Scope: Safe management of the grid

Total Capacity: 40 MW

Number of Sites: (Phase I) : 2

Phase I: 16 MW Storage Lab

Codrongianos
Installed Power: ≈ 8 MW
Status: 5.4 MW completed

Ciminna
Installed Power: ≈ 8 MW
Status: 3.2 MW completed

Technology evaluation

Phase II: 24 MW

Casuzze and Codrongianos: to be started

Energy Intensive

Scope: Solve Grid congestion / bottlenecks

Total Capacity: 35 MW

Number of Sites: 3

Ginestra
Installed Power: ≈ 12 MW
Status: completed

Flumeri
Installed Power: ≈ 12 MW
Status: 6.0 MW completed

Scampitella
Installed Power: ≈ 12 MW
Status: building in progress

MWh/MW ratios in the range 0.5-1

MWh/MW ratios in the range 4 to 8

LESSON LEARNED [1/2]

RES and particularly variable RES as wind and PV have had are having and will have explosive development

RES and specifically wind and PV have become a big business overtaking the investments in conventional generating plants

Combination of technology /construction developments and volumes are driving down CAPEX and OPEX costs of variable VRES

Variability and average low equivalent hours of operation per year of PV and also in many countrie for wind, pose challenges to their extensive development-DSO's and TSO's succeeded to manage electrical systems with no impact on reliability even in presence of high % of VRES.

A holistic approach to overall electrical system design is a key to success –Each country power system is unique even if some general statements can be drawn.

Sophisticated technical, economic and regulatory analyses on a case-by-case basis must be conducted over an adequate period of time

The implications of reductions in subsidies or other support schemes must be carefully analysed t avoid a drastic reduction on VRES investments as results of incentive reductions(e.g. some EU countries)

LESSON LEARNED [2/2]

The right location with high wind and solar factors and low grids connection costs for new large VRES project is a key to success

Regulatory bodies have a fundamental role in both development of VRES and typology o counter measures to smooth the impact on the power system

VRES are in any case a pathway for climate change mitigation, but also investments tha reduce dependence on imported fuel, improve air quality, increase energy access and security of supply, promote economic development, and create jobs.

VRES have contributed to the reduction of pool price even if for some categories of clients this has not been reflected in their bills

Cautions on extrapolations to other countries of auctions $/kWh values got in nations with very high levels of wind and insolation and very low local costs

Working together, the main energy stakeholders will be able to meet all current challenges facing RES integration in electricity systems by learning about both positive and negative experiences of other countries

ANNEXE 1 CAPEX - OPEX - AUCTION RESULTS

- **CAPEX for domestic PV of some few kW from 1.000 $/kW in India and 3.500-4.000 $/kW in Japan and US**
- **CAPEX for PV plants above some MW** from less than **1.000 $/kW in Africa,ME, India ed Latin America to 2.700 $/kW in Japan.**
- ***load factor* for PV** from around 10% in UK to 30% in some countries of South America, ME and Africa.
- ***load factor* for wind plants** in Morocco up to 55%;in Italy average 18% (portion of cost of kWh due to CAPEX triple)

O&M SERVICES

O&M services are in **$ o € per MW installed-**

For wind plants O&M increases with plant age. A ***"full service" contract*** **in Europe between 20 ed i 30 $/MW –** For a low *load factor* 18% as Italy 12,5-18,7 $/MWh .

For PV plants ,the report provides some Italian published data relevant to plants above **2,5 MW and for 1.350 equivalent hour: 45 $/MWh**: 56% O&M (including spare parts,billing etc), 18% land renting when not in CAPEX, 10% insurance *"all risks"*, 10% telecommunications and monitoring, 6% guards .

For Europe ,this is a summary of main auctions from the report at June 2016

- **in Germany: 70 - 85 €/MWh for PV plants above 6 MW**(in Germany from 2017 auctions also for wind)

- -**in France (results confirmed at end 2015 for plants totalling 800 MW):**

"roof top" systems average 130 €/MWh

«on the ground plants» average 120€/MWh.

- In **UK** published results **February 2015 for 15 wind projects "on shore" totalling** 750 MW and 5 PV plants totalling 72 MW,values **80 - 83 £/MWh for wind and 50 - 80 £/MWh for PV.**

Last Auctions in Europe after data from report

NB- In **February 2017** here below results of last auctions

- -In **France** ,**PV plants** on the ground totalling 160 MW,in South of country average value **62,5 €/MWh –For wind plants ,auctions for 3GW in 3 years are under issue with a price reference** of **72€/MWh**
- -In **Germany, 27 PV projects** totalling 163 MW : average price **69 €/MWh**. **For plants in foreign countries to deliver energy to Germany a 53,8 €/MWh got for a plant in Denmark .**
- -In **Italy the last auction for wind plants has shown a discount of 40% with respect to the reference price from the 3 winners of the different lots:**

66 €/MWh -

Further information

ownload the free report from the Council’s website:
ttps://www.worldenergy.org/publications/

Thank you

COUNTRY CASES
ANNEX 2

ALGERIA

lgeria's Power Generation – Basic Information (2014)	
otal installed generation capacity	**16.00 GW**
otal RES generation capacity	0.26 GW
otal VRES generation capacity	0.26 GW
eak load (Northern interconnected network)	10.90 GW
inimum load	10.90 GW
lectricity production	60.50 TWh
lectricity import	686.00 GWh
lectricity export	877.00 GWh

Algeria Renewables (2015)	
Total RES generation capacity	**0.54 GW**
Total VRES generation capacity	0.28 GW
Installed solar PV capacity	0.27 GW
Installed wind capacity	0.01 GW

ALGERIA

% of Algeria's electricity system is based on conventional, primarily fossil-fuelled neration with an increasing percentage of natural gas. Algeria's renewable electricity rtfolio includes some hydro and only small shares of variable RES**. High installation sts and the need for additional reserve capacity have been a barrier for large scale velopment of solar or wind plants. In 2011, first solar facility was commissioned in ybrid 150 MW system (25 MW concentrated solar power and 125 MW gas-fired nt). Large solar and wind power potential is in the Southern** sparsely populated eas. Future developments of **RES are expected to reach up to 22 GW in 2030**. nding for RES comes from a levy on oil tax.

BRAZIL

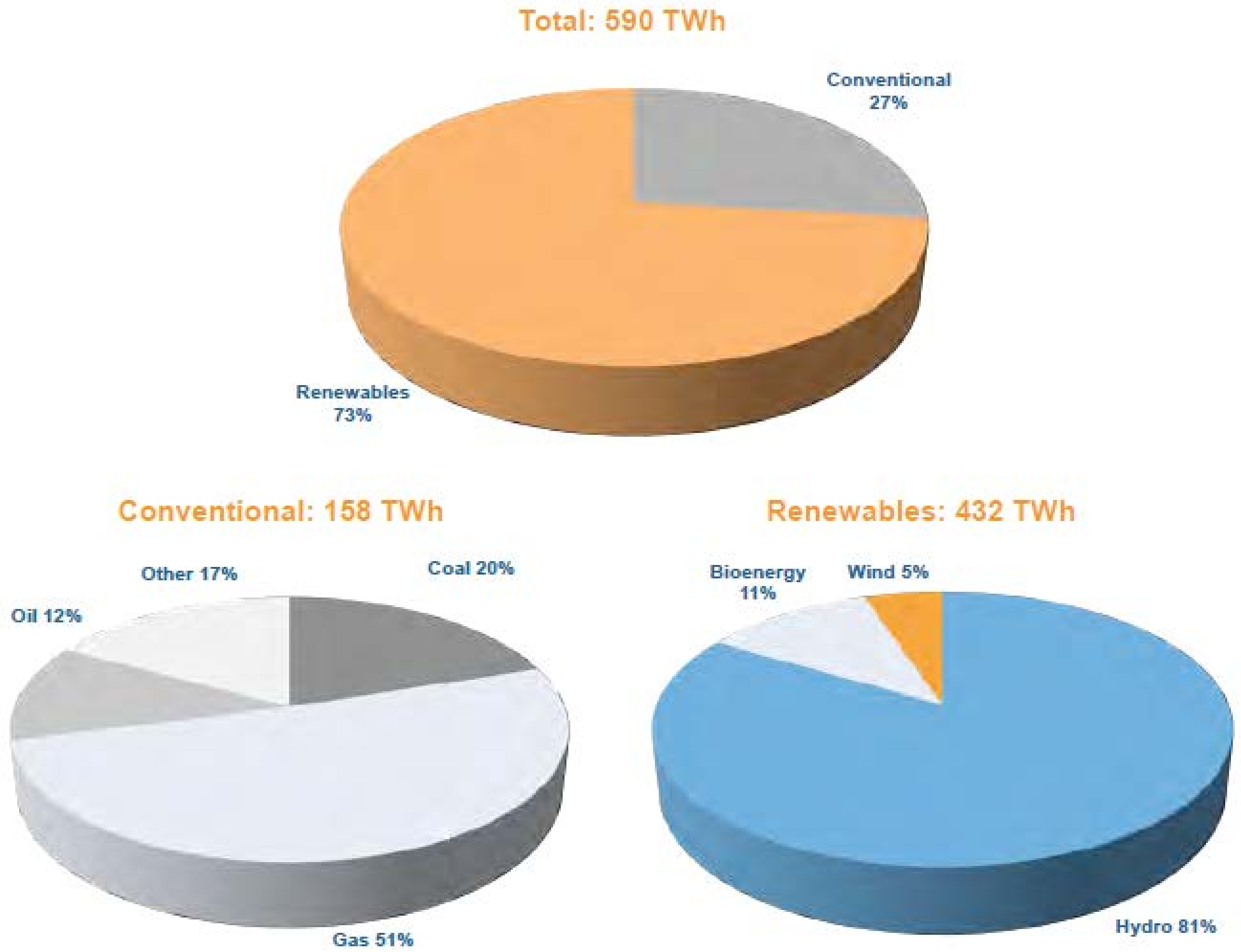
Brazil's Power Generation – Basic Information (2014)

Total installed generation capacity	**133.9 GW**
Total RES generation capacity	106.4 GW
Total VRES generation capacity	5.9 GW
Peak load	85.0 GW
Minimum load	61.1 GW
Electricity production	590.5 TWh
Electricity import	33.8 GWh

Brazil Renewables (2015)

Total RES generation capacity	**114.2 GW**
Total VRES generation capacity	8.7 GW
Installed solar PV capacity	0.021 GW
Installed wind capacity	8.7 GW

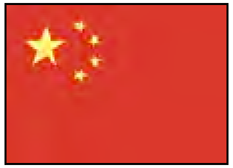
Brazil's electricity production mix (2014)



% of electricity production in Brazil is based on renewables (mainly hydro). Brazil rrently promotes affordable renewable energy at **power auctions of different types supply options with 15 to 30 year contracts. Large-scale bioenergy production** is a tinct feature of the country's energy system. Fast development of wind generation pacity has resulted in its increase from 0.2 GW in 2007 to 5.9 GW in 2014, and a drop **auction prices to USD 50/MWh making wind the cheapest electric energy source er large hydr.**

2014 wind accounted for 2% of total electricity production. **By 2023 wind capacity is pected to reach 23 GW and solar 4 GW. Seasonal nature of local renewables and rther expansion of** ***hydro generation with no reservoirs requires further velopment of conventional generating plants for security of supply.***

CHINA



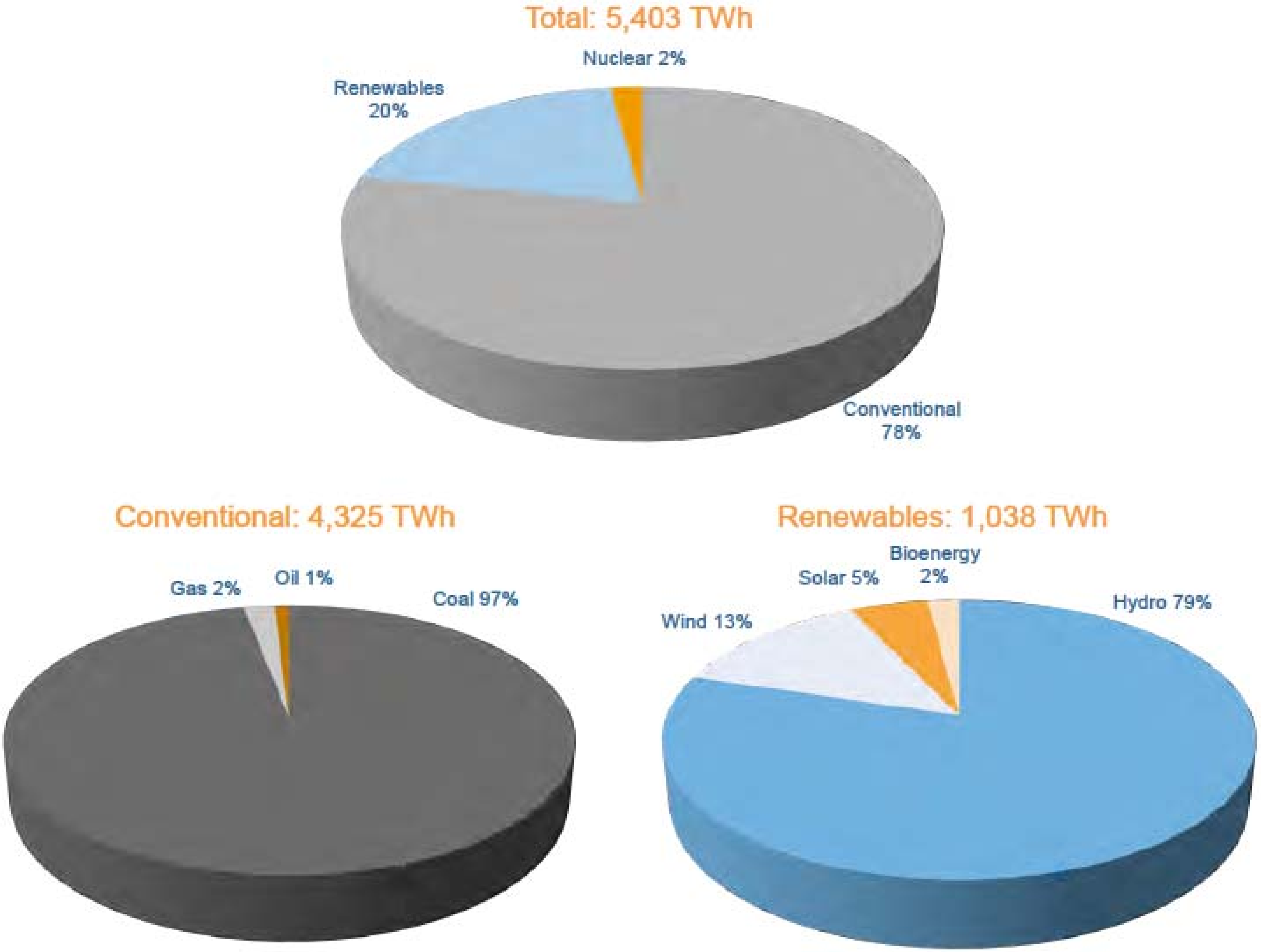
China's Power Generation – Basic Information (2014)

Total installed generation capacity	**1,360.0 GW**
Total RES generation capacity	454.0 GW
Total VRES generation capacity	142.6 GW
Electricity production	5,403.0 TWh

China Renewables (2015)

Total RES generation capacity	**519.7 GW**
Total VRES generation capacity	188.1 GW
Installed solar PV capacity	43.0 GW
Installed wind capacity	145.1 GW

China's electricity production mix (2014)

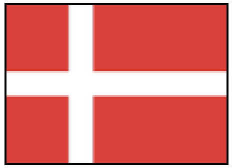


China is **the world leader in installed generation capacity (1,360 GW) and electricity production (5,403 TWh). 78% of it comes from conventional power plants (mainly coalfired)**, while the renewable energy portfolio is dominated by hydropower. Wind and solar PV have grown strongly in recent years reaching installed capacity of 114 GW and 28 GW,respectively at the end of 2014. **Wind currently accounts for 2% and solar PV for less than0.5% of total electricity production, but both are growing quickly with the recent annual capacity increases of 19.7% for wind and 17.1% for solar in 2014.**

Even if the share of variable RES is still low in relative terms, their random fluctuations and lack of flexible conventional power have resulted in significant changes in the power balancing capability of power grid. China has six interconnected grids, and therefore certain consolidated data is not available.

NB From recent, data in some regions only 50% of variable RES can be injected in the network due to bottle necks

DENMARK



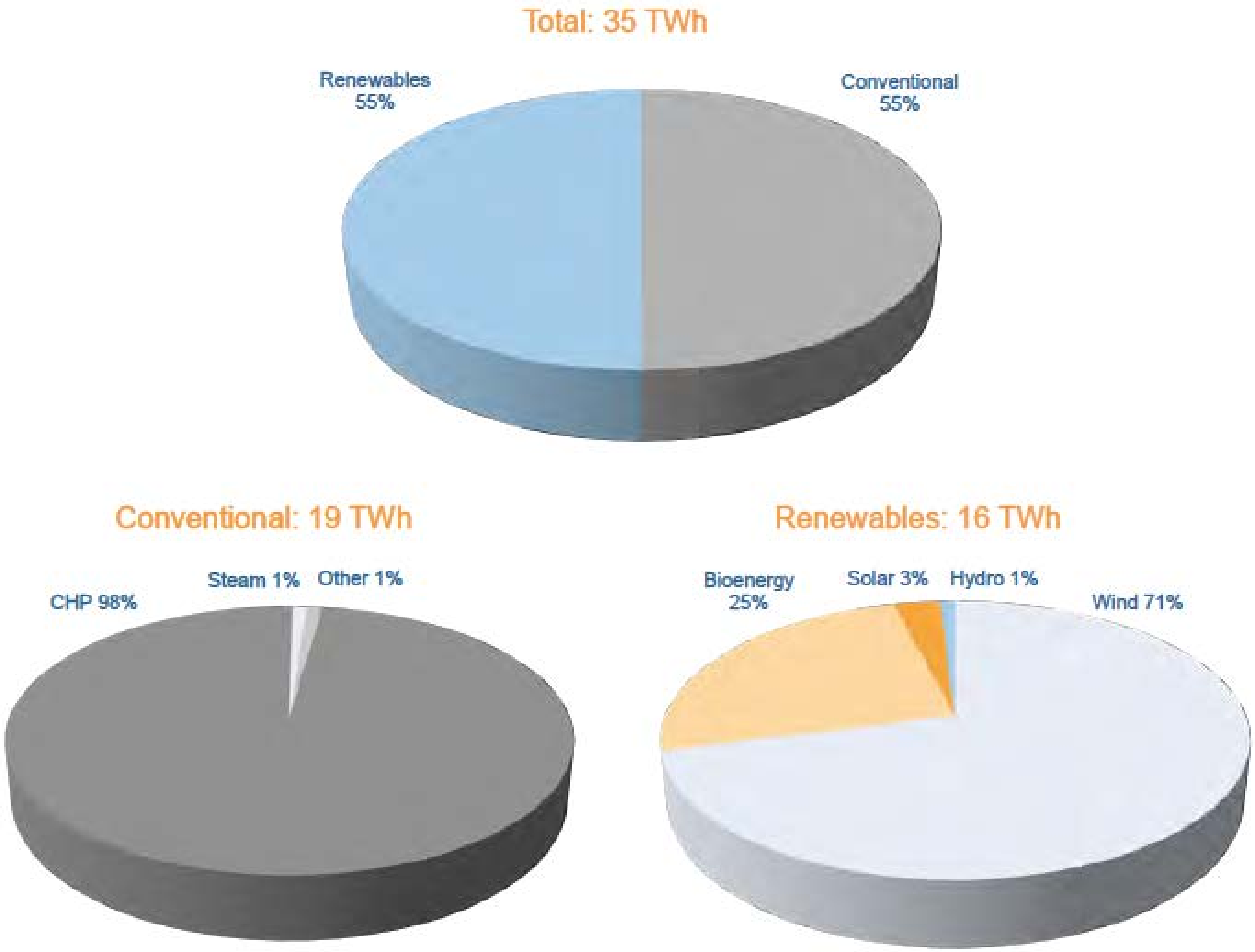
Denmark's Power Generation – Basic Information (2014)

Total installed generation capacity	**13.60 GW**
Total RES generation capacity	7.0 GW
Total VRES generation capacity	5.4 GW
Peak load	6.1 GW
Minimum load	2.3 GW
Electricity production	34.7 TWh
Electricity import	11.5 TWh

Denmark Renewables (2015)

Total RES generation capacity	**7.3 GW**
Total VRES generation capacity	5.9 GW
Installed solar PV capacity	0.8 GW
Installed wind capacity	5.1GW

Denmark's electricity production mix (2014)

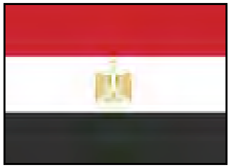


to **35% of Denmark's 35 TWh generation of electricity is produced with renewable** ergy, with wind accounting for 71%. In total, **33%** or 11.3 TWh of Denmark's ectricity was produced from **variable RES** in 2014, achieving the highest VRE netration in the world in relative terms. At the same time, **Denmark imported 11.5 Vh of electricity.**

spatching priorities, feed-in-tariffs, and feed-in premiums for variable RES have been ving growth in VRES. **This large share of RES required significant changes to the nish energy system including interconnectors to neighbouring countries, back-up wer units, demand management and energy storage.**

ne target for 2020 is to reach 50% of electricity consumption supplied by wind thout any use of coal in Danish plants and by 2050 the entire Danish energy nsumption should be supplied by VRES technologies.

EGYPT



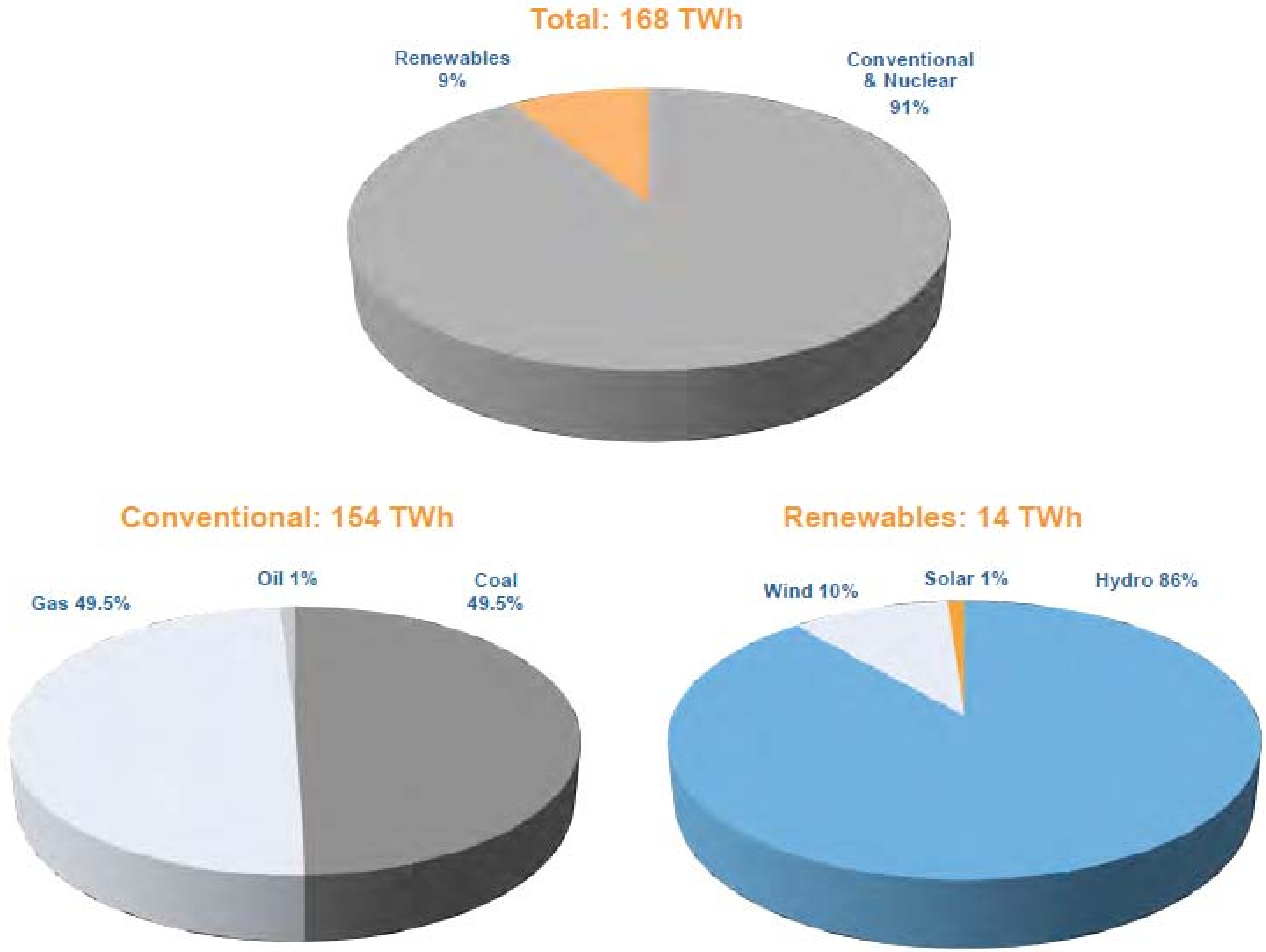
Egypt's Power Generation – Basic Information (2014)

Total installed generation capacity	**32.0 GW**
Total RES generation capacity	3.5 GW
Total VRES generation capacity	0.6 GW
Peak load	26.1 GW
Electricity production	168.0 TWh

Egypt Renewables (2015)

Total RES generation capacity	**3.51 GW**
Total VRES generation capacity	0.64 GW
Installed solar PV capacity	0.03 GW
Installed wind capacity	0.61 GW

Egypt's electricity production mix (2014)



e government strategy approved in February **2008 outlines the objective of RES** aching a **20% share of the total electricity generation by the year 2020**.

e share of the grid-connected wind power is today about 10% of the total electricity neration in Egypt.

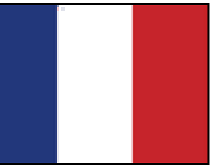
is planned **to develop a broad private participation through both the competitive nder and bilateral agreements. This will be supported by the introduction of long-rm Power Purchase Agreements.**

he Government of Egypt will guarantee all financial obligations under the PPA.

newable energy equipment and spare parts are exempt from the stoms duties & Sales Taxes

ore than 7,600 square kilometres of desert lands have been allocated for ture projects.

FRANCE



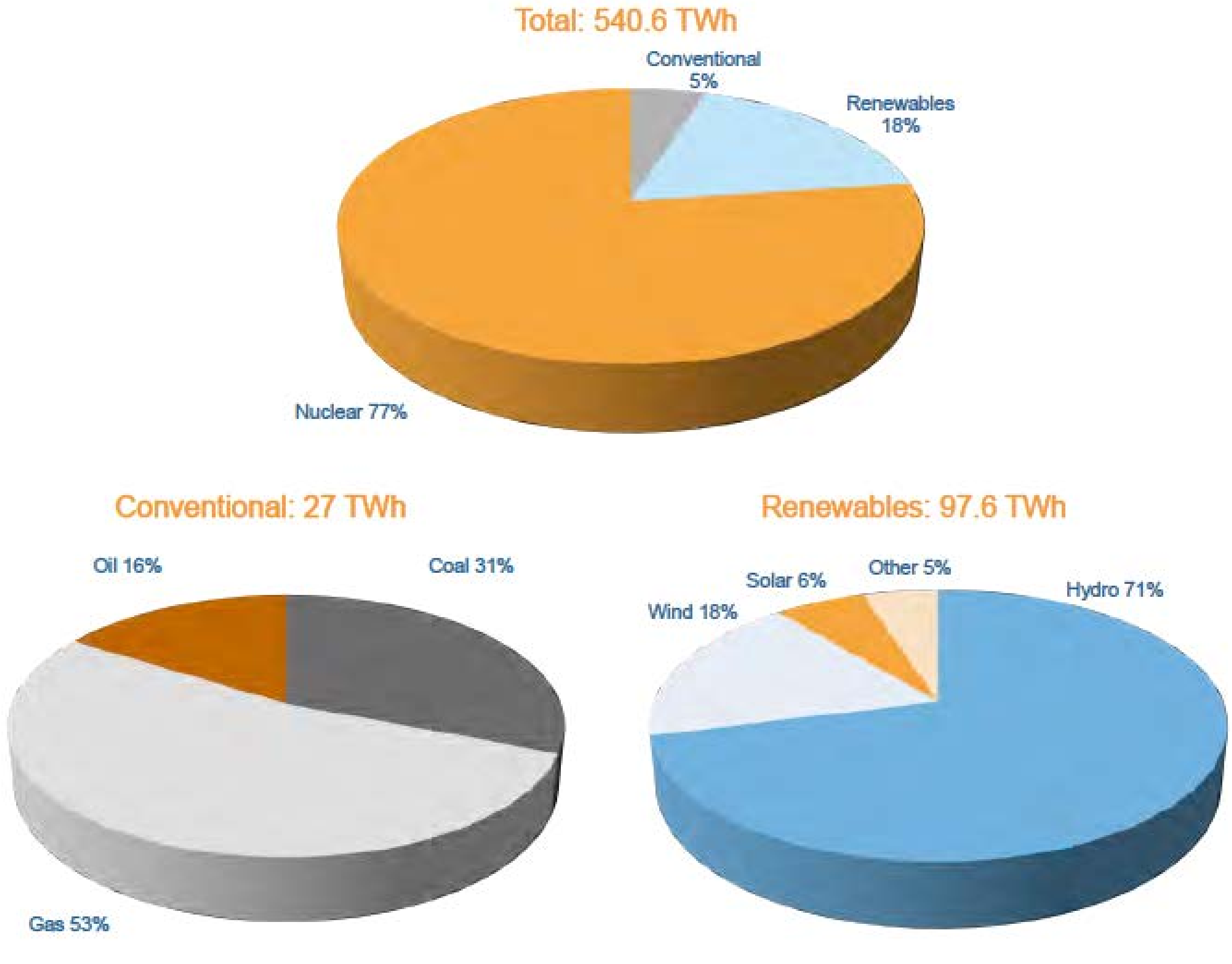
Frances's Power Generation – Basic Information (2014)

Total installed generation capacity	**129.0 GW**
Total RES generation capacity	41.8 GW
Total VRES generation capacity	14.5 GW
Peak load	82.5 GW
Minimum load	29.5 GW
Electricity production	540.6 TWh
Electricity export	92.4 TWh
Electricity import	27.3 TWh

France Renewables (2015)

Total RES generation capacity	**44.2 GW**
Total VRES generation capacity	16.9 GW
Installed solar PV capacity	6.6 GW
Installed wind capacity	10.3 GW

France's electricity production mix (2014)



014, the production from all **RES provided 18% of French electricity**,.
nd and solar PV capacity increased by nearly 1.900 MW in 2014.
rently, France has 9.100 MW of wind and 5.300 MW of solar generation capacity.
ctricity generated by **renewable energies other than hydropower (28 TWh) outperformed fossil fuel**
ver generation for the first time in 2014.
ore than half was generated by wind power, with the remainder split between solar PV and biomass.
ximum wind power generation was reached on 27 December 2014 with output of slightly over 7.000 M
resenting **80% of total installed wind power capacity**.
ximum photovoltaic power generation was reached at 13.30 on 17 May 2014 with output of 3.700
/ (**70 % of total installed solar capacity**). Such levels had never been achieved before
ddition, hydro availability was particular y high in that year, due to heavy rainfall. Output of hydropower
2 TWh was the second highest of the decade after 2013, when it was exceptionally high.
these favourable conditions resulted in the highest level of generation by renewable energies
ounting for nearly 20% of French power production. This contributed to the reduction of
bon emissions, already achieved by both energy consumption efficiency programmes
nuclear power plants. Annex 1 presents some data from auctions of VRES.

ewable energy equipment and spare parts are exempt from the customs duties & Sales Taxes .

GERMANY

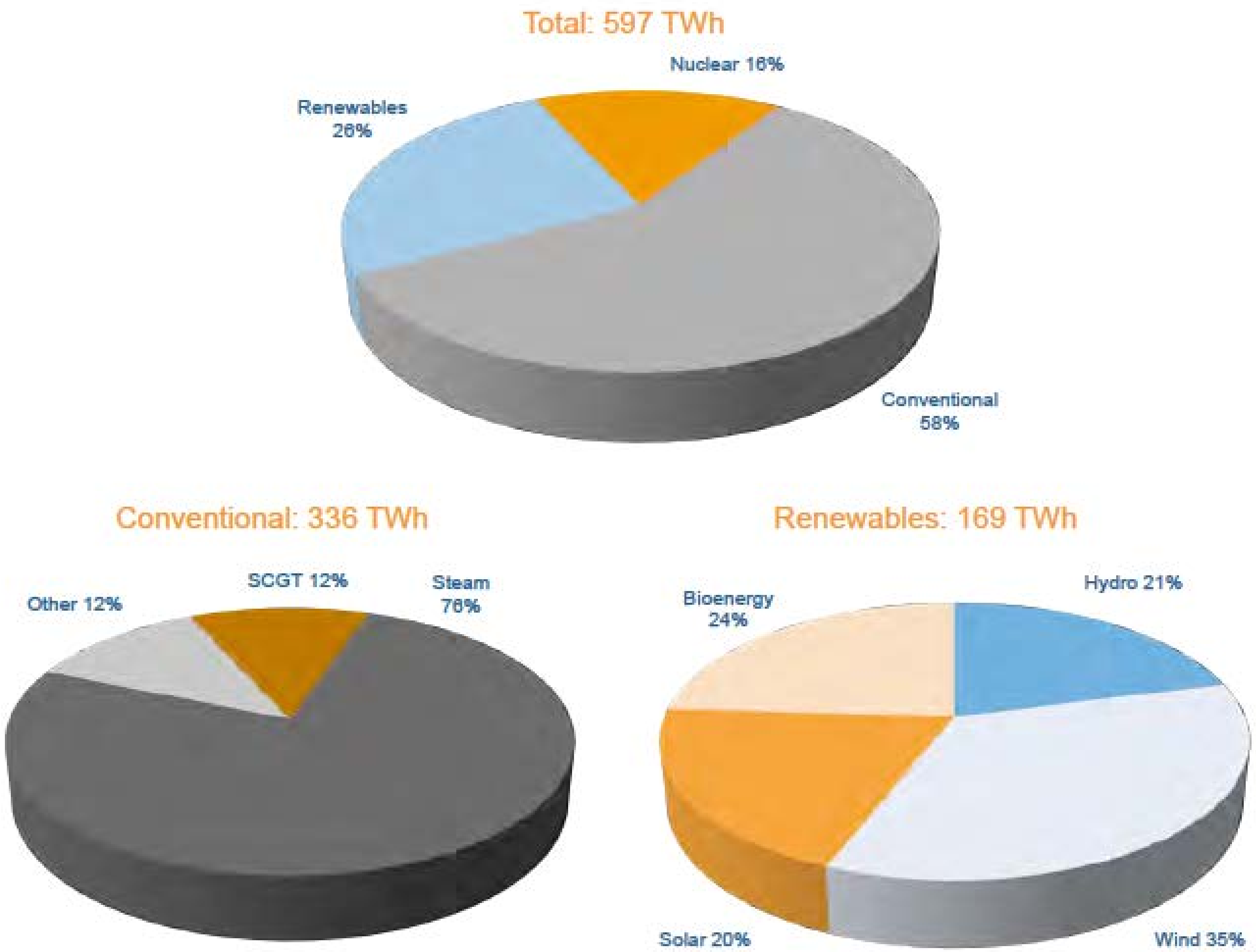
Germany's Power Generation – Basic Information (2014)

Total installed generation capacity	**194.0 GW**
Total RES generation capacity	97.7 GW
Total VRES generation capacity	74.0 GW
Peak load	83.0 GW
Minimum load	32.0 GW
Electricity production (Gross)	614.0 TWh
Electricity production (Net)	597.1 TWh
Electricity export	36.0 TWh

Germany Renewables (2015)

Total RES generation capacity	**105.0 GW**
Total VRES generation capacity	84.6 GW
Installed solar PV capacity	39.6 GW
Installed wind capacity	45.0 GW

Germany's electricity production mix (2014)



rmany has been a front runner in promoting RES development by introducing FIT’s with onsequent sky rocketing increase of the share of wind and solar PV up to the present % of total installed capacity.

e high RES growth has high associated costs. For example, in 2014 alone, 24 billion euros for FIT’s **ed-in-tariffs**) were passed on end consumers (with exemption of energy intensive industries) **ompanied by substantial investments in T&D systems**.

e reduction of FIT’s has caused a drastic reduction of new variable RES installations,especially solar (new capacity additions dropped from 7.6 GW in 2012 to 1.9 GW in
.4)

roduction of pilot auctions will substitute in future FIT’s (see Annex 1).

nventional power producers have been hit by the rise in the share of variable RES which has resulted drop in both wholesale prices and operating hours of their plants used for residual loads.

ur German TSO’s, which are also expected to manage the phase out of nuclear, are facing great allenges in transporting electricity from North to South and viceversa.

ere is a **clear need for market rules readjustments**.

rious technologies and management investments (storage, demand side management etc.) are der development.

the positive side, RES investments have created job opportunities and have contributed to uction of GHG emissions and fuel imports

INDIA

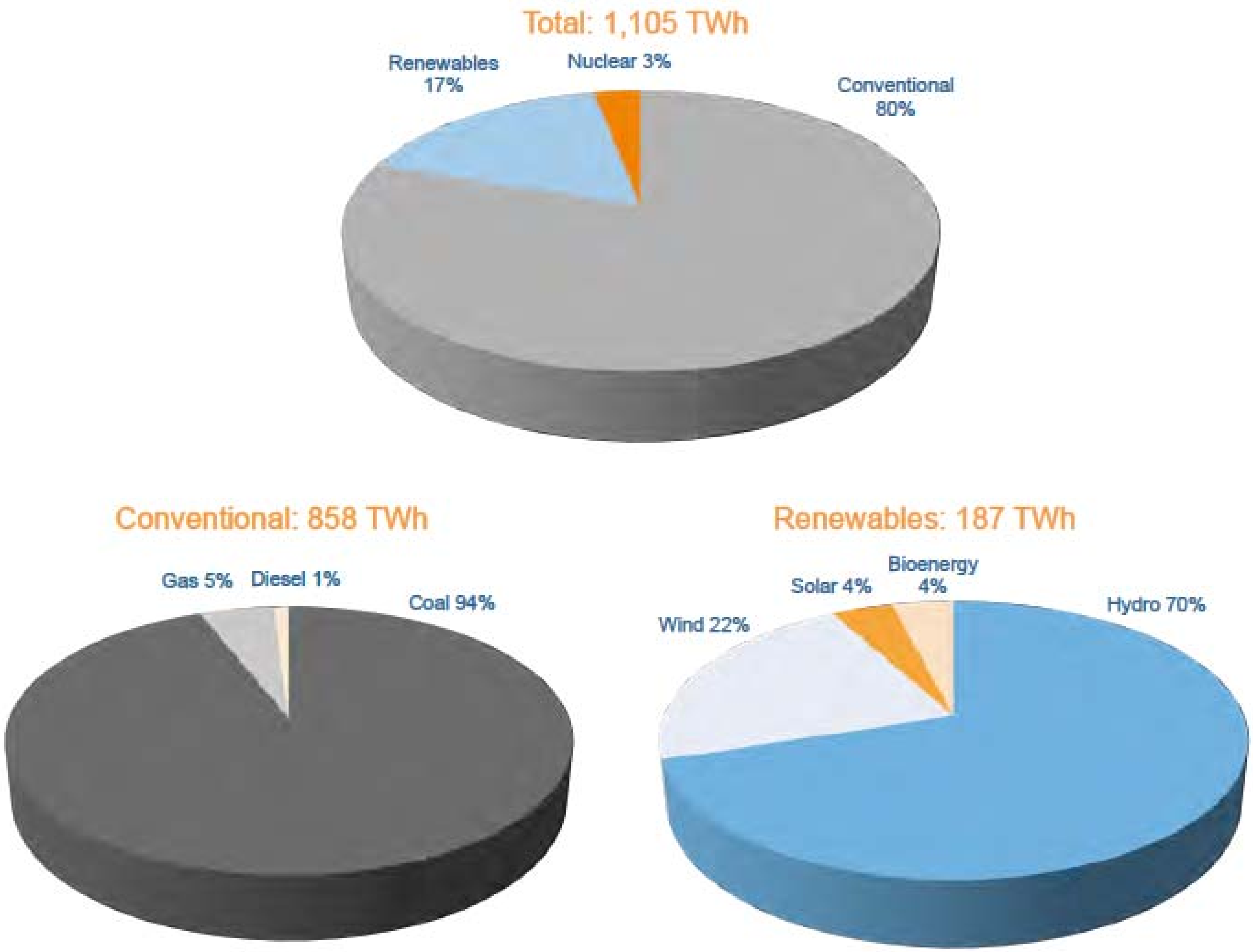
India's Power Generation – Basic Information (2014)

Total installed generation capacity	**271.7 GW**
Total RES generation capacity	77.0 GW
Total VRES generation capacity	27.2 GW
Peak load	148.2 GW
Electricity production	1,105.0 TWh

India Renewables (2015)

Total RES generation capacity	**114.2 GW**
Total VRES generation capacity	30.1 GW
Installed solar PV capacity	5.0 GW
Installed wind capacity	25.1 GW

India's electricity production mix (2014)



dia is positioned well for large-scale renewable energy development due to its **undant solar and wind resources which today account for approximately 3.5 % of tal electricity with installed wind capacity of 23.4 GW and solar PV of 3.7 GW.**

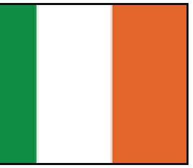
nd has benefitted from accelerated depreciation and generation based incentives.

lar PV enjoys direct capital subsidy; FITs are around USD100/MWh and the allocation solar **PV projects has been through auctions in the recent years**. Net metering has en introduced by many states.

veral measures, including **green corridors** are being taken to address technical allenges of increased variable RES with their intermittency.

ne 2022 targets envisage an installed capacity of 100 GW for PV and 60 GW for nd.

RELAND



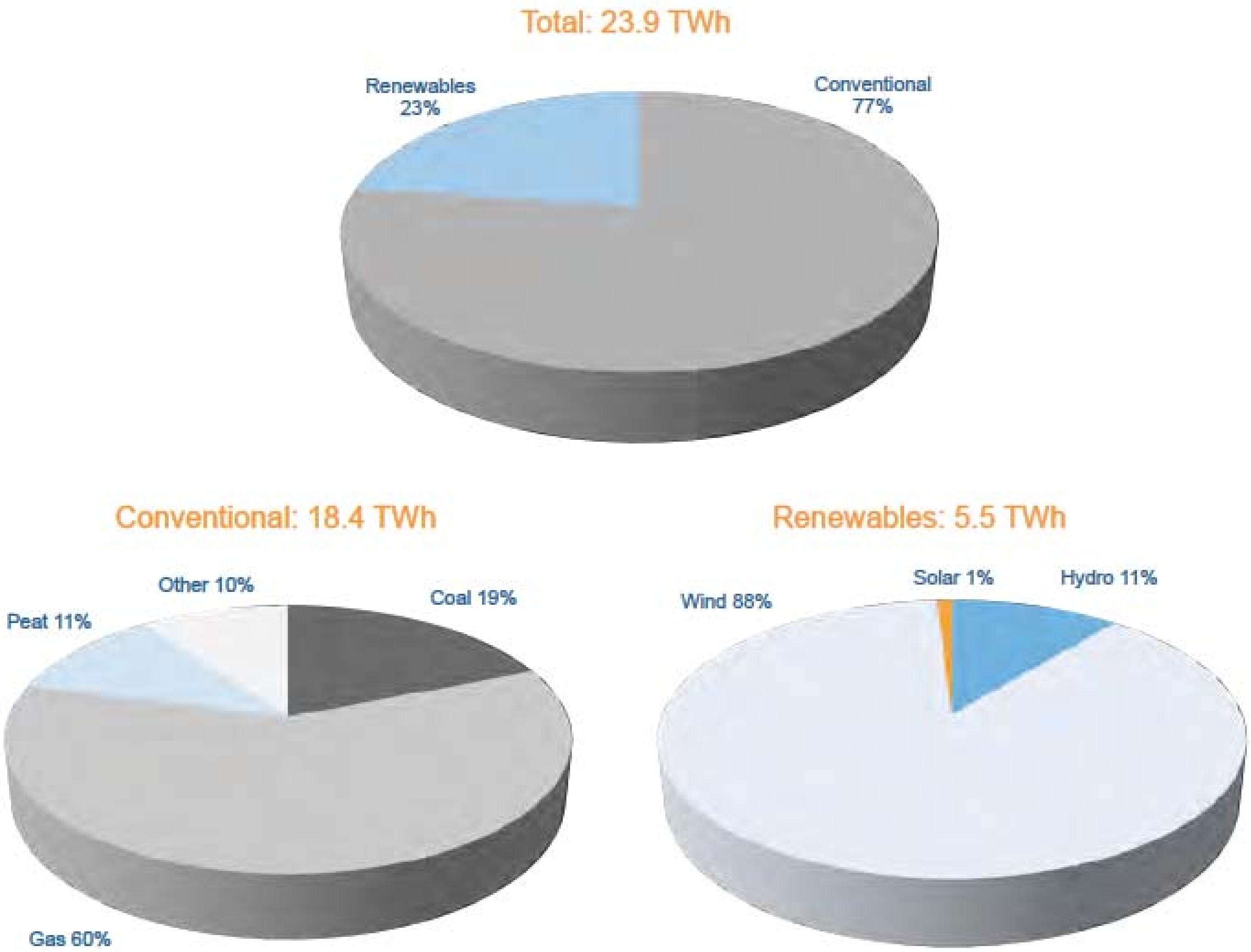
eland's Power Generation – Basic Information (2014)

otal installed generation capacity	**9.99 GW**
otal RES generation capacity	3.1 GW
otal VRES generation capacity	2.3 GW
eak load	6.3 GW
ectricity production (Gross)	23.9 TWh
ectricity export	1.8 TWh

eland Renewables (2015)

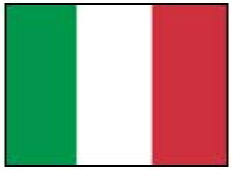
otal RES generation capacity	**3.1 GW**
otal VRES generation capacity	2.5 GW
stalled solar PV capacity	1.0 MW
stalled wind capacity	2.5 GW

Ireland’s electricity production mix (2014)



land has excellent renewable energy resources, which will be a critical and growing
mponent of Irish energy supply to 2020 and beyond.
digenous renewable energy already plays a vital role in domestic fuel mix. It also
reases sustainability through the use of clean power sources and enhances energy
curity by reducing Ireland's dependence on imported fuels.
nd and solar energy can yield additional opportunities for suppliers and consumers
ke.
der the 2009 Renewable Energy Directive, **Ireland is committed to produce at least
% of all energy consumed from renewable sources by 2020.** This will be met by 40%
m renewable electricity, 12% from renewable heat and 10% from the renewable
nsport sector.
e **target to have 40% of electricity consumed from renewable sources by 2020** is
e of the most demanding in the world.

ITALY



Italy's Power Generation – Basic Information (2014)

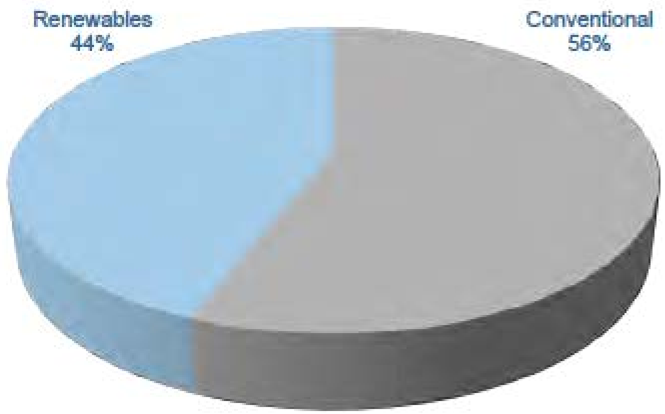
Total installed generation capacity	**125.0 GW**
Total RES generation capacity	53.9 GW
Total VRES generation capacity	27.5 GW
Peak load	54.0 GW
Minimum load	20.0 GW
Electricity production	268.0 TWh
Electricity import	40.0 GWh

Italy Renewables (2015)

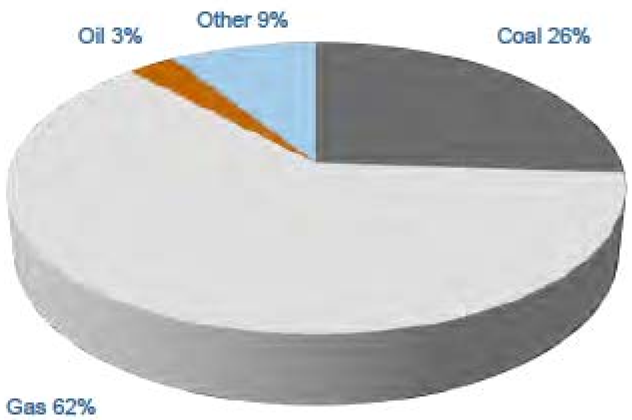
Total RES generation capacity	**54.8 GW**
Total VRES generation capacity	28.0 GW
Installed solar PV capacity	18.9 GW
Installed wind capacity	9.1 GW

Italy's electricity production mix (2014)

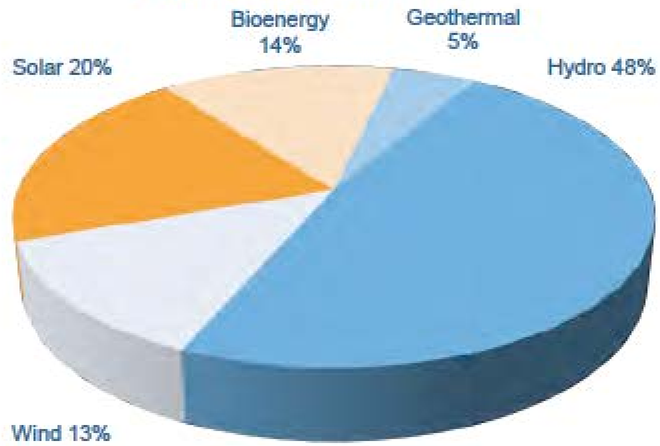
Total: 268 TWh



Conventional: 151 TWh



Renewables: 117 TWh



Italy's VRES production is high, 39 TWh (14.5% of the country's electricity generation)using 20 GW of PV and 9 GW of installed wind capacity.

The PV production has reached 8% of the total generation (world record).

Fast **development of RES** technologies has been **driven by a number of generous incentives** such as green ertificates and especially FIpremium tariffs.

The **incentives for PV were introduced in 2005 and amounted to 450€/MWh**; but now the price is based only n auctions for large plants and tax deductions for small installations.

For wind there are currently only a few auctions operating at reduced capacities.

-The sudden **decrease of incentives has resulted in a drastic collapse of annual additions to installed capacity** of V from 9 GW in 2011 to less than 1 GW in 2014 and for wind from 1.2 to 0.3 GW.

RES integration has had an impact on the power system and on the market behavior, **including drastic reduction f operating hours for the high efficiency combined cycle fleet.Another contributing factor was strong reduction f demand.**

Incentives for RES paid by consumers amount to around 13 billion Euros per year,while 6 billion € will be nvested into transmission improvements over the next 10 years.

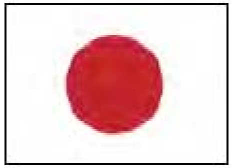
Ancillary services market costs are close to 2 billion €/year (doubled with RES ntroduction).

-**Pilot electrical storage systems both for TSO and DSO grids are already installed or under installation**.

-New market designs are being developed to provide further opportunities for RES investments which in any case ontributed to reduction of GHG emissions and import of primary energies, and also created job opportunities. ---

Annex 1 presents some details on recent costs for CAPEX and O&M of PV and Wind plants.-----

JAPAN



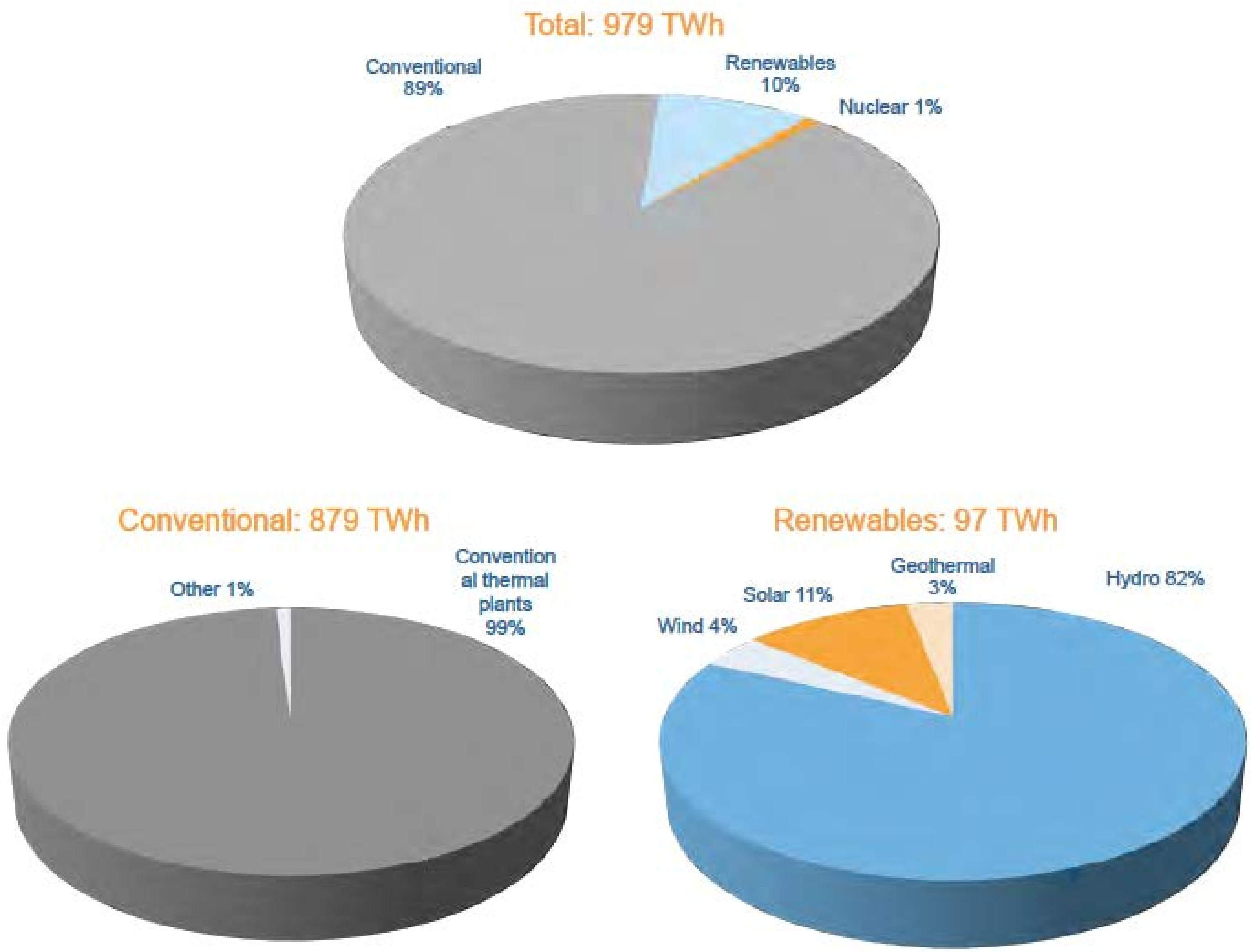
Japan's Power Generation – Basic Information (2013)

Total installed generation capacity	**252.5 GW**
Total RES generation capacity	69.7 GW
Total VRES generation capacity	15.1 GW
Peak load	159.1 GW
Electricity production	979.0 TWh

Japan Renewables (2015)

Total RES generation capacity	**90.1 GW**
Total VRES generation capacity	36.3 GW
Installed solar PV capacity	33.3 GW
Installed wind capacity	3.0 GW

Japan’s electricity production mix (2013)



2010, before Fukushima, 30% of Japan's electricity production was from nuclear plants ich are now shut down, anticipating new safety standards.

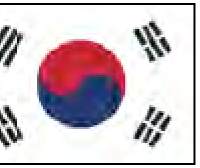
th **renewables contributing only 10% of the country's electricity production whereof 1% solar and % wind,** there is a pressing need to import considerably more fossil fuels and this places a large ancial burden on Japan's economy.

erefore, **the country is strongly promoting RES; and a FITpremium scheme was introduced in 2012.** **that had a tariff of 35 US cents/kWh in 2012 (now above 45**), **has got the highest increase of RES ich have a target capacity of 70 GW**.

is requires significant **investments in T&D systems and system balancing issues**.

e acceptable supply targets for utilities generating power from PV are by far lower than approved limits for other technologies, and METI has established a Working Group of ependent experts to a study of variable RES integration.

OREA (REP. OF)



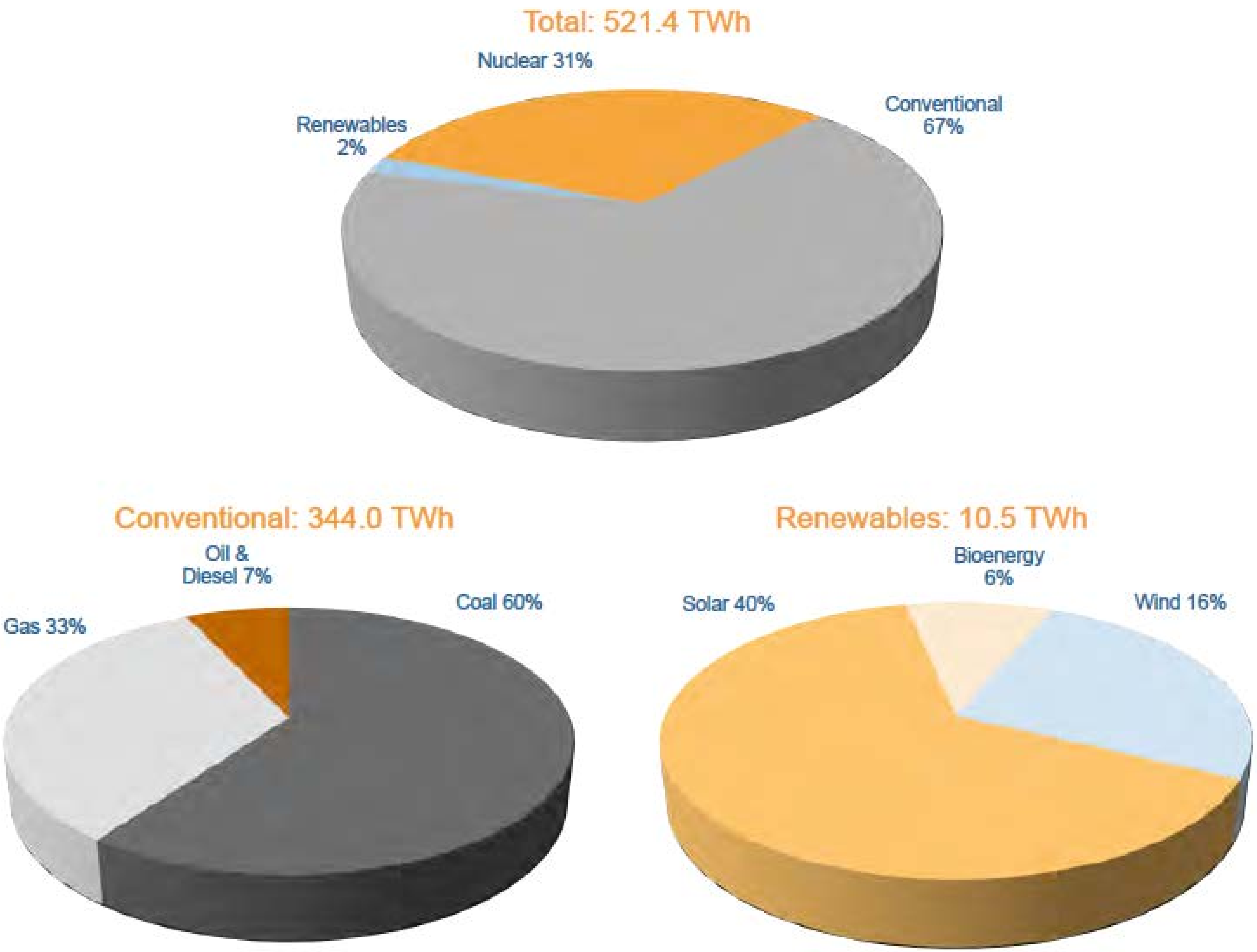
orea's Power Generation – Basic Information (2014)

otal installed generation capacity	**93.2 GW**
otal RES generation capacity	11.7 GW
otal VRES generation capacity	4.0 GW
lectricity production	521.4 TWh

orea Renewables (2015)

otal RES generation capacity	**12.7 GW**
otal VRES generation capacity	4.0 MW
stalled solar PV capacity	3.2 MW
stalled wind capacity	0.8 MW

Korea's electricity production mix (2014)



cording to the 4th national plan for development and supply of renewable energy in rea, **renewables will reach 13.4% of total installed power generation capacity by 2035 mpared to 3.7% in 2012.**

ar and wind are expected to increase from 0.5% in 2012 to7.5% in 2035.

h the public and private sectors, invest actively in research and development of “green” and smart hnologies such as Energy Storage System (ESS),smart and micro grids.

tain incentives have been introduced to support the private sector investment in a stable renewable ergy supply system.

r example, **additional Renewable Energy Certificate (REC) points will be added to the utilities who tall wind power plants combined with Energy Storage System (ESS).** These points can be sold in the C trading market, and this brings additional profits for renewable energy producers.

ean government adopted the Renewable Portfolio Standards (RPS) in 2012, making it **ndatory for power generators to produce each year 2% of their electricity from renewable energy rces. Utilities can run their own renewable energy power plants or the points of REC from other generators to meet their annual 2% quota.**

MEXICO

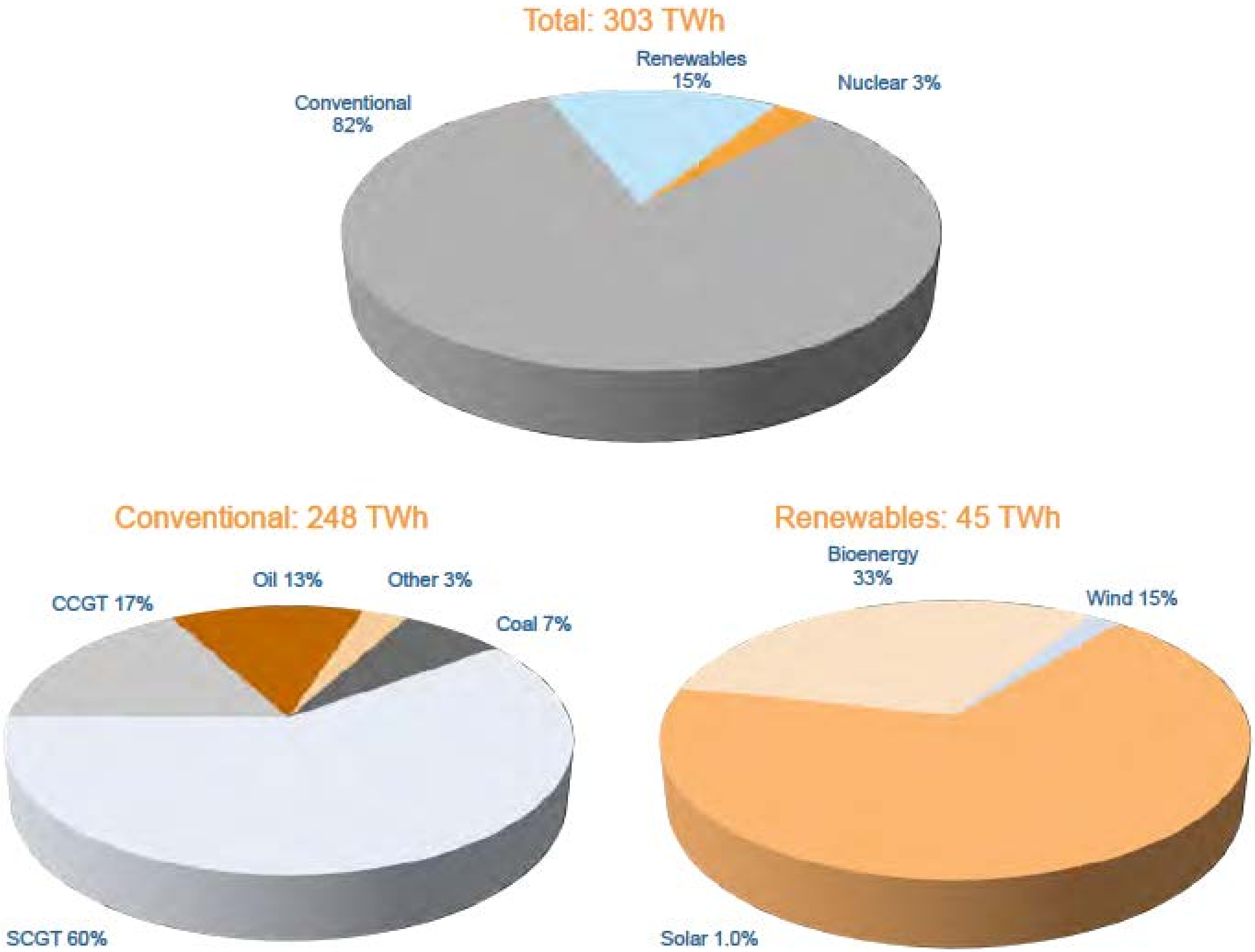
Mexico's Power Generation – Basic Information (2014)

Total installed generation capacity	**65.4 GW**
Total RES generation capacity	16.5 GW
Total VRES generation capacity	3.2 GW
Peak load	39.0 GW
Minimum load	17.1 GW
Electricity production	303 TWh

Mexico Renewables (2015)

Total RES generation capacity	**17.6 GW**
Total VRES generation capacity	3.3 GW
Installed solar PV capacity	0.2 GW
Installed wind capacity	3.1 GW

Mexico’s electricity production mix (2014)



S account for nearly 15% of electricity production in Mexico and wind is by far the most veloped VRES with a share of 2% of the country's production and of installed capacity.

nd resources are located mainly in the Southeast, while PV is in the Northern regions;however, both **far from important load centres and require development of transmission infrastructure.**

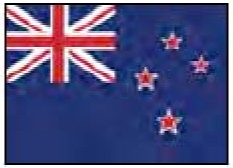
erage O&M costs are 9 USD/MWh for wind and 12 USD/MWh for PV.

xico is aiming to increase **its renewable electricity production to 25% by 2025 and to % by 2050.**

s planned **to achieve these targets with clean energy certificates ,accelerated depreciation, ferential wheeling charges, net metering and other solutions**.

rtain approaches that have been used **to foster RES integration are transmission reinforcement and re are plans for demand side management** through smart grids technologies.

NEW ZEALAND



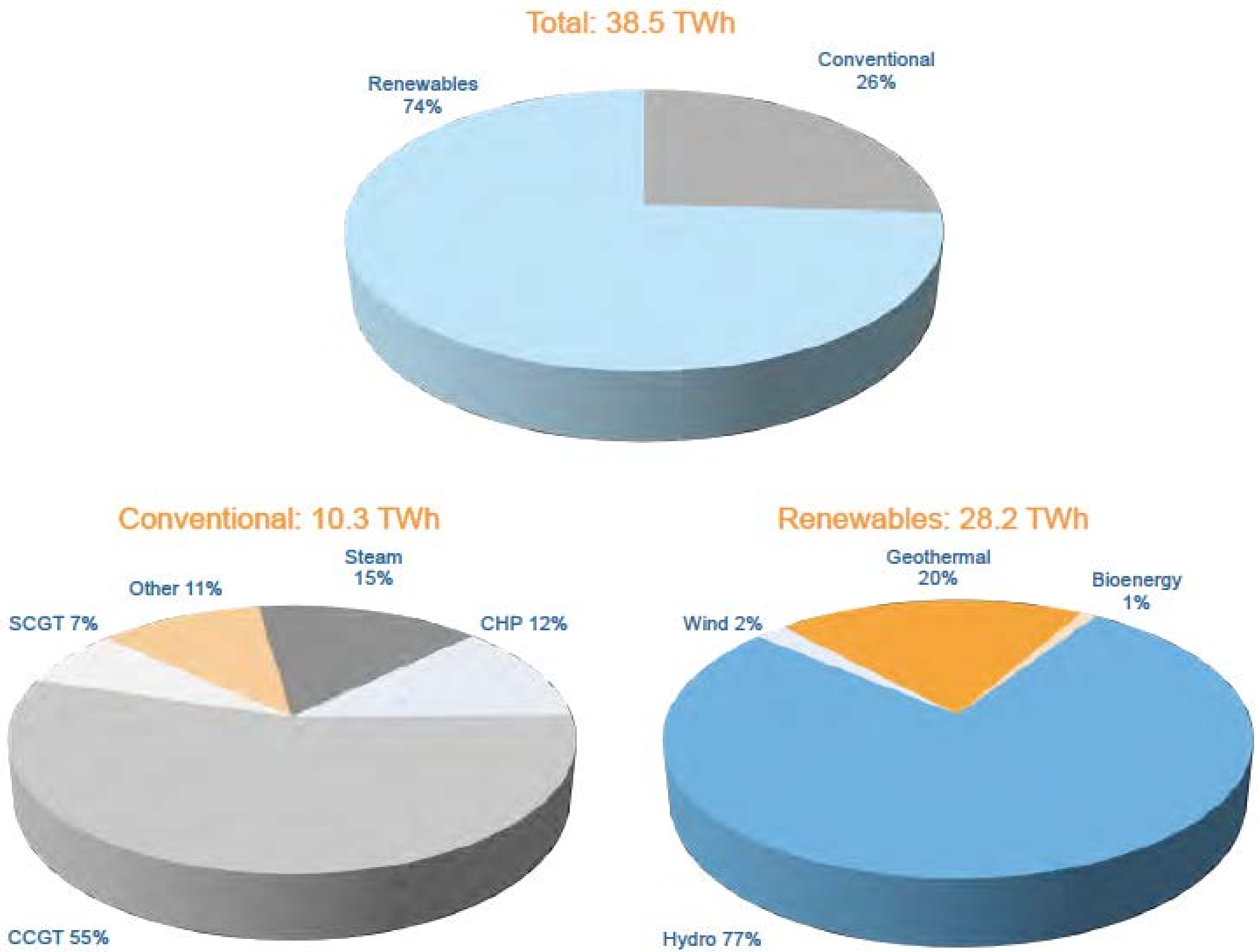
New Zealand's Power Generation – Basic Information (2014)

Total installed generation capacity	**11.06 GW**
Total RES generation capacity	7.0 GW
Total VRES generation capacity	0.64 GW
Peak load	6.41 GW
Minimum load	2.84 GW
Electricity production	38.5 TWh

New Zealand Renewables (2015)

Total RES generation capacity	**7.0 GW**
Total VRES generation capacity	0.65 GW
Installed solar PV capacity	0.03 GW
Installed wind capacity	0.62 GW

New Zealand's electricity production mix (2014)



th **large water and geothermal resources**, the majority of New Zealand electricity oduction is from renewable energy sources.

ind energy with a load factor 38–43%comprises 2% of these renewables energy d it will cover 40% of next foreseeable capacity additions.

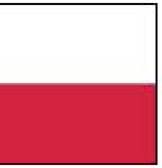
production is just at the beginning with maximum **expected** future installed pacity providing **2–3% of country energy**.

incentives to RES. New Zealandhas a unique market with a carbon price emission ding scheme combined with "location marginal pricing LMP" which includes offer-sed merit order dispatch and a nodal price which takes care of losses and ngestion.

nerators offer energy in real time avoiding balancing payments.

verters in new windfarms are used to provide voltage support even when there is wind and the turbines are not generating.

OLAND



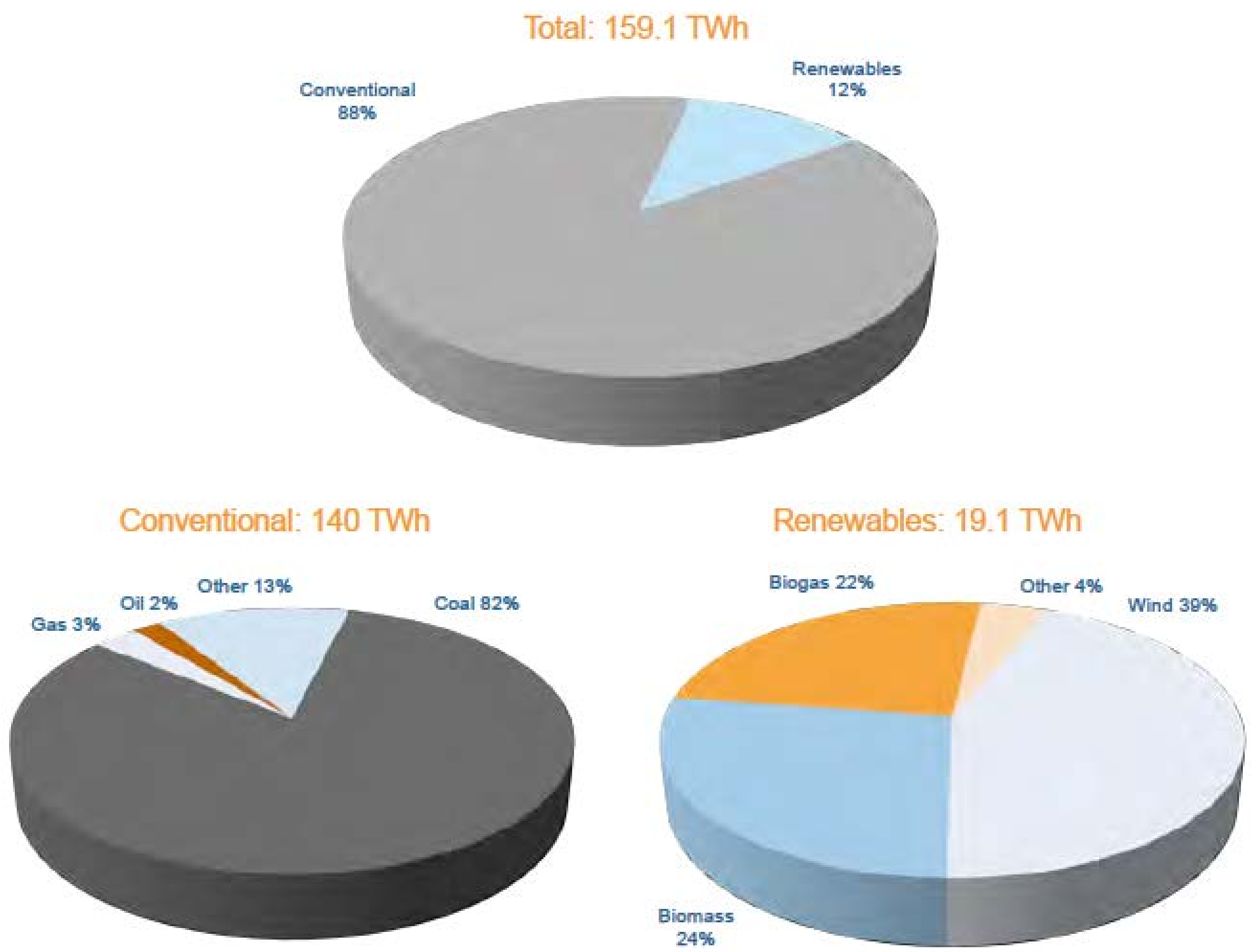
and's Power Generation – Basic Information (2014)

al installed generation capacity	**39.4 GW**
l RES generation capacity	7.0 GW
l VRES generation capacity	3.9 GW
k load	25.5 GW
mum load	20.5 GW
tricity production	159.1 TWh
tricity import	40.0 TWh
tricity export	0.0 TWh

and Renewables (2015)

al RES generation capacity	**8.4 GW**
l VRES generation capacity	5.1 GW
alled solar PV capacity	0.07 GW
alled wind capacity	5.17 GW

Poland’s electricity production mix (2014)



e **Polish energy sector is historically based on the domestic abundant hard coal and lignite,** which used to produce nearly **88% of Poland's electricity**

the **last five years rapid development of variable renewable energy**;(VRES) generation capacity reased **from 84 MW in 2005 to 3,863 MW in 2014 and 5,056MW in 2015**. **Electricity production from** se plants increased from **135.5 GWh in 2005 to7,683 GWh in 2014.**

e development **is driven by wind energy**. **At the end of June 2015,there were 981 wind power plants** Poland **with a total capacity of 4,117 MW** .Most wind farms are located in North-Western Poland and h potential wind onshore and offshore sites are located in the Baltic Sea region.

lish public policy ensured the achievement of the 20/20/20 objective under the EU climate and the rd energy package through **generous incentives for VRES**. According to the Energy Law Act,connecting the grid VRES plants with an installed capacity up to 5 MW requires only 50% of the fee, calculated on basis of actual costs of establishing the connection.

ORTUGAL

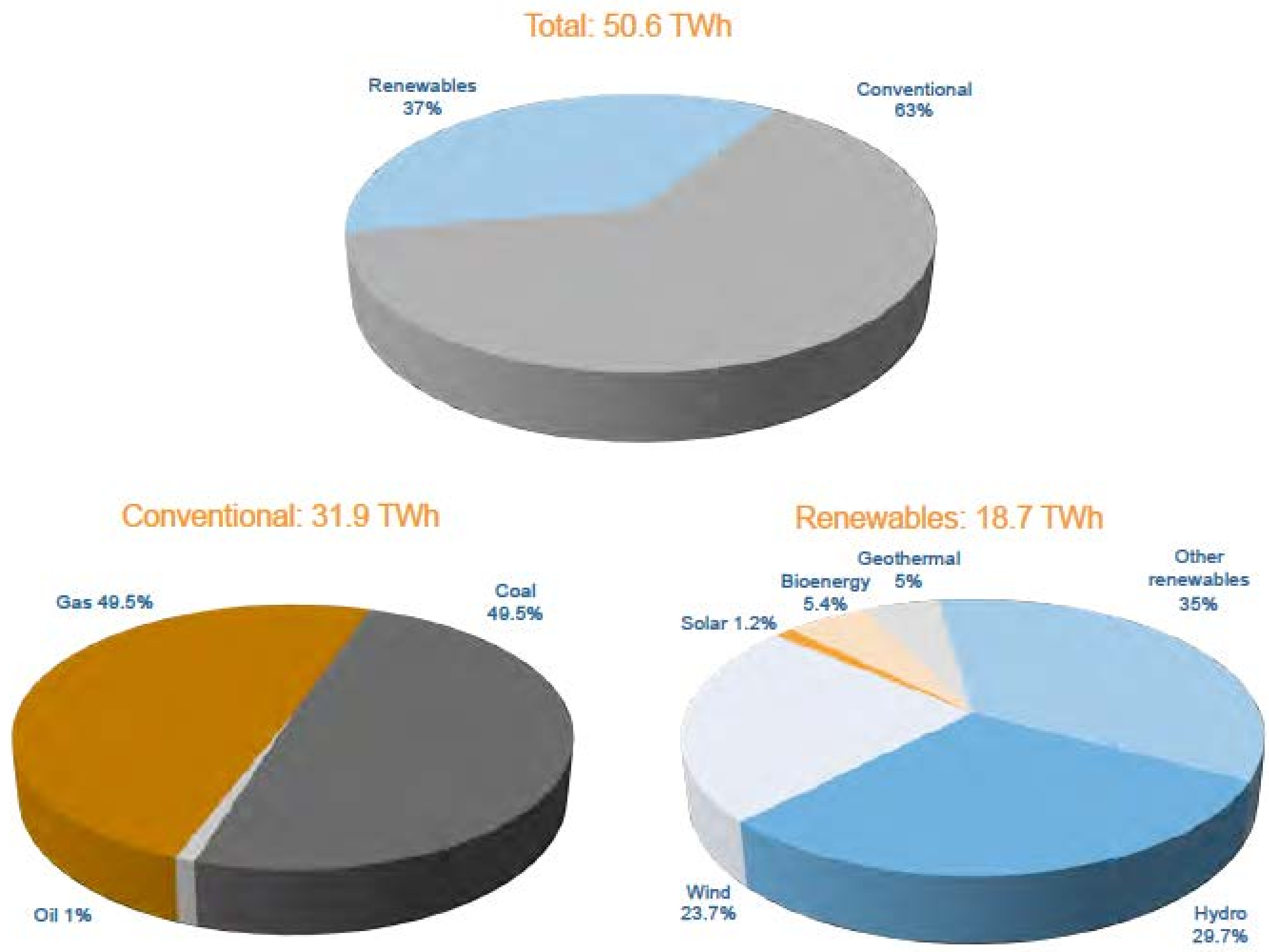
rtugal's Power Generation – Basic Information (2014)

tal installed generation capacity	**19.7 GW**
al RES generation capacity	11.6 GW
al VRES generation capacity	5.0 GW
ak load	10.3 GW
nimum load	4.7 GW
ctricity production	50.6 TWh
ctricity import	3.1 TWh
ctricity export	4.0 TWh

rtugal Renewables (2015)

tal RES generation capacity	**11.9 GW**
al VRES generation capacity	5.53 GW
talled solar PV capacity	0.45 GW
talled wind capacity	5.08 GW

Portugal's electricity production mix (2014)



the end of **2014, RES represented 37% of electricity consumption in Portugal mainland**,a value above rage mainly due to the high precipitation levels along the year.

e sector has an **important impact on jobs creation** and in the Portuguese GDP. Referring to 2014 the tor employed around **43 478 individuals** (indirect and direct jobs) and **contributed with 2 902 M€ for GDP.**

e RES directive 2001/77/CE, implemented through the national decree-law n. º 339-C/2001, cember 29th, was the main precursor of RES in Portugal.

2013, the Portuguese National Renewable Energy Action Plan (Plano Nacional de Ação a as Energias Renováveis) in accordance with Directive 2009/28/EC on the promotion the use of energy from renewable sources, was published. This NREP was prepared in ordance with the template published by the Commission, and provide detailed dmaps of how each Member State expects to reach its legally binding 2020 target for share of renewable energy in their final energy consumption.

RUSSIAN FEDERATION

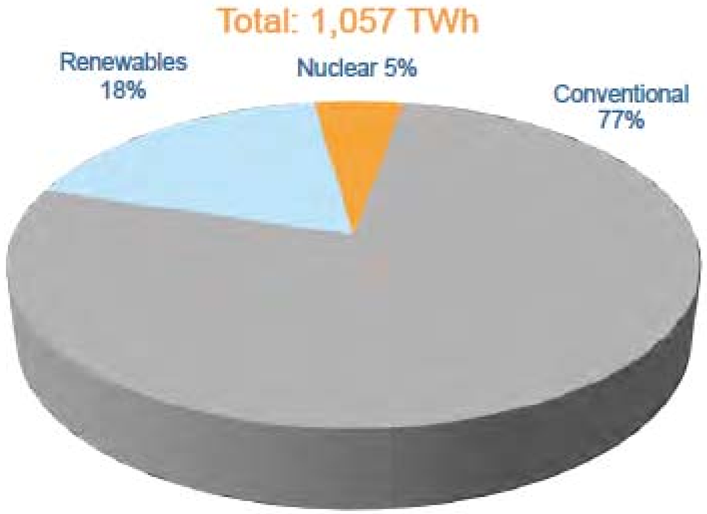
Russia's Power Generation – Basic Information (2014)

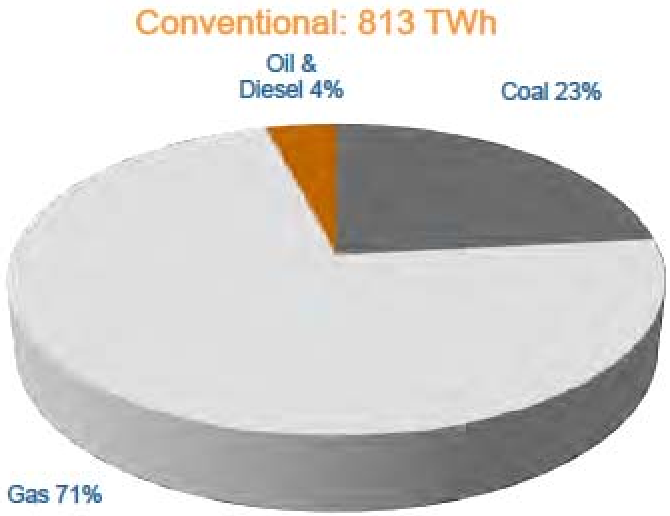
Total installed generation capacity	**240.0 GW**
Total RES generation capacity	51.7 GW
Total VRES generation capacity	0.42 GW
Electricity production	1,057 TWh
Electricity import	4.5 TWh
Electricity export	17.5 TWh

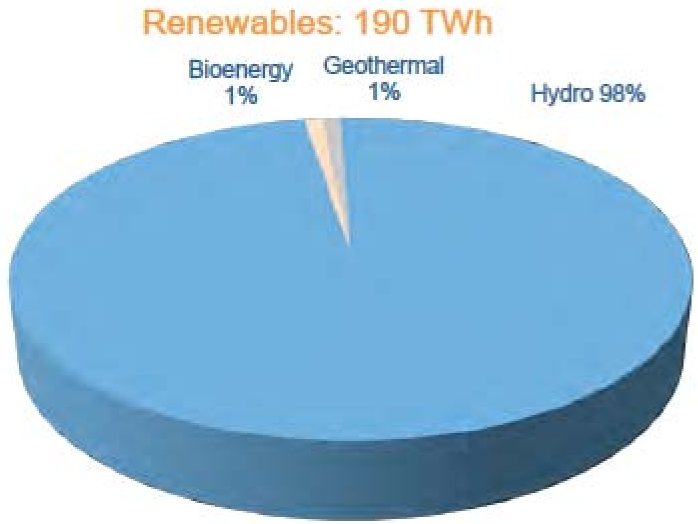
Russia Renewables (2015)

Total RES generation capacity	**52.0 GW**
Total VRES generation capacity	0.50 GW
Installed solar PV capacity	0.40 GW
Installed wind capacity	0.10 GW

Russia's electricity production mix (2014)







Given its huge and diverse energy resource base **there is little interest in developing renewable ene sources in Russia.**

In terms of environment, **the energy industry has different serious issues with the aging conventio and nuclear plants.**

The previous administration, with its active promotion of new technologies, was the first in modern Russia's history to **set a non-binding renewable energy target of 4.5% of electricity production by 2020**.The **provisional target of 2.5% by 2010 was however missed** and there had **been no institutio developments in support of renewables**, apart from the Ministry of Energy **six-year plan, which includes commissioning of 5.87GW of renewable energy capacity by 2020;the plan stipulates that energy should become the leading technology for new projects.**

-**Of the 3.6GW wind capacity planned to be installed by 2020, only 190 MW been completed by 2016**.

Implementation of **several renewable energy projects initiated in 2013-2014 has been postpo** as the devaluation of the Russian ruble against hard currency made **the projects too expensive**.

SOUTH AFRICA

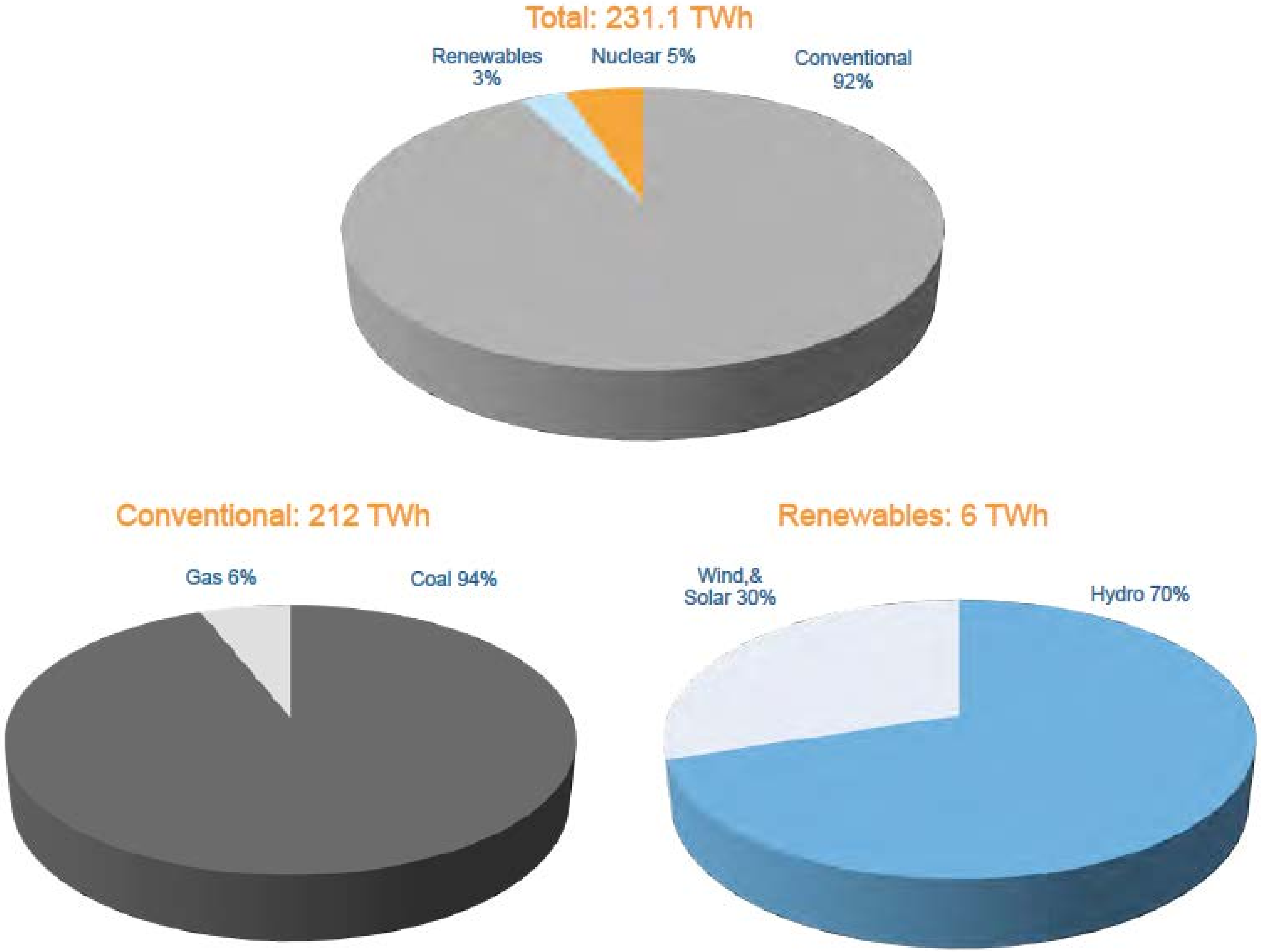
outh Africa's Power Generation – Basic Information (2014)

otal installed generation capacity	**44.2 GW**
otal RES generation capacity	4.0 GW
otal VRES generation capacity	1.5 GW
eak load	35.5 GW
lectricity production	231.1 TWh
lectricity import	12.7 TWh

outh Africa Renewables (2015)

otal RES generation capacity	**5.12 GW**
otal VRES generation capacity	2.41 GW
nstalled solar PV capacity	1.36 GW
nstalled wind capacity	1.05 GW

South Africa's electricity production mix (2014)



available supply of low cost coal, **South Africa's energy is predominantly coal-based powering a bon intensive economy**. As at 31 March 2014.

estment in renewable energy has rapidly accelerated as a result of a massive, **utility le,Renewable Energy Independent Power Producer Programme (REIPPPP) started in 2011-**

e **REIPPPP** has enabled rapid development of energy capacity and investment by the vate sector, **growing South Africa's share of installed RE generation capacity from gligible in 2010 (0%, IRP 2010) to 2.43% in 2014**.

March 2014, 21 Renewable Energy-Independent Power Producer (RE-IPP) projects had been cessfully connected to the national power grid, contributing 1076 MW of installed capacity.

the end of 2014,three new RE bid rounds were in various stages of completion.

a result of the REIPPPP, major shifts have been achieved in the energy industry in an eptionally short space of time, **demonstrating the country's commitment to re-orientate economy towards a sustainable, low-carbon growth trajectory** while securing an usive and equitable society. Annex 1 presents results of the recent auctions.

PAIN

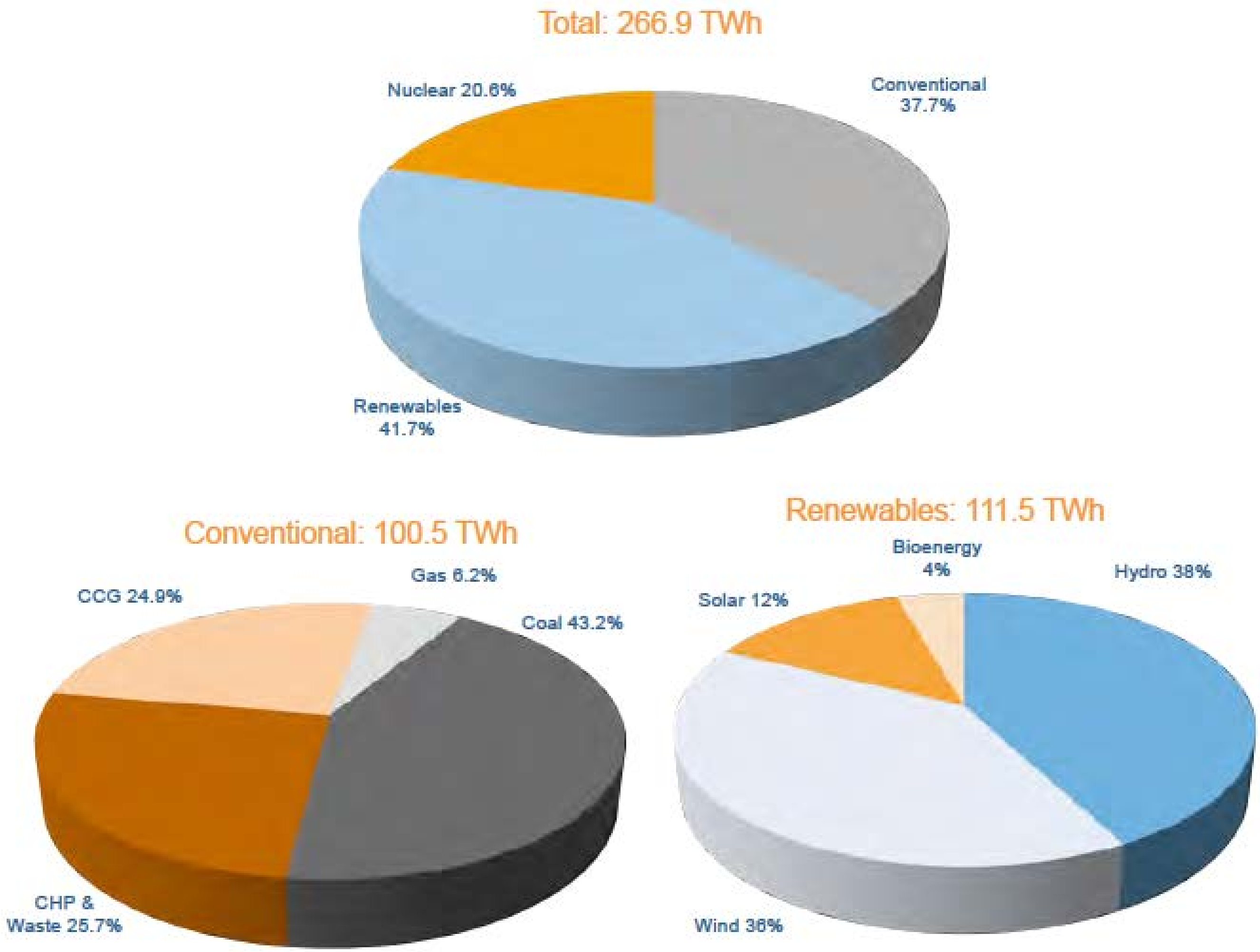
ain's Power Generation – Basic Information (2014)

al installed generation capacity	**105.8 GW**
al RES generation capacity	50.4 GW
al VRES generation capacity	27.7 GW
ak load	38.7 GW
imum load	18.1 GW
ctricity production (Gross)	266.9 TWh
ctricity production (Net)	258.1 TWh
ctricity export (Net)	3.4 TWh

ain Renewables (2015)

al RES generation capacity	**51.5 GW**
al VRES generation capacity	27.8 GW
alled solar PV capacity	4.8 GW
alled wind capacity	23.0 GW

Spain's electricity production mix (2014)



implementation of a **FIT's scheme and the development of the power grid have contributed to a significant increasing of renewable electricity eration, reaching 41.7% of total electricity demand in 2014**. As a matter of fact, by the end of that year **both solar and wind technologies ounted for 28.% of the overall installed electric power**

intense growth entailed a significant extra cost associated with the incentives involving these technologies contributing meaningfully to erate a high tariff deficit on Spain's electrical power grid, which threatened its sustainable development. Until 2013, this cost reached an umulated value of € 43,726 million. **Since mid-2013, a comprehensive reform of all regulated activities in the electricity system has been carried** with the aim of correcting this imbalance. In particular, for renewable energies, **a new remuneration system has been introduced** that guarantees easonable return" on investments for efficient and well-managed companies.

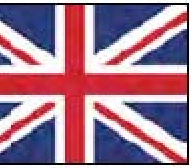
newable electricity is granted priority dispatch in the electricity markets by Law under equal economic conditions ,as well as priority to grid's ess and connection

rthermore, in order to implement new plants within the electric system at the lowest possible cost, **a competitive auction system has been nched too.** The reform has allowed eliminating the tariff deficit along with a progressive reduction of consumer prices. Since 2014 the electrical tem is already in surplus (+550.3 million € in 2014).

growth of renewable energies generation contributes to improving self-supply, with the consequent decrease of fossil products orts, and the reduction of greenhouse gas emissions. Likewise, based on lower generation variable costs compared to plants based on ventional technologies, , **it enables a reduction in the price within electricity production market.**

on the other hand it's **essential to increase the level of interconnection with the rest of Europe in order to integrateSpain's renewables output well as to guarantee security of supply and maintain the proper functioning of the system.**

NITED KINGDOM



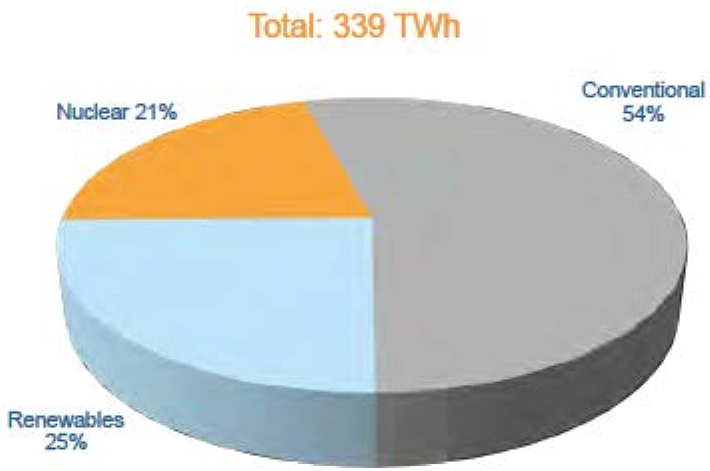
K's Power Generation – Basic Information (2014)

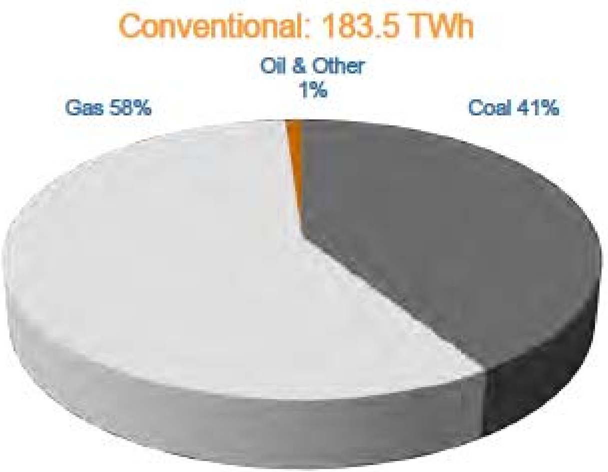
otal installed generation capacity	**94.0 GW**
otal RES generation capacity	27.7 GW
otal VRES generation capacity	18.3 GW
eak load	53.8 GW
ectricity production	339.0 TWh
ectricity import	23.0 TWh
ectricity export	2.4 TWh

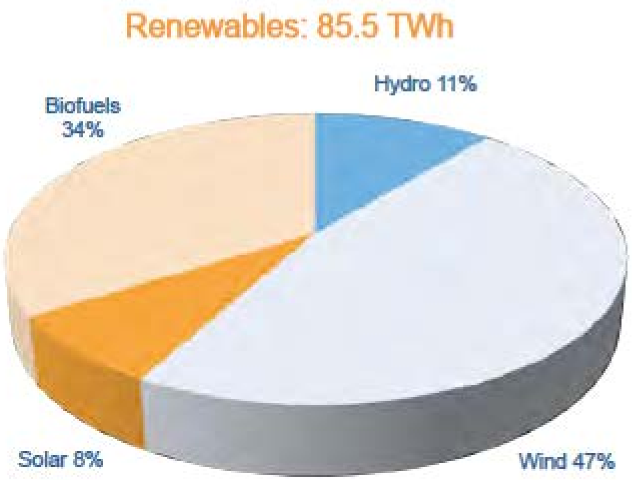
K Renewables (2015)

otal RES generation capacity	**33.1 GW**
otal VRES generation capacity	23.0 GW
stalled solar PV capacity	9.1 GW
stalled wind capacity	13.9 GW

UK's electricity production mix (2014)







s among front runners in the developed energy markets moving towards a low carbon omy. The electricity sector is undergoing rapid transition across the entire value chain.Coal fired generation is decreasing, gas umption increasing, renewable production grows, with variable renewable technologies leading the growth.

development is drivenby the 5th Carbon Budget targets which are legally binding for the UK following from **The Climate nge Act announced in December 2015. This binds the UK to a target of 80% reduction from 1990 levels by 2032**. UK is on its to meet the target of 15% renewable generation by 2020, with 7% of its final energy consumption being achieved by electricity or alone.

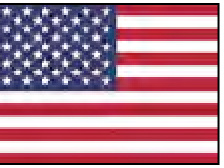
UK **Transmission system and the regional electricity distribution systems** which have gone through a long period of incentive d regulatory comparative competition on the RPI-X formula has **now been adapted to meet the new emerging requirements anaging for energy efficiency, low carbon distributed generation and low carbon foot print. This new mechanism, called the Model incentivizes network operator Revenues based on performance Incentives+Innovation and Output.**

enues = Incentives + Innovation + Output is the new RIIO framework.

hanisms to connect distributed renewable generation at low voltage levels are being introduced to be able to provide security pply, optimal grid stabilization and greater efficiencies. At the consumer end, **energy efficiencies are evident but peak and down from 60.11 GW in 2002 to 53.8 in 2014, mainly attributable to the overall slowdown in the economy in recent s**

mmary, the UK is in a state of very rapid transition and issues relating to the management of variable renewable energy in er generation are the centre stage. The biggest challenges for UK: to optimize its supply security, deliver lowenergy costs to the umer and ensure decarbonisation are going to be implemented through appropriate management and integration of wables into the changing energy mix.

UNITED STATES OF AMERICA - USA



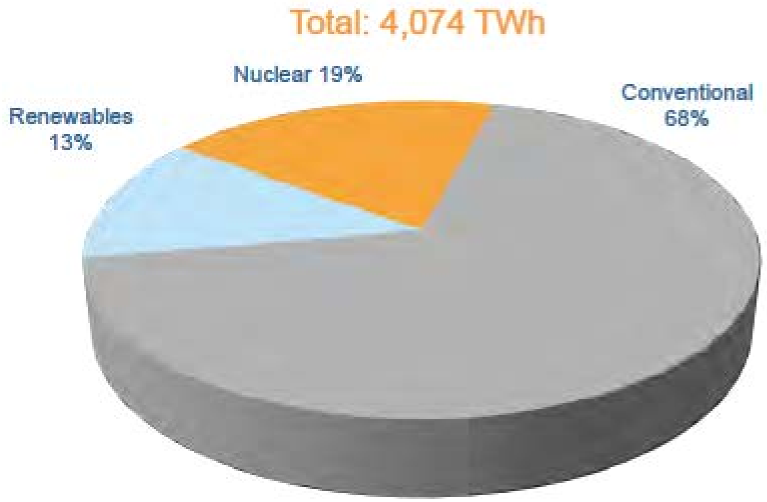
US's Power Generation – Basic Information (2014)

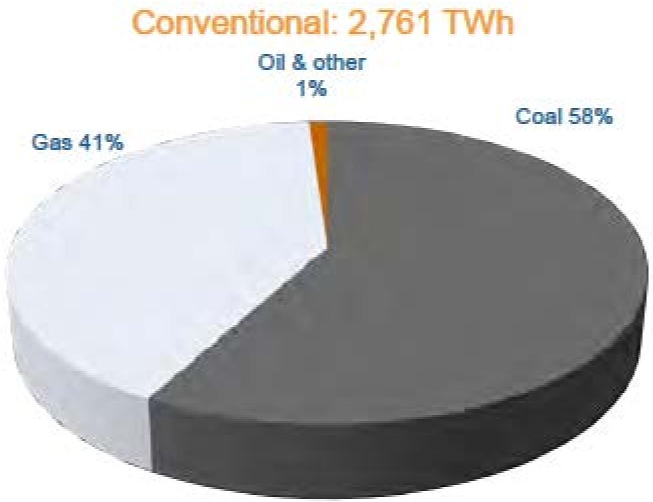
Total installed generation capacity	**1,155 GW**
Total RES generation capacity	203.5 GW
Total VRES generation capacity	84.0 GW
Net Electricity production	4,074.0 TWh
Electricity production (renewables)	534.0 TWh
Electricity import	15.5 TWh

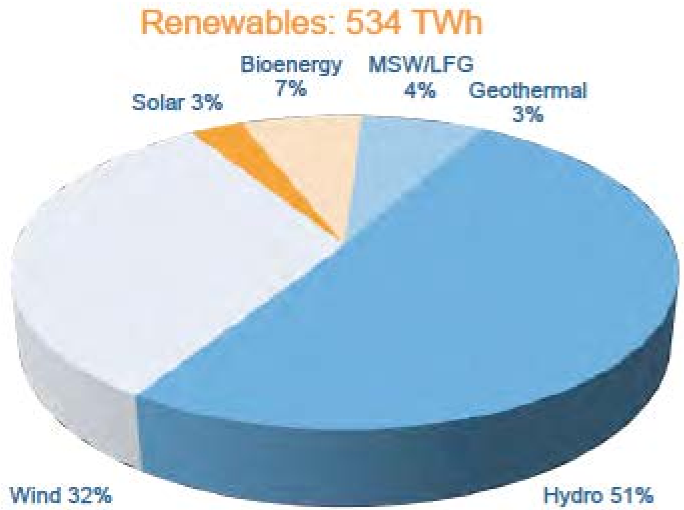
US Renewables (2015)

Total RES generation capacity	**219.3 GW**
Total VRES generation capacity	98.1 GW
Installed solar PV capacity	25.5 GW
Installed wind capacity	72.6 GW

US's electricity production mix (2014)







he last few years, **renewable energy capacity in the United States power system has increased by % from 2008, resulting in 13% of electricity production coming from renewable energy sources.**

riable RES accounted for the largest increase and their **share in the production of electricity is rently at 4% and 0.4% for wind and solar,**respectively. Installed wind capacity was 66 GW in 2014 and ar 18 GW.

E goal for wind is to reach 20% of country production by 2030. States with most wind capacity are as, California and Iowa while most solar capacity is concentrated in California, Arizona d New Jersey.

S penetration requires significant investments in T&D systems and costs are different for different ities and regions.

icies for development of RES are Federal (Tax Credit and Production Tax Credit), State (Net tering) and Local (rebates and financing options, green power rates).

tigation measures under implementation or emerging are: improved forecasting, faster eduling, reserve optimization, greater flexibility from generation, larger balancing areas, nsmission expansion, demand response, and energy storage solutions. Annex 1 sents recent data from auctions.

RUGUAY

uguay's Power Generation – Basic Information (2014)

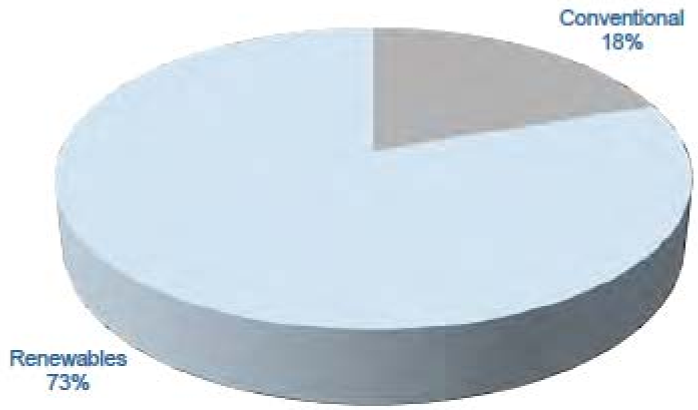
otal installed generation capacity	**3.7 GW**
otal RES generation capacity	2.3 GW
otal VRES generation capacity	0.57 GW
eak load	1.92 GW
nimum load	0.66 GW
ectricity production	12.9 TWh
ectricity import	0.0 TWh
ectricity export	1.27 TWh

uguay Renewables (2015)

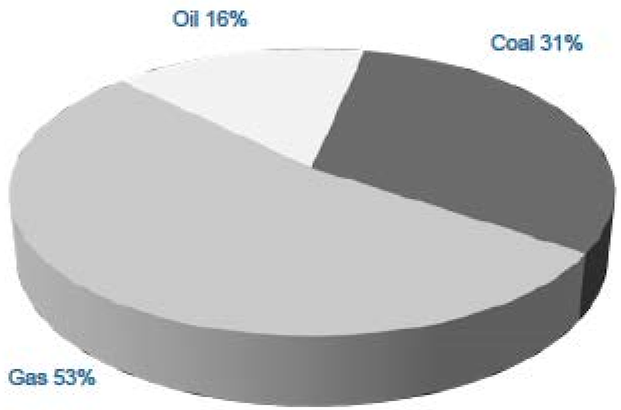
otal RES generation capacity	**2.7 GW**
otal VRES generation capacity	913 MW
stalled solar PV capacity	68 MW
stalled wind capacity	845 MW

Uruguay's electricity production mix (2014)

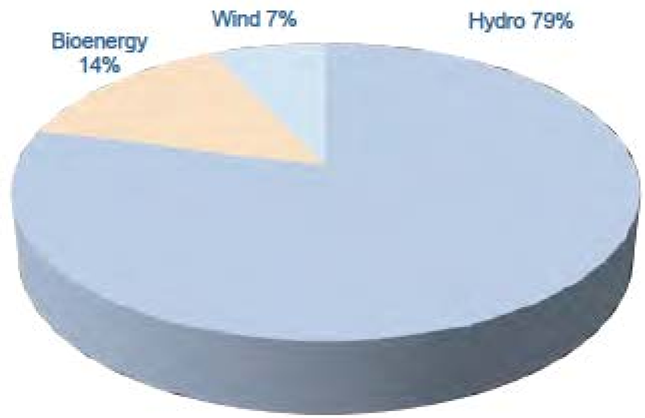
Total: 13 TWh



Conventional: 2.3 TWh



Renewables: 11.7 TWh



uguay has a large share of production from renewable energy sources: 82% of total electricity oduction in the country **comes from RES, mainly from hydro**.

e majority of Uruguay's **hydropower has however no storage capacity** and production is variable pendent on the yearly and seasonal rainfall.

e **most important new VARIABLE RES** in the country is wind with presently installed capacity of **485 V(13% of total installed generating capacity) and a planned expansion in 2016 to 1,470 MW** % of total expected installed capacity) **and to 2,300 MW in 2030.**
nd power is through auctions and at the 2011, the auction price was around 63
D/MWh. Auctions for PV have
e **development of** shown values of 90 USD/MWh.

ther 200 MW of plant capacity are expected to come online in 2016. **Main objectives for the velopment and integration of wind in electricity systems are to provide flexibility to the existing et, expansion of transmission systems and demand side management even if currently Uruguay erate interconnections with Brazil and Argentina.**