Dealing with the rise of Renewables

Investing in smart renewables





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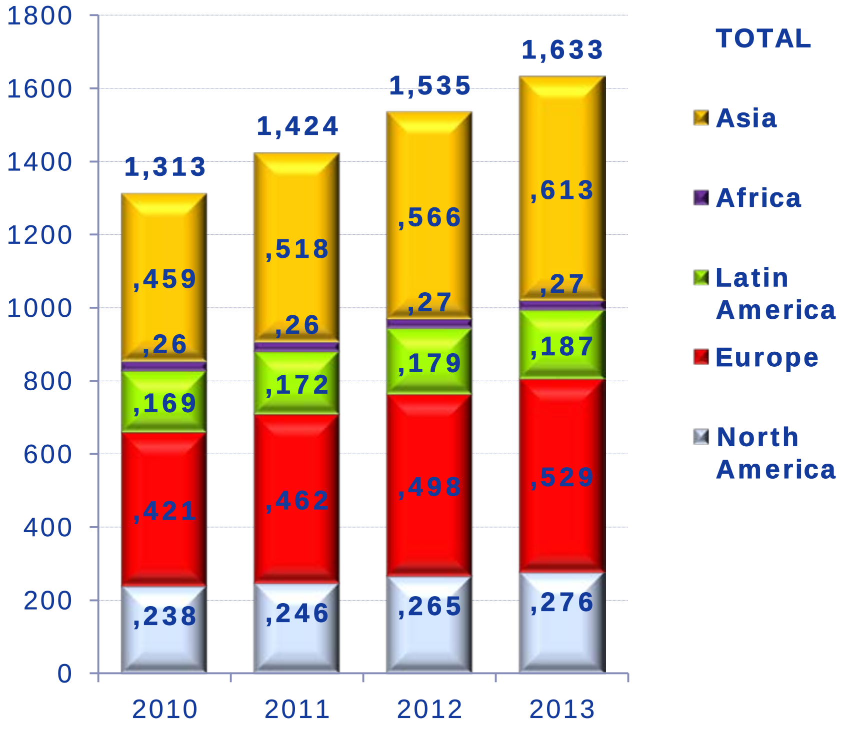
Summary

- RES worldwide
  - Global Investments ($bln)
  - Global Installed Capacity (GW)
  - Expected growth (GW)
- New challenges for the Utility sector
- Technical Variation in Italy
- Demand and Market Price
- EU RES Policy
- Renewable Peculiarities
  - System flexibility
  - Market Model
  - Back up capacity
- EU Balancing Markets & RES participation
- Renewable Forecast example
- Closing Remarks

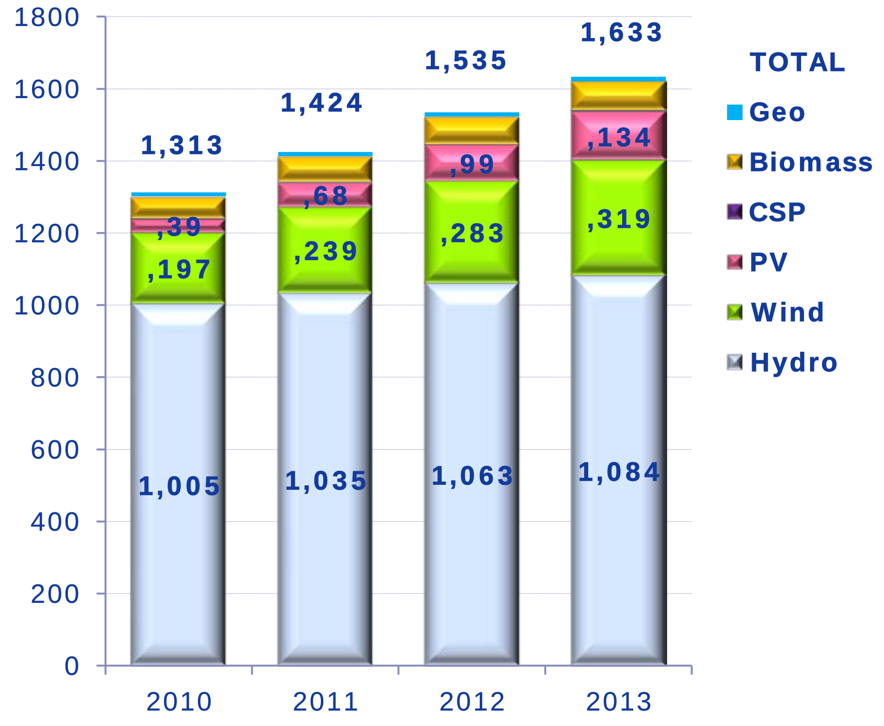
RES worldwide

Global Installed Capacity (GW) 1/3

Breakdown by area



Breakdown by technology

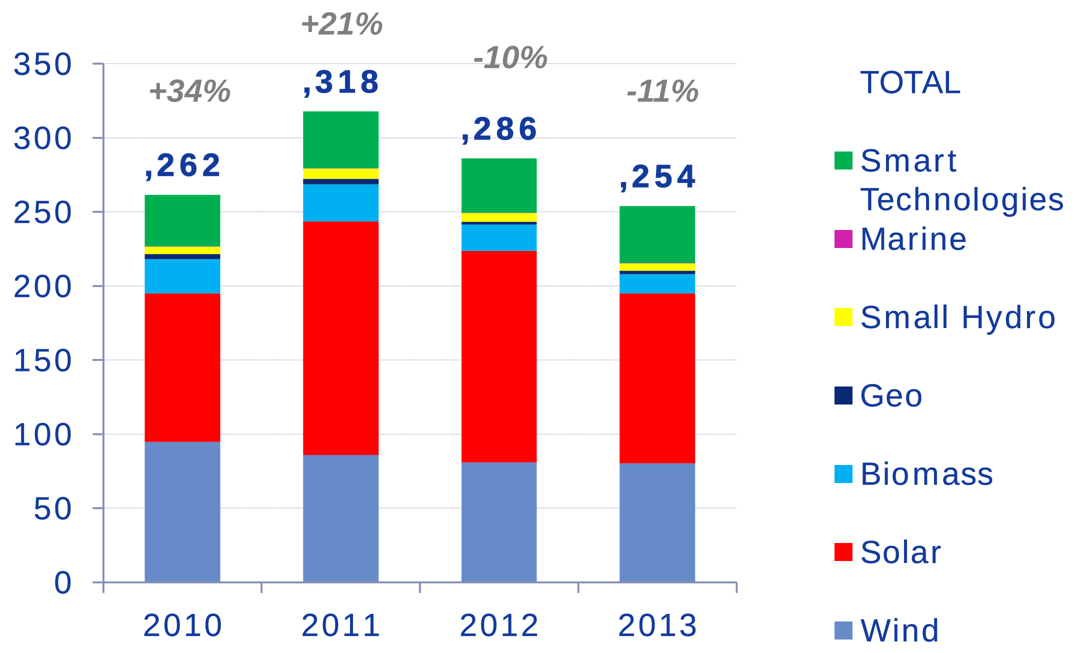


Source: Enerdata, WEO 2013, EER, GWEC, EWEA, EPIA, NREAP, REN 21, BNEF, EGP estimate
Note: 2013 preliminary figures

RES worldwide

Global Investments ($bln) 2/3

Breakdown by technology



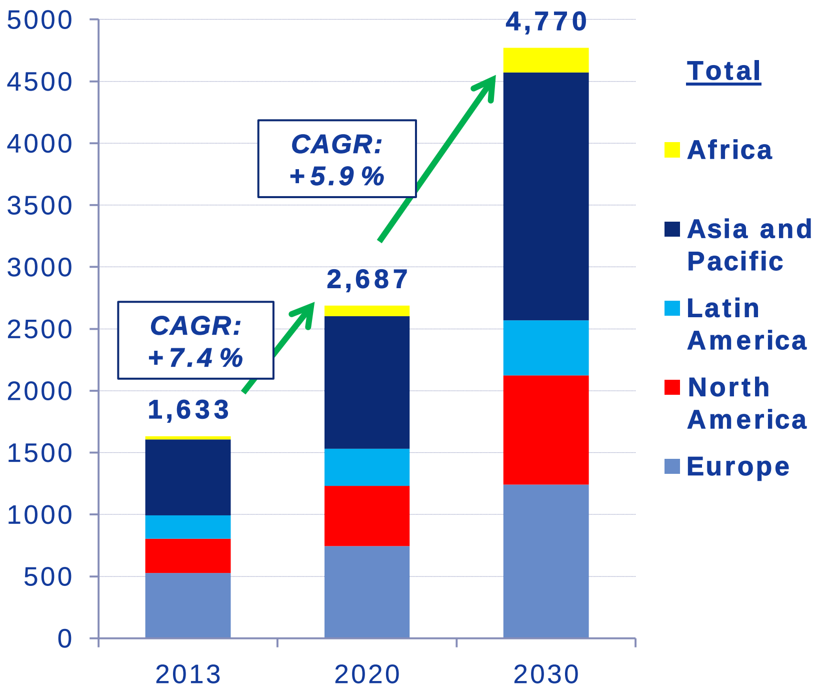
- ✓ **2012 investment in clean energy are estimated to be around 286 bn$, -11% vs. 2011, but it was the second highest ever (above 2010)**
- ✓ **Decline was mainly due to uncertainties and regulatory changes as well as CAPEX decrease, in particular for Wind and PV**

Note: Clean Energy investments includes corporate and government R&D, investment in Smart Technologies (i.e. smart grid, storage, electric vehicles, efficiency and digital energy projects) and investment in all renewable technologies
Source: Bloomberg New Energy Finance, "Global Trends in Clean Energy Investment", Jan 2014

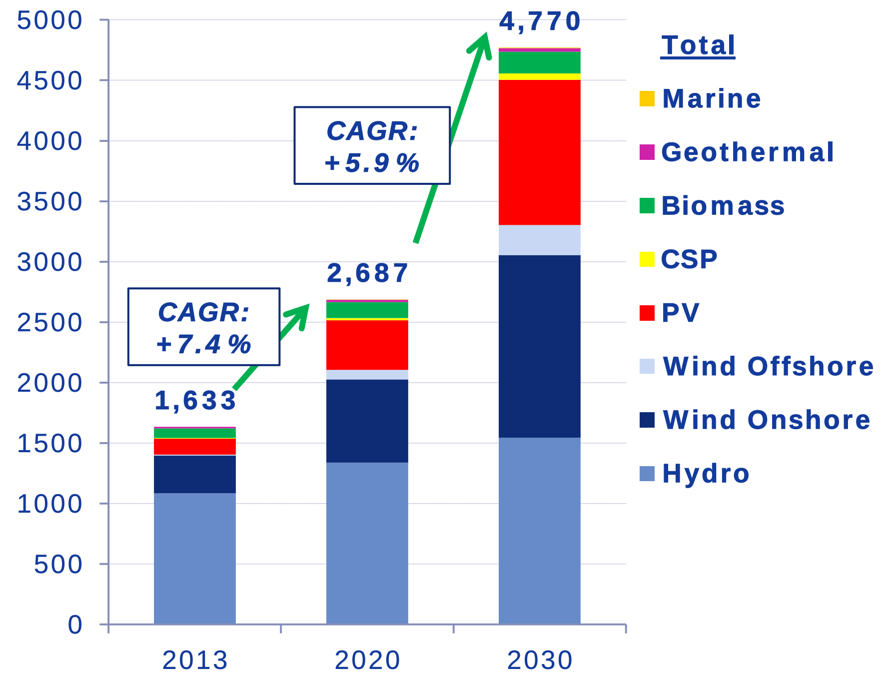
RES worldwide

Expected growth (GW) 3/3

Breakdown by area



Breakdown by technology



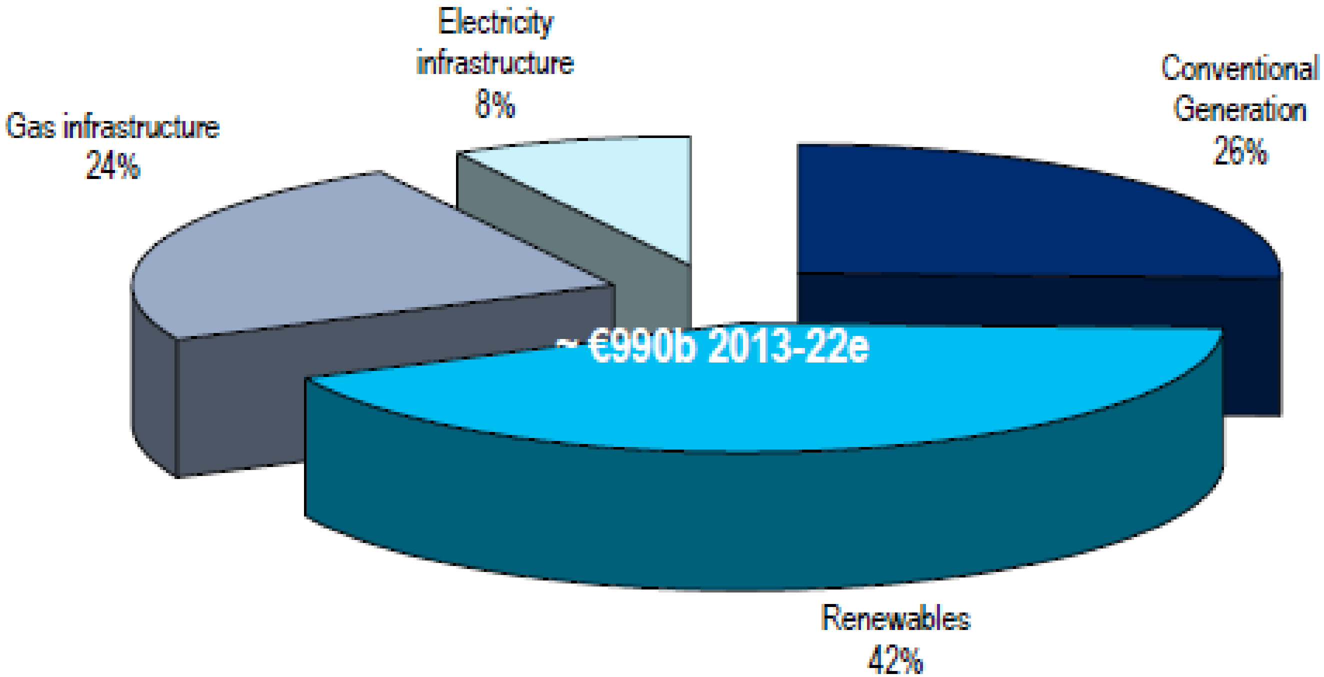
✓ **Massive RES growth expected worldwide**

✓ **RES show intact growth corridor with CAGR between 5 and 8%**

Sources: Enerdata, IEA, EER, GWEC, EWEA, EPIA, NREAPs, REN 21, Governmental Target , EGP estimates
Note: 2013 Prelliminary Data

New challenges for the Utility sector
CAPEX demand per sector

CAPEX demand for the pan EU utility industry estimation (2013-2022)



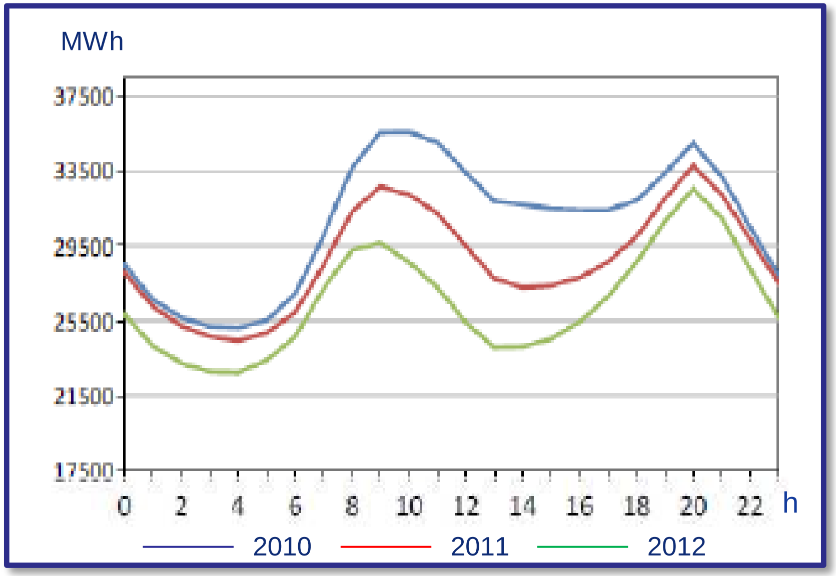
- ✓ **Addressable market for traditional Utility business is shrinking due to the expected lower demand and the growth of renewable business**
- ✓ **About 42% of CAPEX demand are concentrated in the renewable business**

** Citi Research. Note Data are illustrative for EU.*

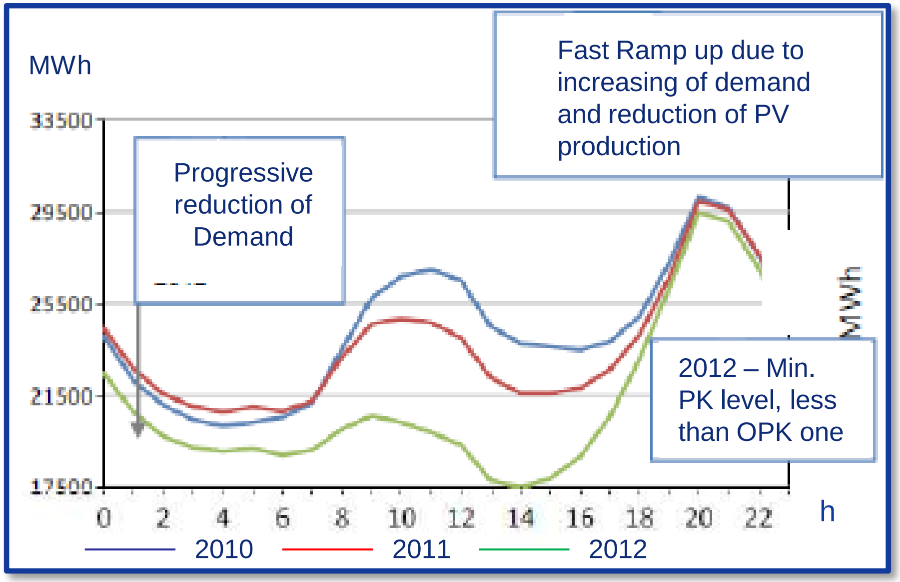
Technical Variation in Italy

Demand and RES Production

Net Demand (MW): Hourly Profile – April Working Days



Net Demand (MW): Hourly Profile – April Non-Working Days



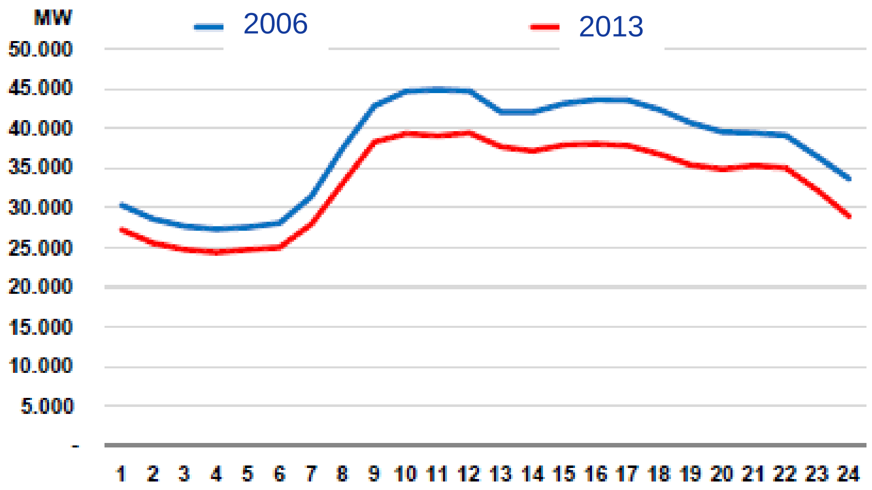
- ✓ **Significant variation during last 3 years in terms of net demand**
- ✓ **Very important difference especially in non-working days during peak hours with low demand level and high RES production**

Sources: Terna – Italian TSO
-Average of hours during April
-Net Demand= Demand – Solar and Wind Production (hourly base)

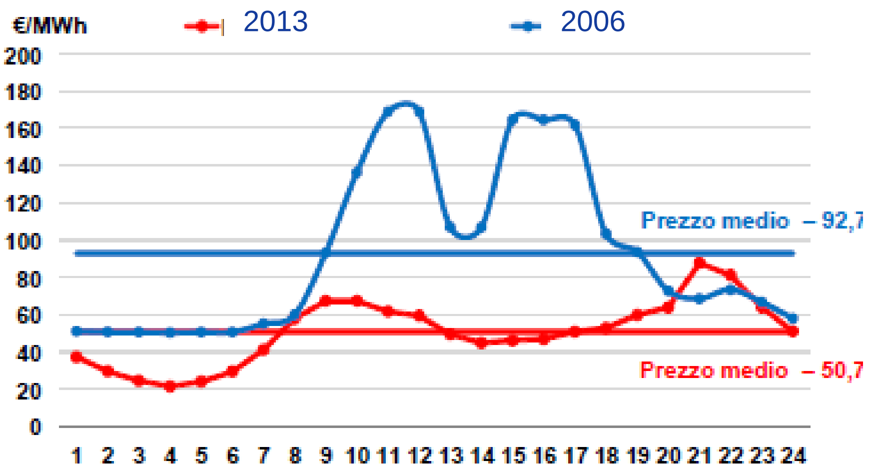
Demand and Market Price

Italian same working day in 2006 vs. 2013*

Demand (MW): Hourly Profile – Working Day (2006 vs. 2013)



Day Ahead Market Price (€/MWh): Hourly Profile (2006 vs. 2013)



- ✓ **Significant price variation in peak hours due to the reduction in demand and the increase of renewable energy**
- ✓ **Increasing price during the second period of off-peak due to the ramp of thermal plants for the production in place of PV**

Source: GSE / TERNA

Renewable Peculiarities

System flexibility 1/3

System structure

- Flexible generation capacity to back up RES volatility (Capacity payments mechanism)
- Upgrade the grids in order to reduce possible congestions and transmission losses
- Develop interconnecting networks and storage to prevent the risk of short supply among Members States
- Demand side management through smart grids (Possible peak shaving)

System flexibility

System Management

- Incentives on the correct forecast (especially in a first phase of development of renewable energy) in order to ensure a more careful programming, as well as compatibility with TSO / DSO,
- Demand response measure to help balancing intermitting RES
- Aggregation of production at portfolio level
- Large and flexible balancing zones
- Adequate model for balancing responsibility duties for NP RES (e.g. higher threshold)
- Liquid ancillary services markets open to RES

Renewable Peculiarities

Market model 2/3

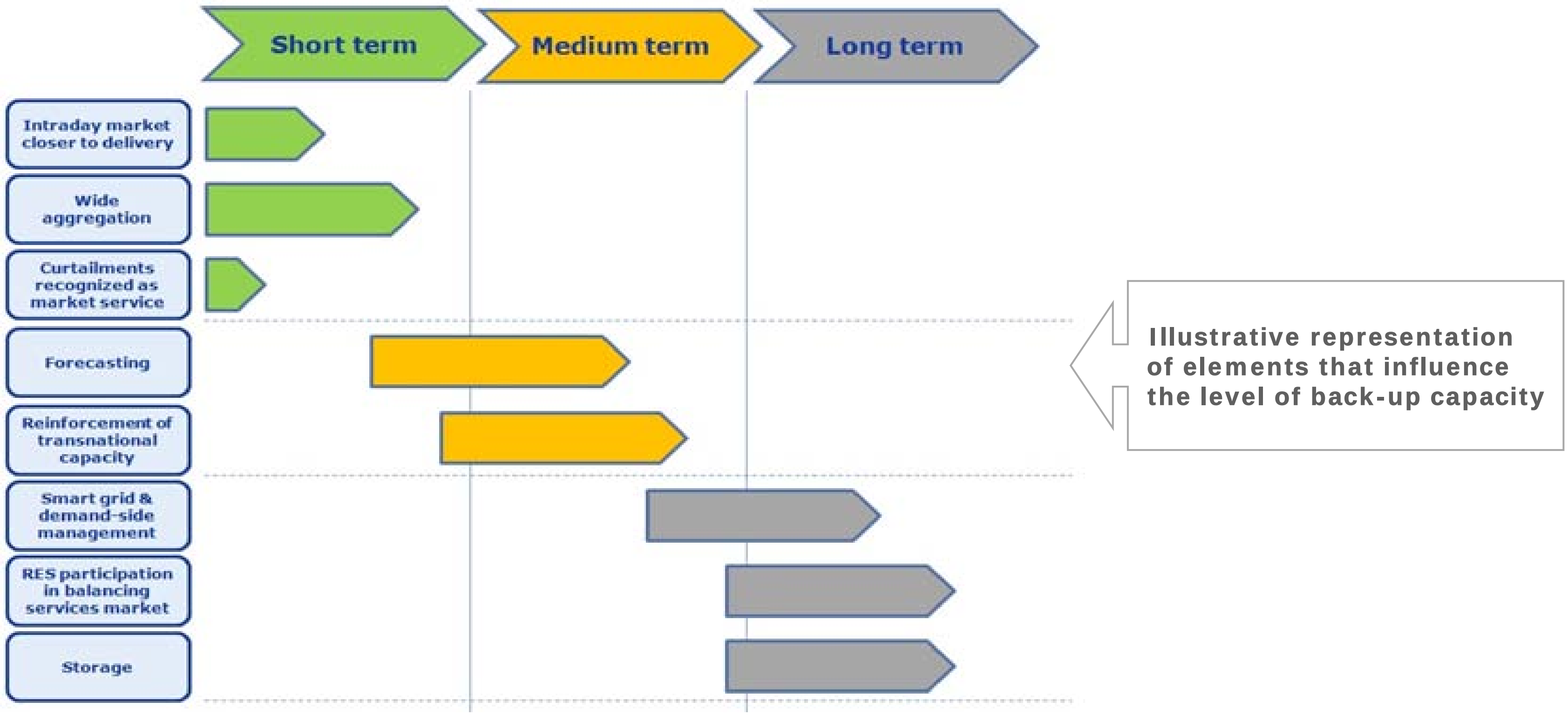
Market model

- Liquid forward markets or long term bilateral contracts (stabilize the return of investments by hedging prices and volumes)
- Coupled markets
- Demand side management (increase consumers' responsibility)
- Liquid Real time markets (Intraday and Day Ahead Market close to delivery time – up to 1h)
- Imbalances liability tailored to RES peculiarity
- Special support for RES to reflect properly the benefits of RES comparing to other sources (in terms of climate and costs of fossil fuels production)

Renewable Peculiarities

Back up capacity 3/3

Before the market and the system is adjusted, in order to integrate a high share of intermittent RES generation, there is the need to have a transparent capacity market



The level of required back up capacity depends on the level of the market and the system development stage

EU Balancing Markets & RES participation

Examples

Enel Green Power

GERMANY

- RES are allowed to participate to balancing market but must be prequalified

ITALY

- RES are NOT allowed to participate (DCO of AEEG proposed a future integration)
- RES don't pay for imbalances (ongoing changes)
- Wind and PV can receive dispatching orders for security reasons

RES participation to the balancing market

SPAIN

- RES are not allowed to participate (biomass can submit for prequalification)
- RES>10 MW must be connected to CECRE(1) and can receive dispatching orders
- RES pay for imbalances

UK

- RES are allowed to participate to some services of balancing market but they must be prequalified
- Curtailments are remunerated at bidding prices

FRANCE

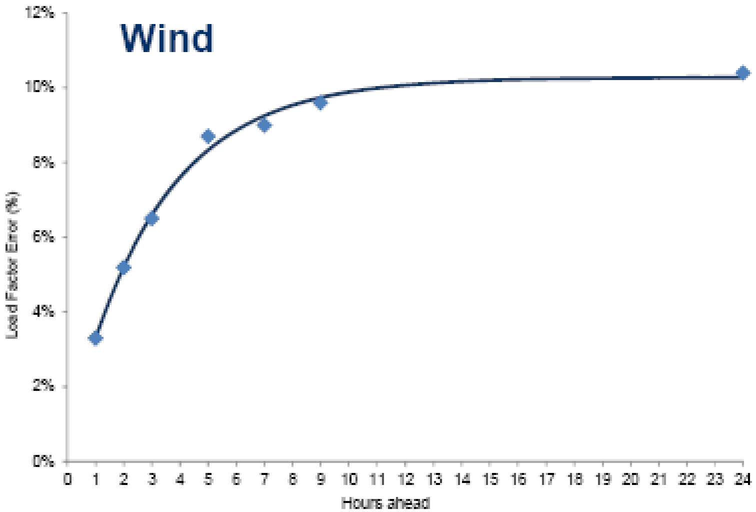
- RES under FIT don't pay for imbalances
- RES are not allowed to participate to balancing market (exceptions in some cases for run of river)

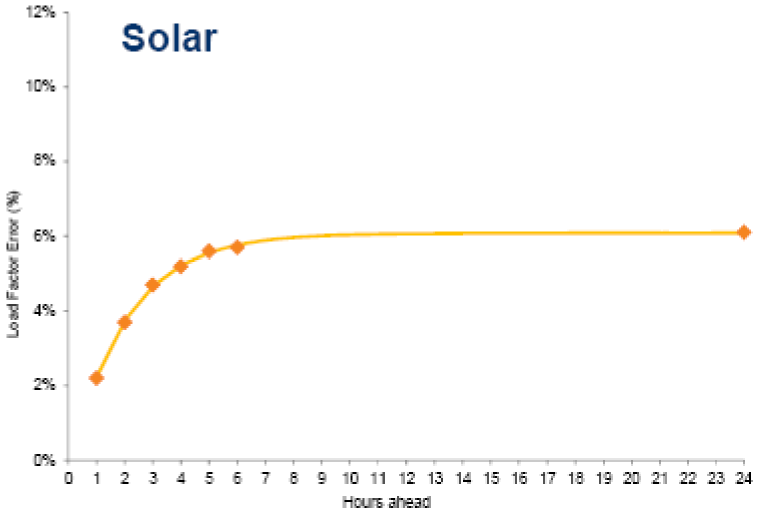
Renewable Forecast example

Two Considerations (1/2)

Evolution of average forecast errors for Wind and PV

How the error changes from day-ahead (i.e. 24h ahead in the charts) to delivery





✓ **As delivery time approaches, the forecasting error decreases as follows:**

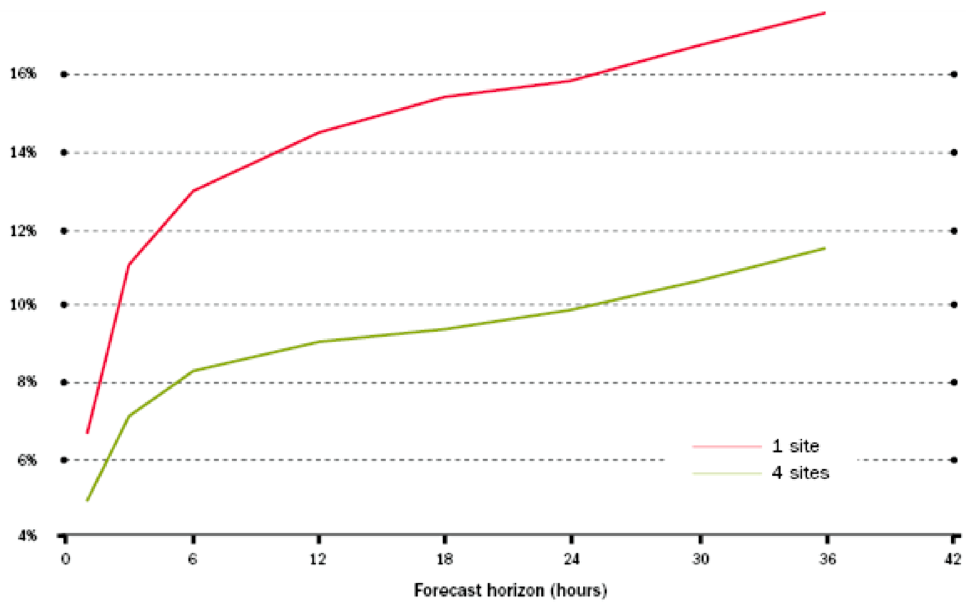
- **6 hours ahead, error falls by 15% for wind and 6% for solar**
- **Hour ahead, error is roughly one third of 24-h ahead (in % terms)**

Source: Pöyry, Future scenarios of the Italian electricity market: 2020 and beyond, 20 April 2012

Renewable Forecast example

Two Considerations (2/2)

Mean absolute error as % capacity for single site and aggregated output of 4 sites



The amount of prediction errors for wind power in a geographical region diminish as the region size increases, especially for shorter forecast horizons

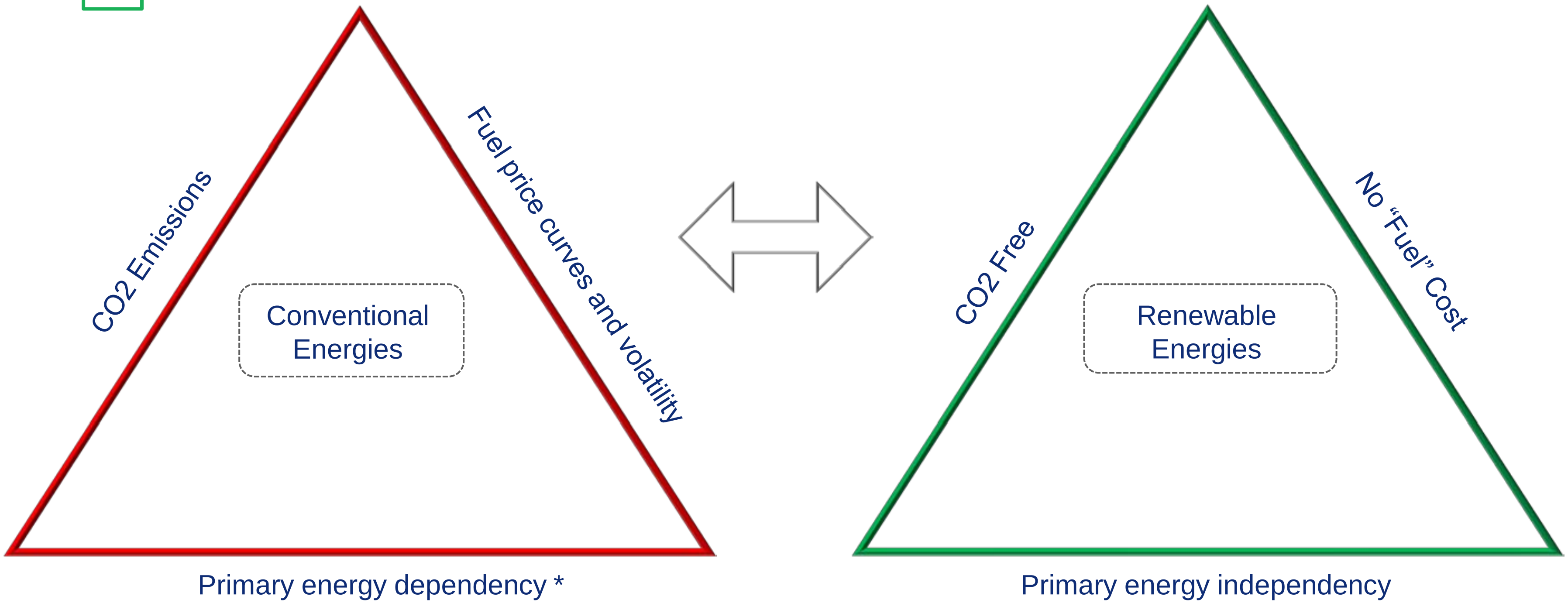
Source: Tradewind, Integrating Wind Developing Europe's power market for the large-scale integration of wind power, 2009

Closing Remarks

- RES plays an important role in the climate and energy security policy of EU
- The current regulatory framework, system status and market structure are not enough to properly accommodate RES, and fundamental changes are required
- Flexible and stable regulations, as well as coherent national strategies and plans are required to attract the necessary investments
- Finalization of internal energy markets as a crucial role
- Grid investments to secure energy supply
- Capacity markets could be necessary until the market will be adequately designed to allow the full integration of RES
- Level playing field for RES requires a proper market design and regulations as well as a transparent accounting of fossil fuels related costs

BACK UP

RES response to the “Energy Trilemma”

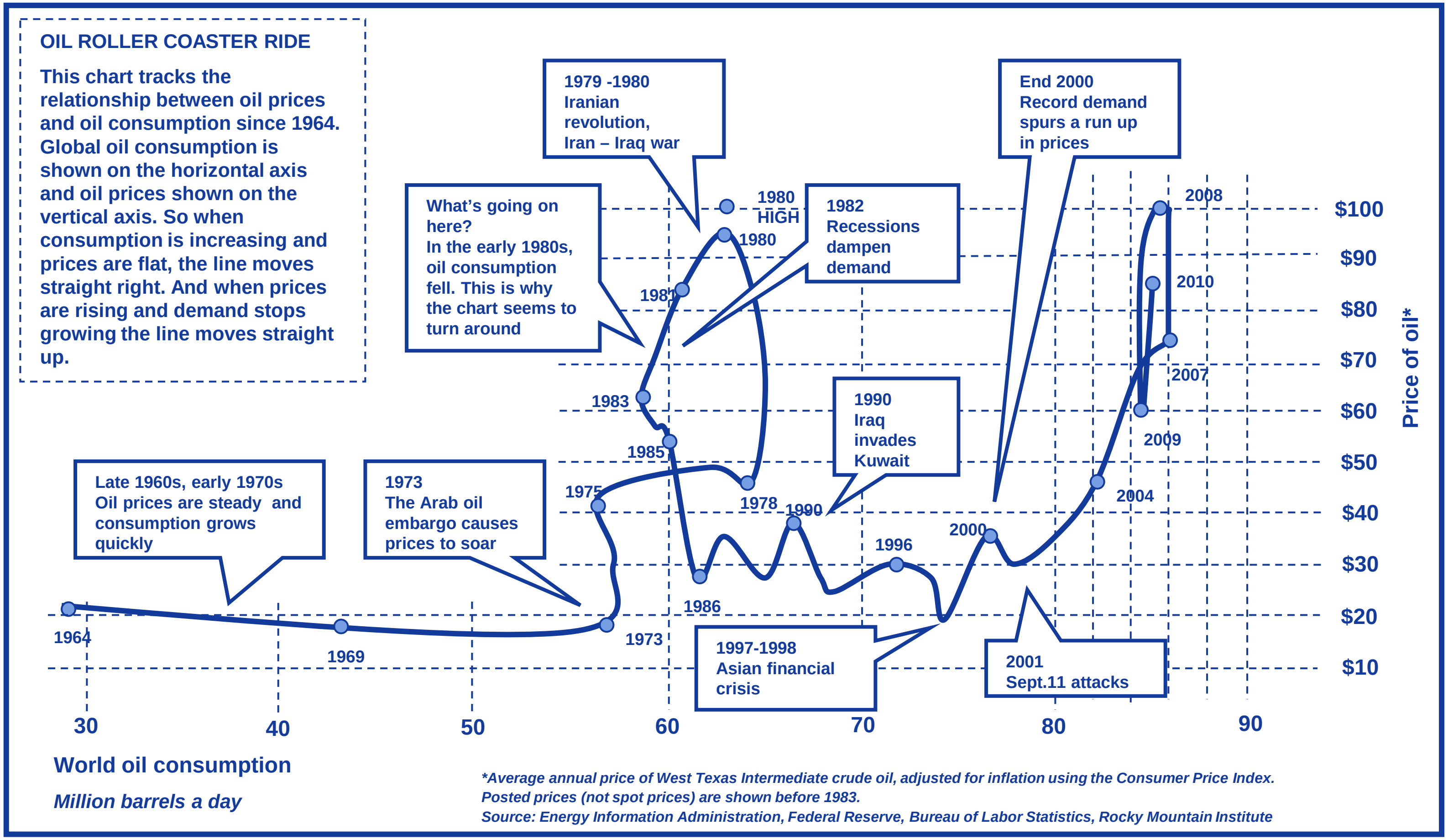


RES have better risk profile than traditional technologies

* Today, EU imports 53% of the total energy consumed

RES in a volatile world…

Graphical Oil Path - 1964 – 2010



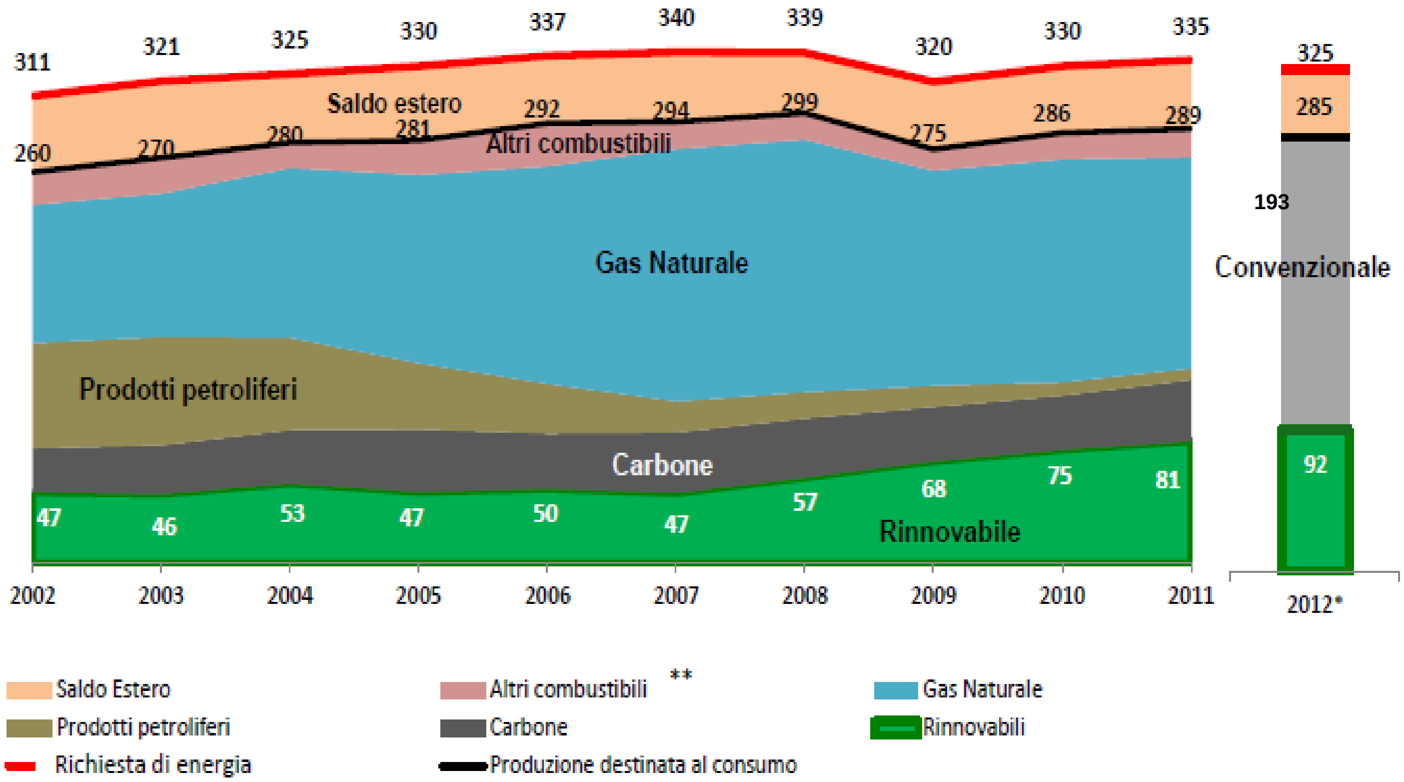
*Average annual price of West Texas Intermediate crude oil, adjusted for inflation using the Consumer Price Index. Posted prices (not spot prices) are shown before 1983.
Source: Energy Information Administration, Federal Reserve, Bureau of Labor Statistics, Rocky Mountain Institute

High volatility...low predictability…

Barclays Capital Projections: 1) Demand 2009 84,6 mb/d 2) Average WTI 2009 62 $/b
3) Demand 2010 85,6 mb/d 4) Average WTI 2010 85 $/b

Electricity production in Italy

2002 – 2012 (TWh)



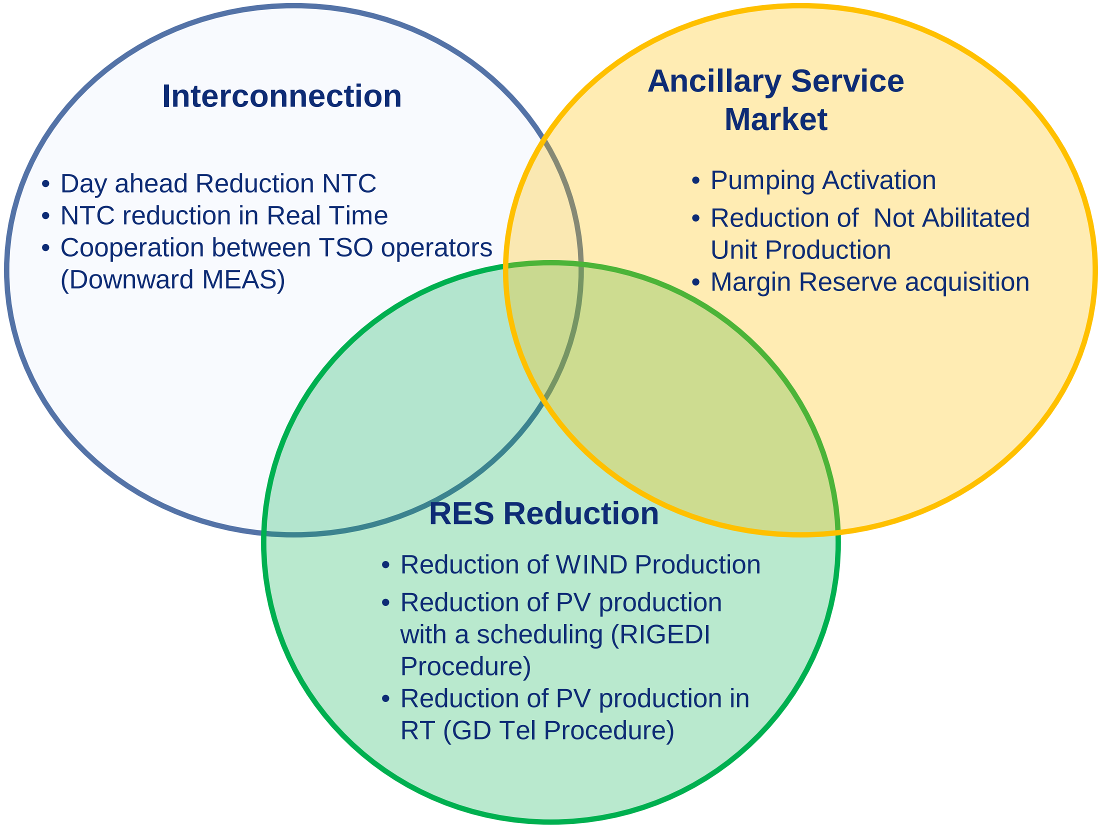
- ✓ **Conventional production reduction from 213 TWh (2002) to 193 TWh (2012)**
- ✓ **RES increases from 47 to 92 TWh**

**Source Terna / GSE preliminary data*
*** Include pump storage production (not include natural inflows), gas derivates and other*

Italian Framework

RES Balancing

TSO Actions



Investments and proper regulation are required to avoid RES cuts in times of congestions

Source: TERNA

EU RES Policy
Evolution

Inception Before 2010	Take off 2010 - 2014	Consolidation From 2015
• Full guaranteed intake • Predefined remuneration	• Remuneration linked to market prices and costs evolution • Gradual integration into the balancing market • Mechanisms to control over capacity and support costs	• RES integration into the newly designed market: • Intraday markets • Smart grids • Competitive support instruments adjusted to the technology maturity level

No balancing responsibility

Balancing responsibility

A low level of penetration didn't create any impact to the system	When level of penetration increased, RES started to be gradually integrated into the market, according to each country peculiarity	A high level of RES penetration requires an adequate and more convergent market design at EU level

History RES regime evolve according to level of penetration, country peculiarity and EU objectives

Renewable Peculiarities

Integration requirements and Market Model

RES among many other, are defined by the following peculiarities:

- High resource availability dependence
- CAPEX intensive

- ZERO CO_2 emissions
- ZERO marginal cost
- Unlimited resource (especially Wind & PV)

RES peculiarities

Requirements:
- System flexibility
- NEW Market Model

Objective

Barriers:
- EU Market fragmentation
- Unstable and incoherent regulatory framework
- Outdated market models and infrastructure
- Lack of financing

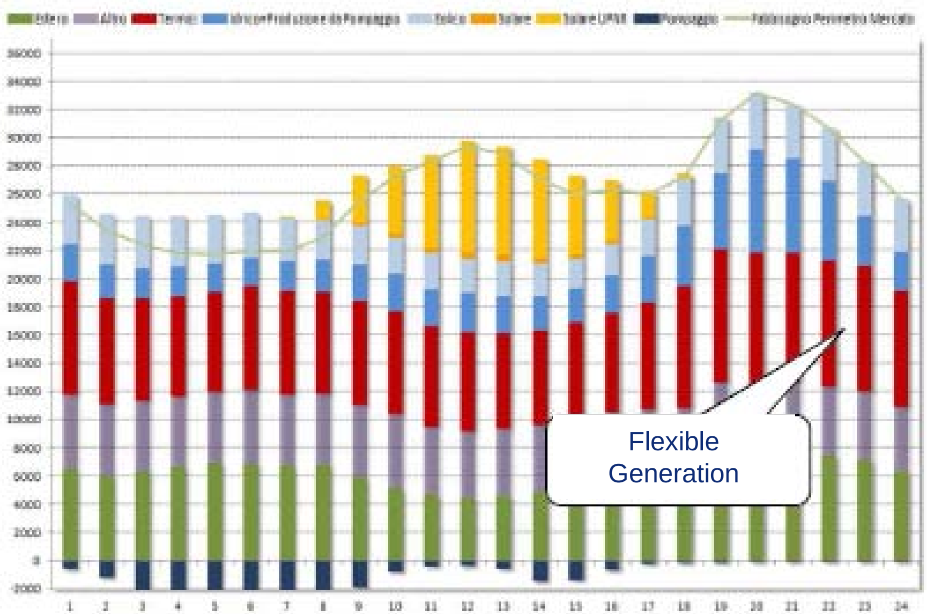
Level playing field for RES integration

RES plays an important role in the climate and energy security policy of EU, and therefore an adequate, predictable and stable regulatory framework is required

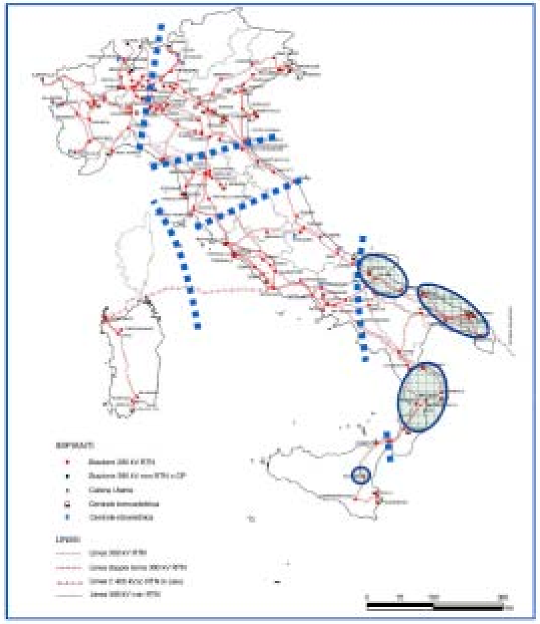
Italian Renewable Balancing

Highly critical in periods with low demand and high RES production level

Demand (MW): Hourly Profile – Working Day (2006 vs. 2013)



Italian Grid Network



- ✓ **Over generation linked to Demand reduction and RES production is characterized by:**
  - **Fast increasing of demand level during off peak hours**
  - **Very cheap number of power plant with Flexible generation**

Source: TERNA

Renewable monitoring example

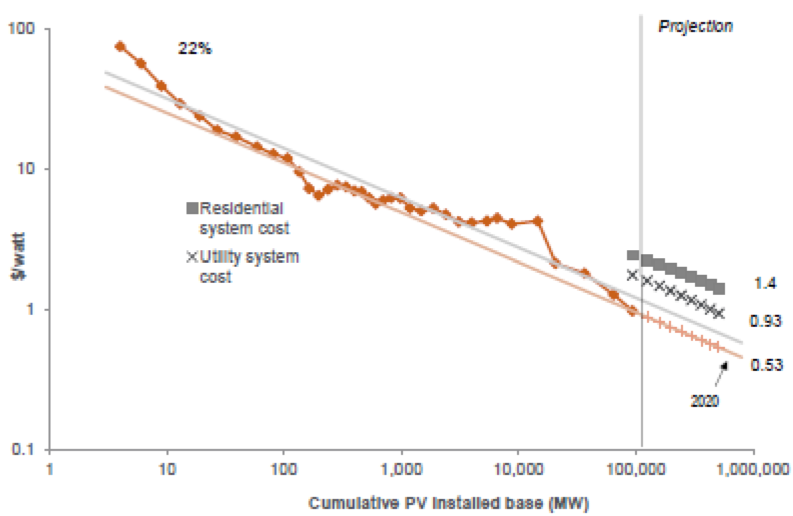
Spanish Control Centre – CECRE

- ✓ Spanish TSO (REE) has set up an specific centre to monitor and control renewable energy (CECRE)
- ✓ CECRE centralizes all dispatch instruction to wind farms, keeping the system in a stable and safety state while maximizing renewable energy output
- ✓ In This Centre, wind farm above 10 MW are fully monitored.
- ✓ Real time metering of renewable sources

Renewable Technologies Competitiveness

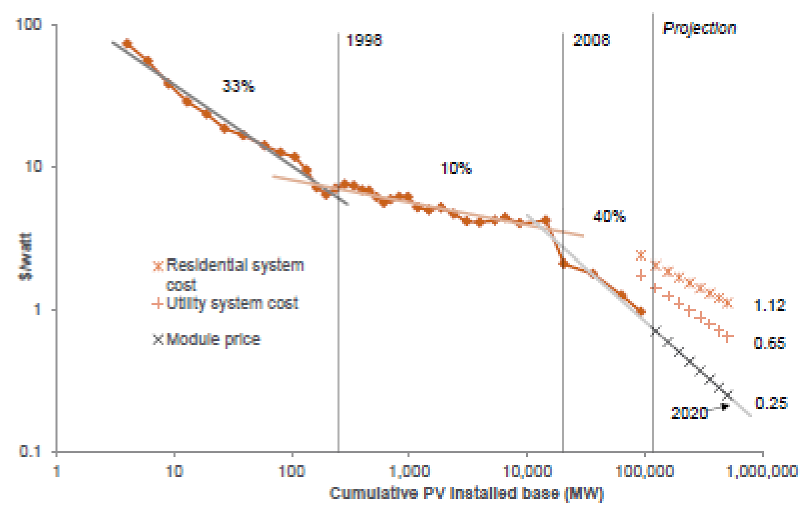
Solar PV Technologies: cost reduction trend

Solar PV systems cost reduction ($/W) from 1972



- Solar module price declines from 1972 show an overall learning rate of 22%

Solar PV systems cost reduction ($/W)



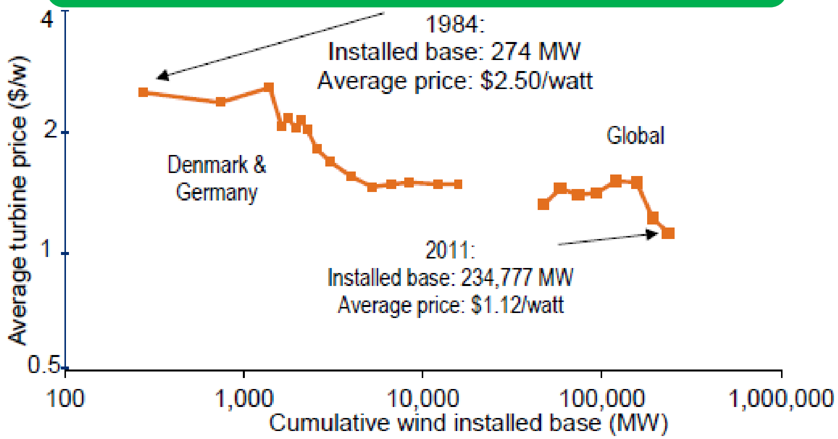
- Post 2008 boom showing a faster learning rate of 40

Source: Citi Research, Bloomberg New Energy Finance

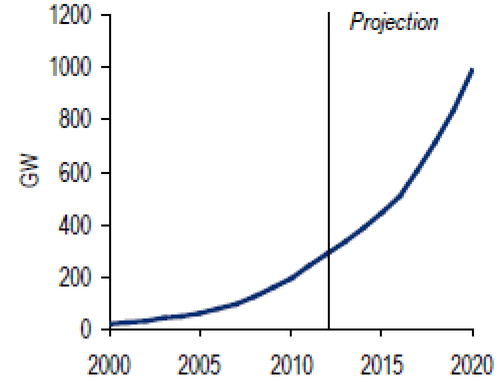
Renewable Technologies Competitiveness

Wind Technologies: cost reduction trend

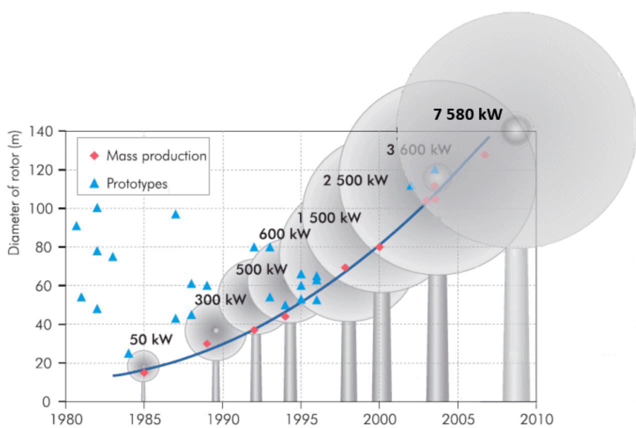
Historical average turbine costs against cumulative installed capacity (1984-2011)



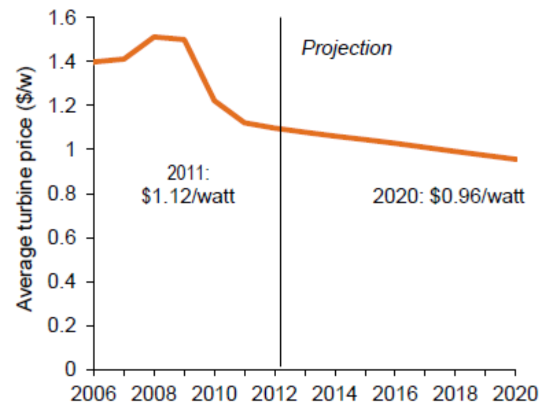
Forecast for future cumulative wind installed base (GW)



Historical Wind turbine dimensions (1980-2010)



Forecast for future average turbine price ($/W)



Source: Citi Research, October 2013; Bloomberg New Energy Finance.