



L'innovazione al servizio delle Fonti Rinnovabili

Innovazione e nuove soluzioni tecnologiche per favorire lo sviluppo e l'integrazione delle Fonti Rinnovabili nel sistema energetico italiano

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Terna overview

> Terna is...

- ...the sixth **Transmission System Operator (TSO)** in the world
- ...the **owner** of the National High Voltage Transmission Grid
- ...responsible for the **transmission and dispatching** of the electricity all over the Country

> Grid

{ ~ **72,300_{Km}** of electric lines
25 interconnections (NTC ~ **9.2_{GW}**)
841 substations

> Demand

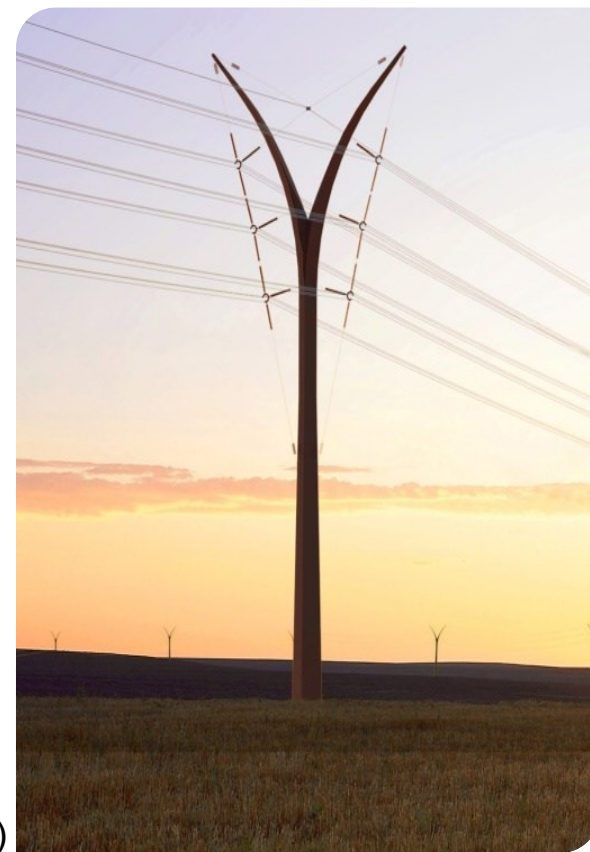
{ **315_{TWh}** energy demand (2015)
59.3_{GW} highest peak of demand (21st July 2015)

> Generation Asset

{ **75_{GW}** Conventional (gas, coal, oil, hydro pumping)
46_{GW} RES (PV, wind, hydro, biomass, geothermal)

> Electricity Market

{ **62%** Conventional (gas, coal, oil, hydro pumping)
38% RES (PV, wind, hydro, biomass, geothermal)





EU 2030 Climate and Energy Framework targets (2014)



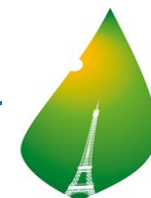
40% reduction in greenhouse gas emissions, compared to 1990 level

At least **27%** share of **renewable energy consumption** in the EU

Energy efficiency increase of at least **27%*** compared with the business-as-usual scenario

Electricity interconnection target of **15%** between EU countries

COP 21 - Paris Agreement (2015)



195 Countries adopted the first global binding agreement on climate, defining an international action plan in order to **limit global warming well under 2° C in the long term**

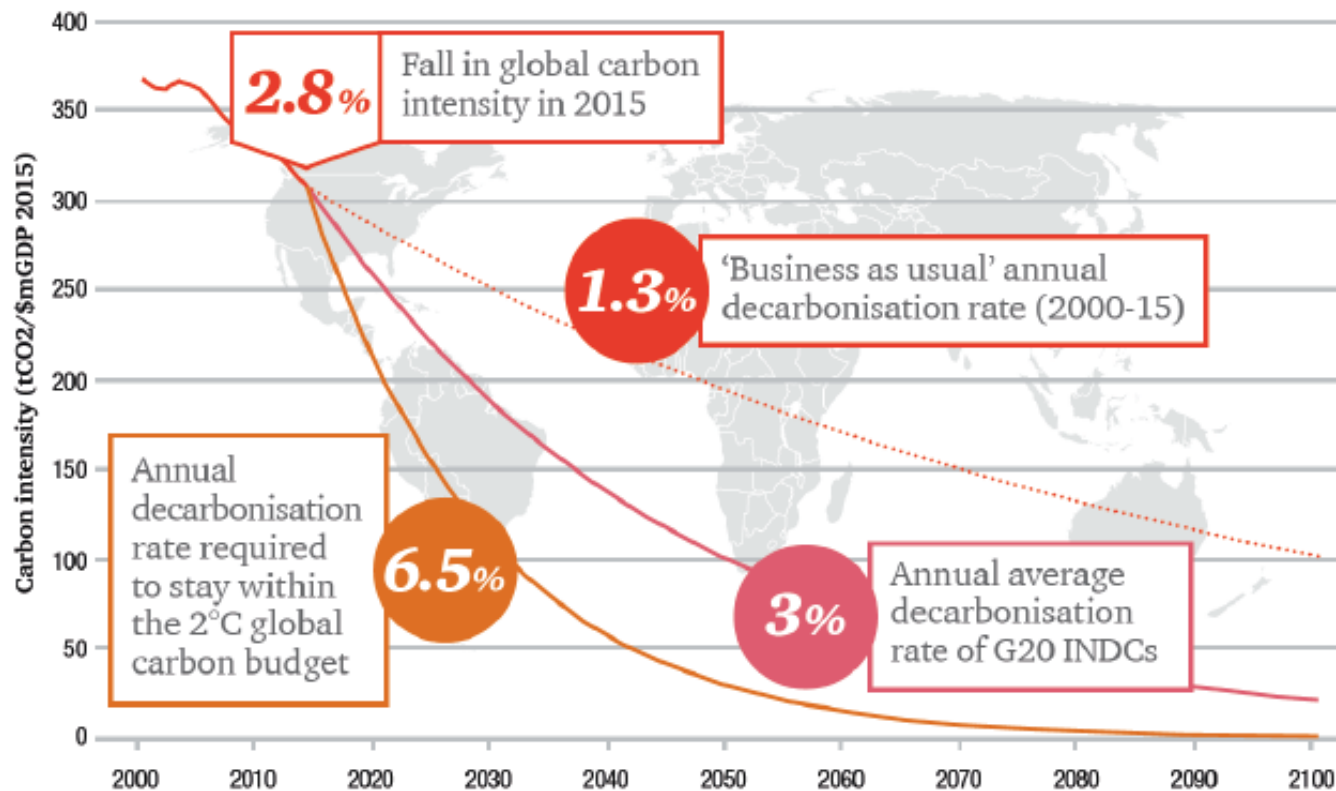
Signatory Countries presented their respective National action plans (**INDC****).

In its INDC, **EU reiterated the intents established in the Climate Energy Framework 2030**

International agreements on climate and energy, designed to reduce GHG emissions, impose great challenges to the energy systems

Evolution of global economy carbon intensity

PATHWAY TO 2°C - From “Low Carbon Economy Index 2016”, PWC

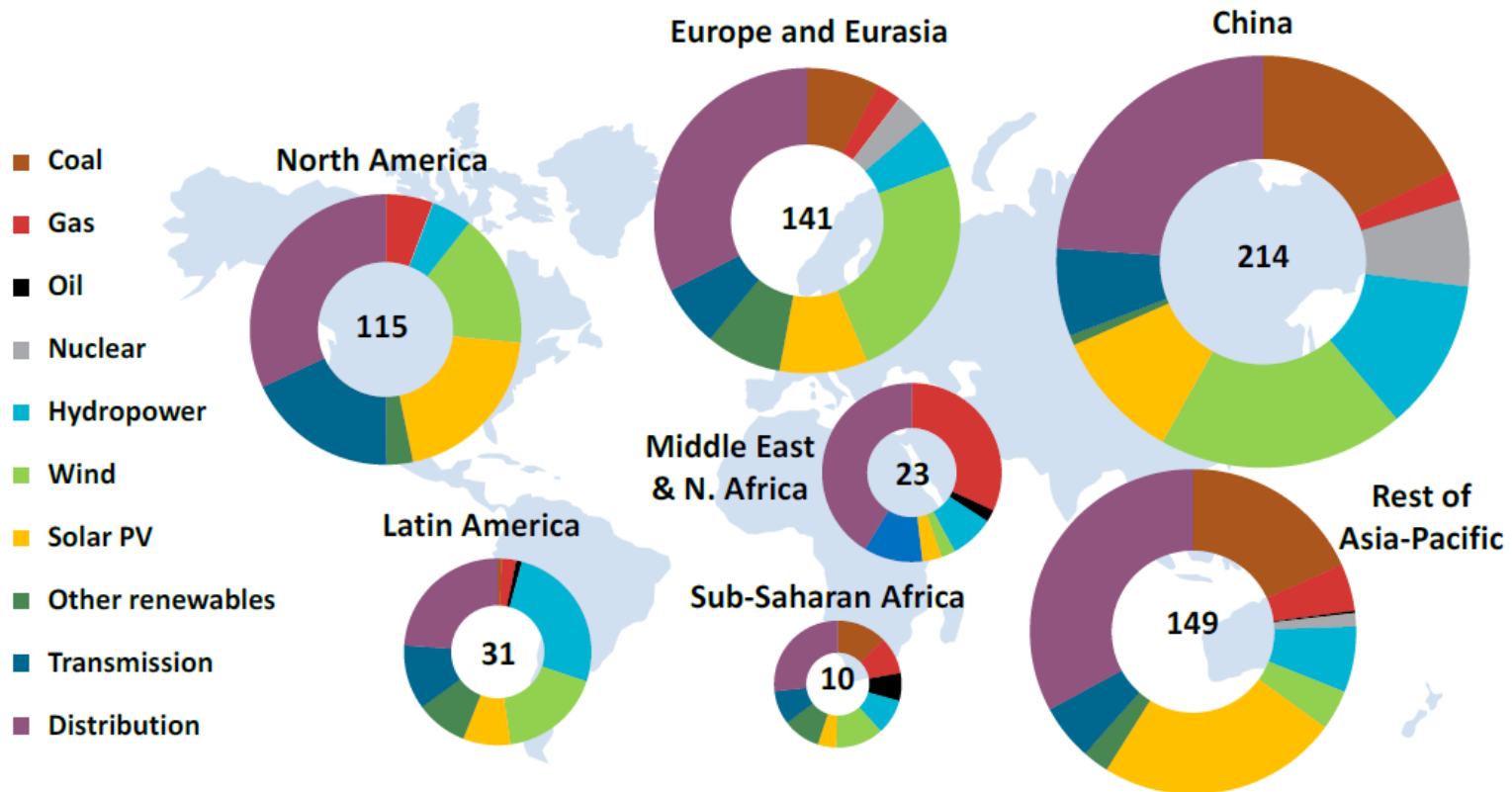


To prevent warming in excess of 2°C global economy needs to cut its carbon intensity by 6,5% a year from now to 2100.

Twice Paris pledges, according to PWC

Energy sector investments

Generation, distribution and transmission investments, 2015 (USD billion)



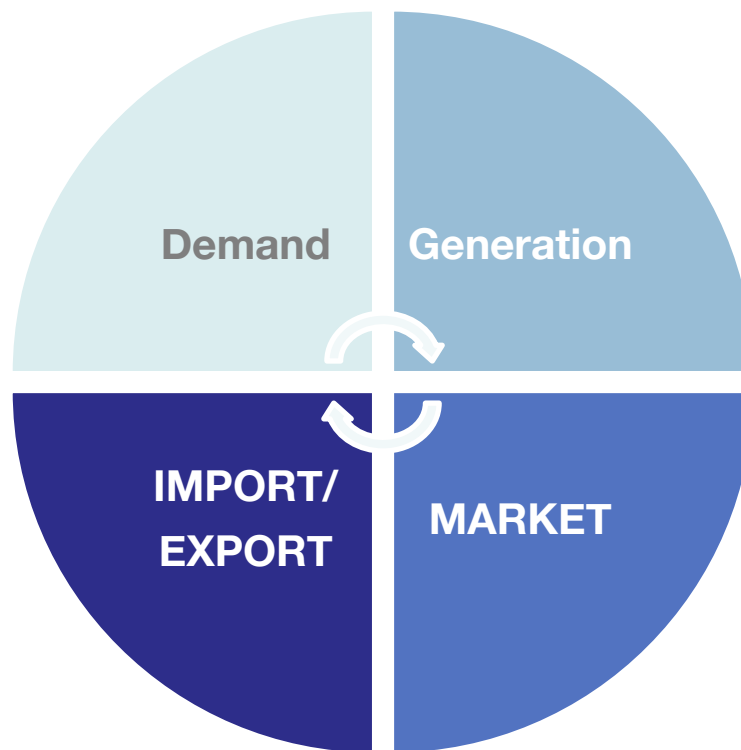
Source: IEA 2016

680\$bn global investments in the electricity sector in 2015, of which 40% on networks (distribution and transmission).

RES development covered \approx 70% of the total investments in electricity generation

Overview of the Italian Power System

- **Energy Demand** : - 2%
(2016 vs 2015)



- **Decreasing** differential prices: 10 €/MWh del 2016 vs. 17-18 €/MWh del 2015-2014

- In 2016 **Import decreasing** (Nuclear Power plan fault)

- **RES** growing

- **Thermal** decommissioning

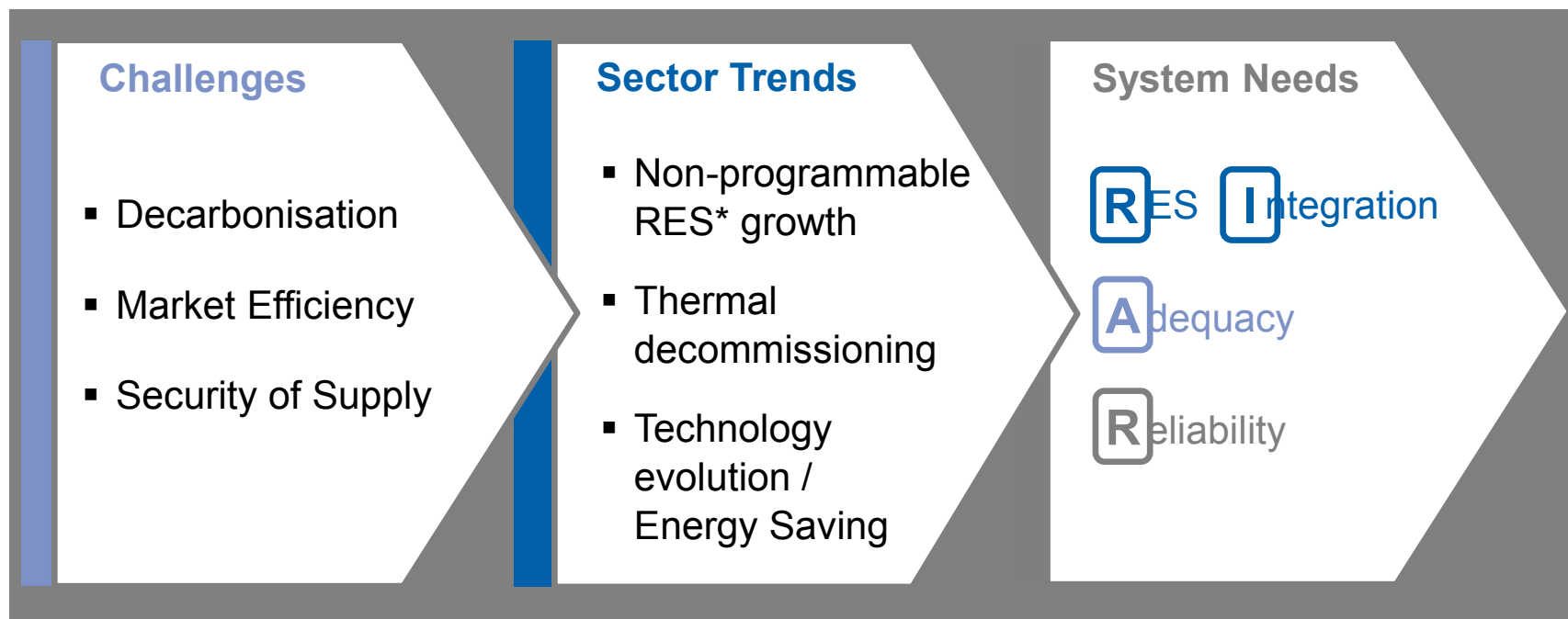
- Decreasing **price in day-ahead market** : -26% PUN 2016 vs. 2014

- **Increasing** cost of ancillary services : +45% 2016 vs. 2015

The Energy Transition is Accelerating

ENABLING ENERGY TRANSITION

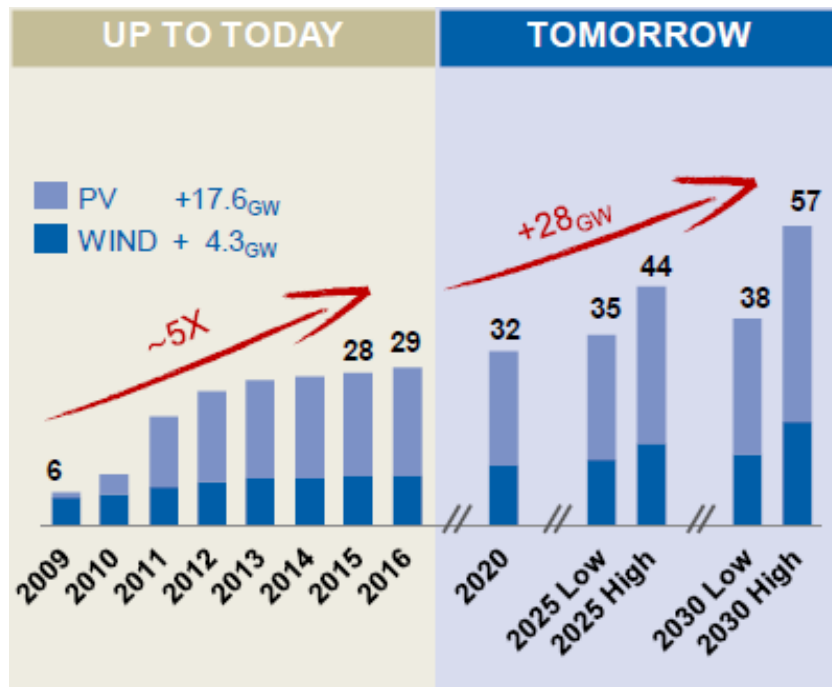
Key drivers of Terna Strategic Plan 2017-2021 (Feb 2017)



At the **lowest cost** for the System with **high quality** standards

RES growing & Thermal decommissioning

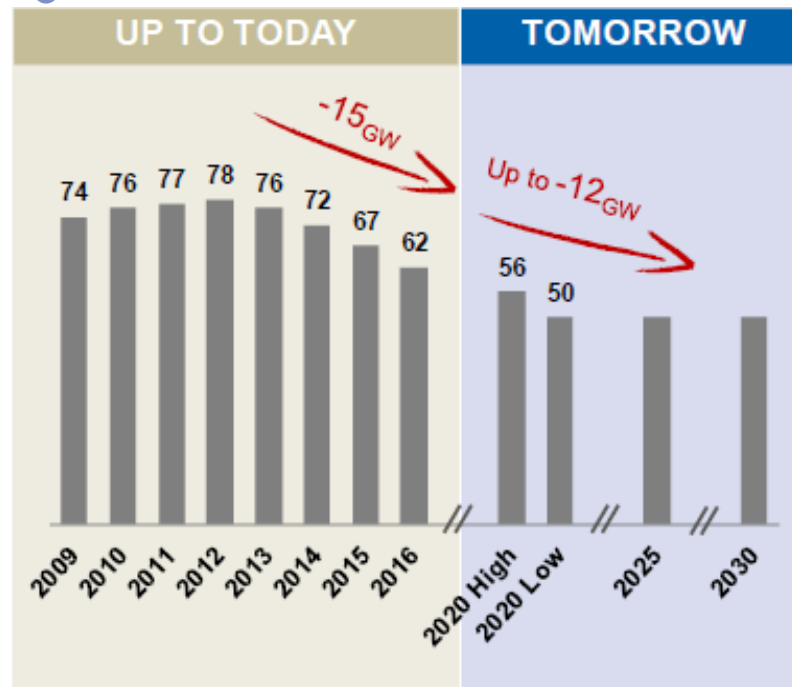
FURTHER INCREASE EXPECTED



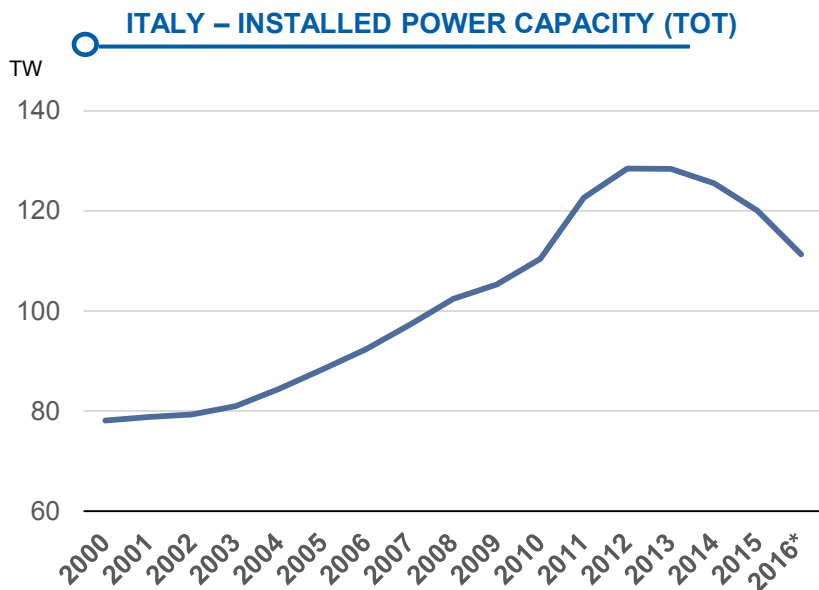
Further growth driven by competitive tenders with long term contracts

> 2017 target +1.4_{GW}

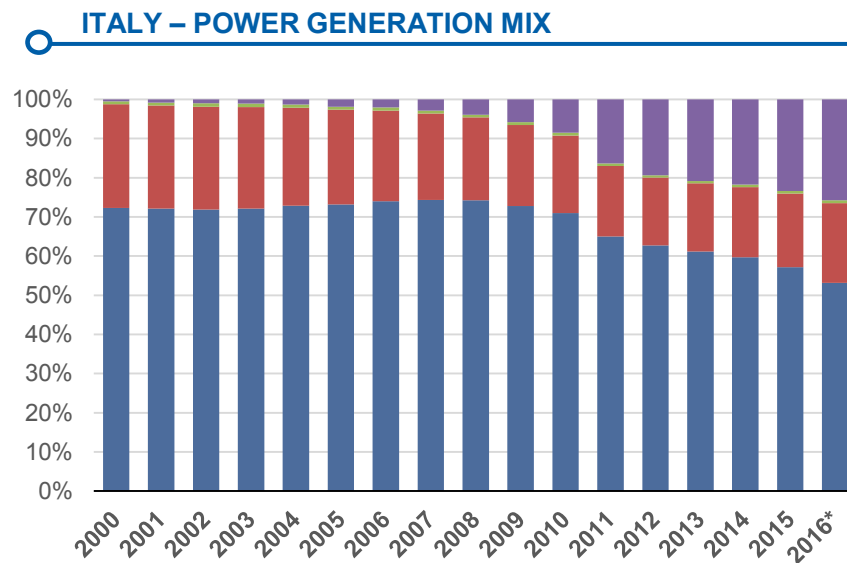
THERMAL DECOMMISSIONING



Further decommissioning driven by efficiency



Fonte: Terna



■ Termoelettrica tradizionale ■ Idroelettrico ■ Geotermo-elettrica ■ Eolico-solare

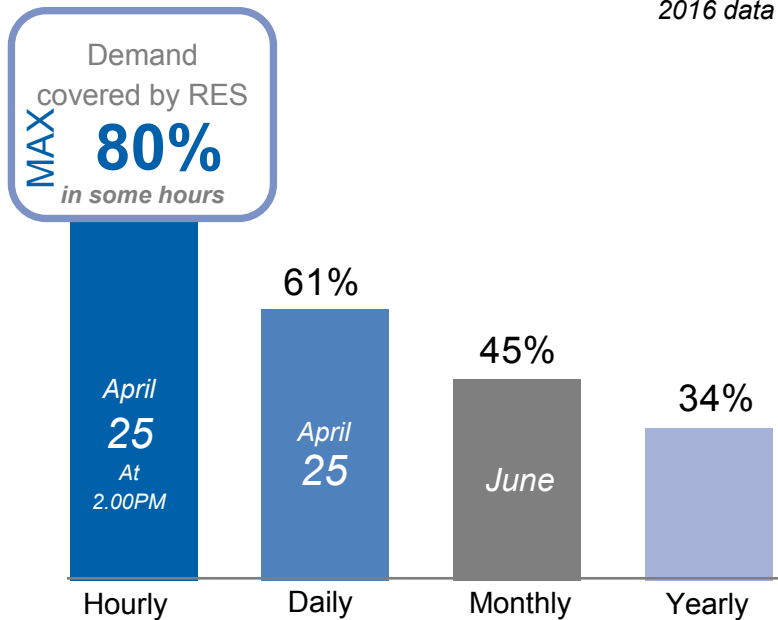
Fonte: Terna

The capacity generation mix is changing, with an ever greater share of non-programmable renewable sources
Total installed capacity is decreasing after peaking in 2012-2013

Understanding RES Integration

DEMAND COVERED BY RENEWABLES¹

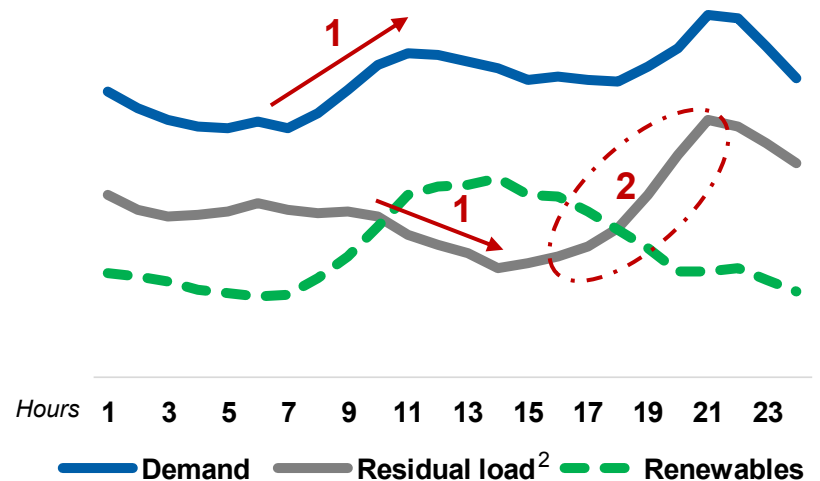
2016 data



SYSTEM BALANCING NEEDS

GW

2016



> **1** Peak inversion management

> **2** Increased complexity of ramp up management

Need to integrate RES production

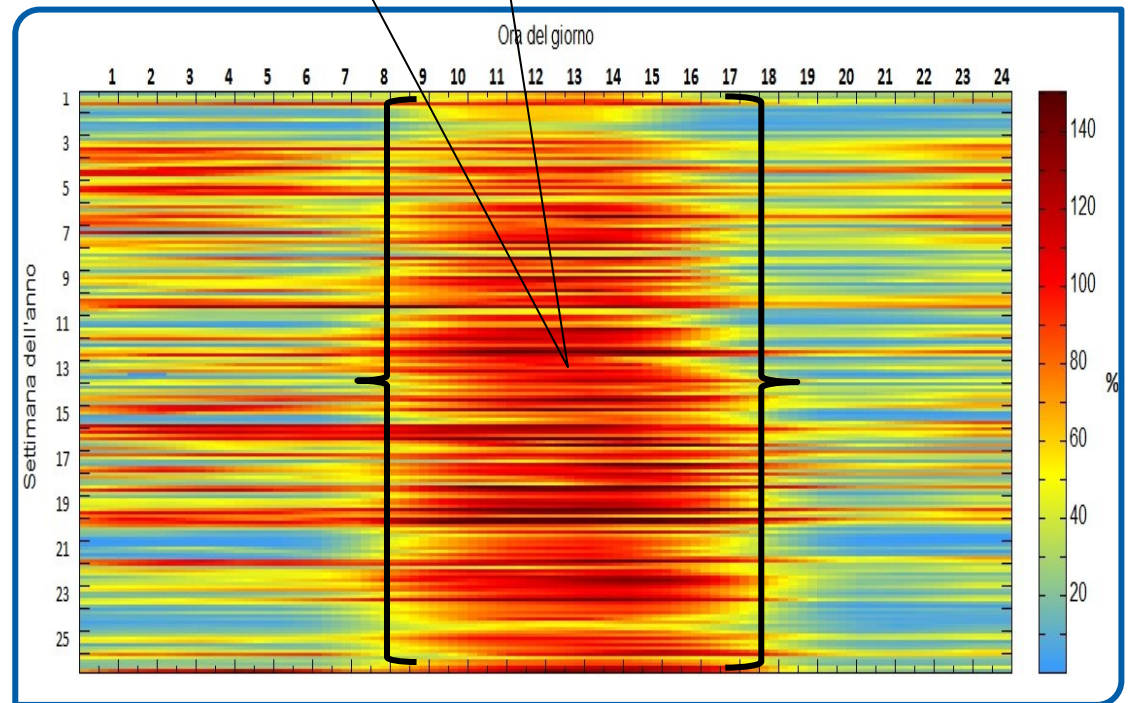
Main changes in the last years

Demand stagnation and **Renewable growth** make system operation more complex

- More flexible dispatching resources are needed
- Less regulation resources are available



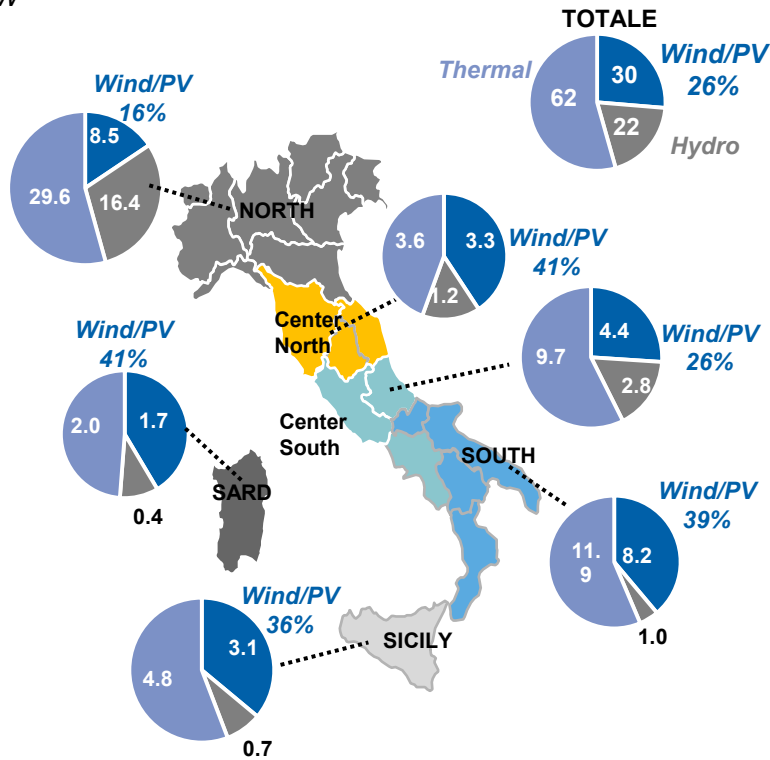
Wind and solar generation in the South of Italy exceed the demand (in red)



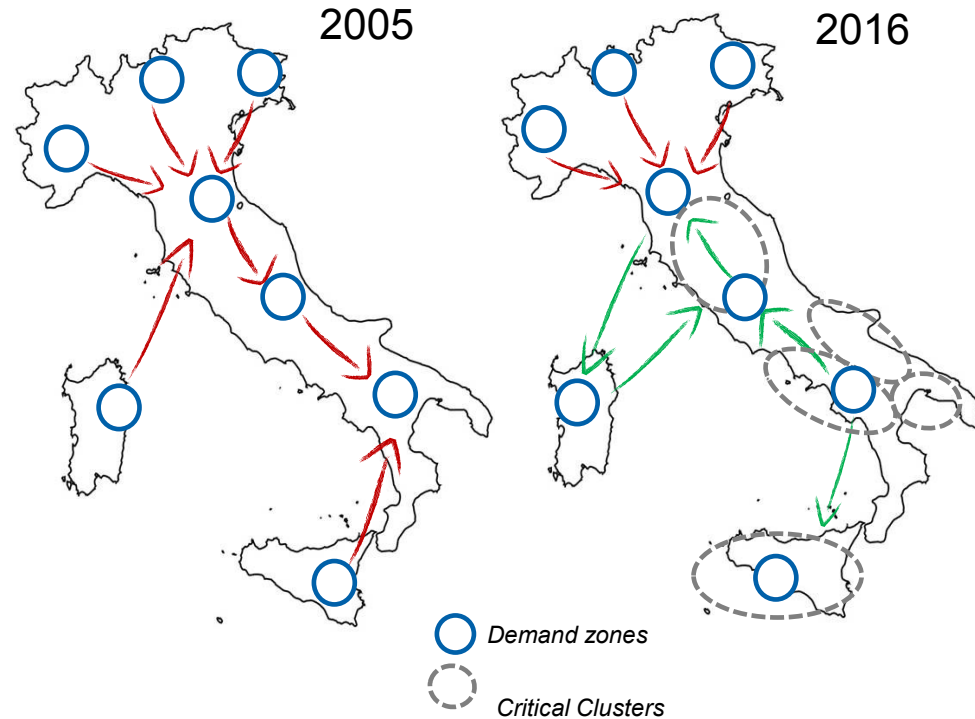
REShuffling Energy Map

CAPACITY MIX IN THE 6 MARKET ZONES*

GW



ENERGY FLOWS



- > **Not homogeneous** renewables distribution within the Country (concentrated in the South)
- > Need for RES integration and new grid reinforcements on the backbone for South-North energy flow

RES: main impacts on the security of the energy system

Fast and massive growth of RES make system operation more complex:

Cause

- 1 RES do not contribute to power reserves
- 2 Replacement of the spinning reserves with «static» elements
- 3 RES plants disconnect from the grid due to change in such a way to be a threat to the security of the system
- 4 Non-programmability of RES production



Effect

- 1 Loss of available reserves, especially critical in low consumptions situations
- 2 Reduction of the system's inertia and, consequently, of the stability of the grid
- 3 Repercussions on the grid defense plan and wide risk of disruption
- 4 Greater need for replacement sources, higher adequacy margins needed

The system needs more flexibility

Key enablers of the energy transition

Capacity Market

Fundamental to deliver long term price signals in an energy only market; **fully integrated in the energy market structure**

Network Development

Transmission capacity increase on a zonal and local basis; **interconnections** with other countries

Storage

Both **large scale storage** solutions (5 GW additional PHES might be necessary by 2030) and **distributed small-medium scale** solutions (typically electrochemical storage)

Demand Response

Enabling demand to provide ancillary services based on **explicit and/or implicit price signals**

Smart Grids

Investing in **FACTS** (Flexible AC Transmission systems), **voltage compensators** and **real time digital management** systems

Market Evolution

Driving the evolution of Ancillary Services Market **to foster the participation of new resources** (demand, distributed generation, storage)

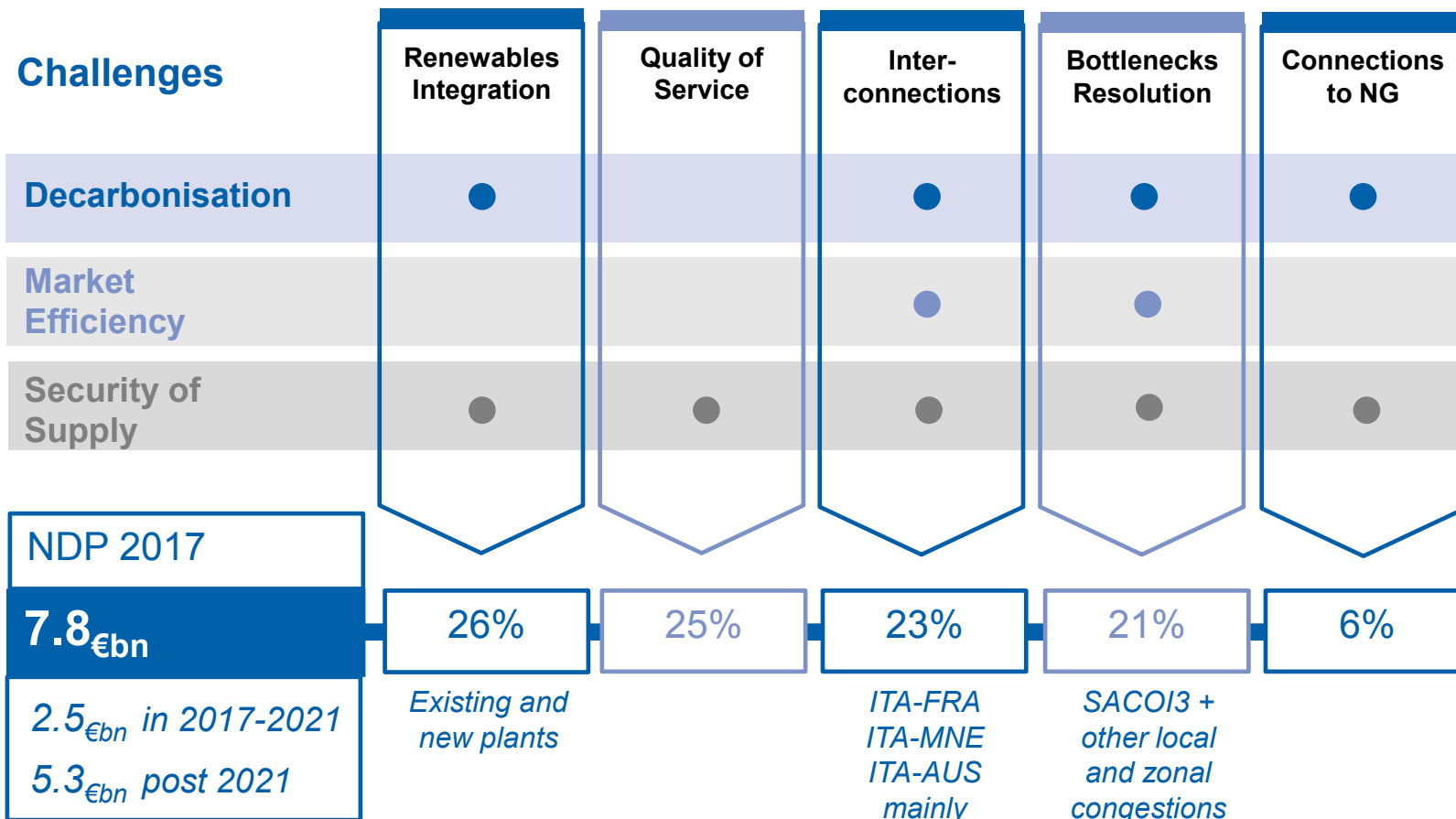
Data Management

Full availability of metering data is a fundamental enabler to allow for the participation of new resources to ASM

Not one single solution exists but a full set of measures is needed

2017 National Development Plan

Benefits for the Electricity System (Categories)



Generation



Generators providing Flex Services Today

| <i>Voltage level</i> | <i>Number</i> | <i>[GW]</i> |
|----------------------|---------------|-------------|
| HV | 233 | 62,5 |

Other Generators

| <i>Voltage level</i> | <i>Number</i> | <i>[GW]</i> |
|----------------------|---------------|-------------|
| HV | ≈ 1.000 | 24,2 |
| MV | ≈ 26.800 | 18,1 |
| LV | ≈ 670.000 | 7,2 |

Demand



To date, consumers are not enabled to provide flexibility services; there are about 580 sites with interruptible loads (for about 3.500 MW overall)

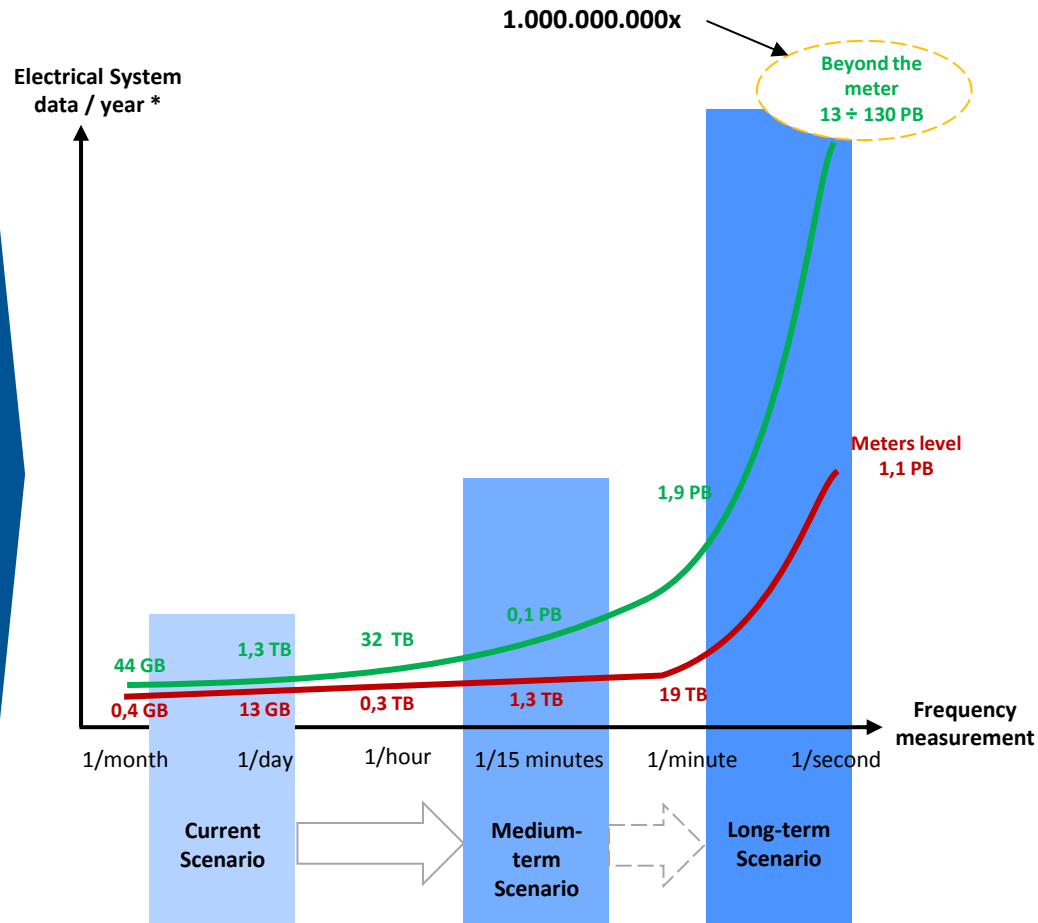
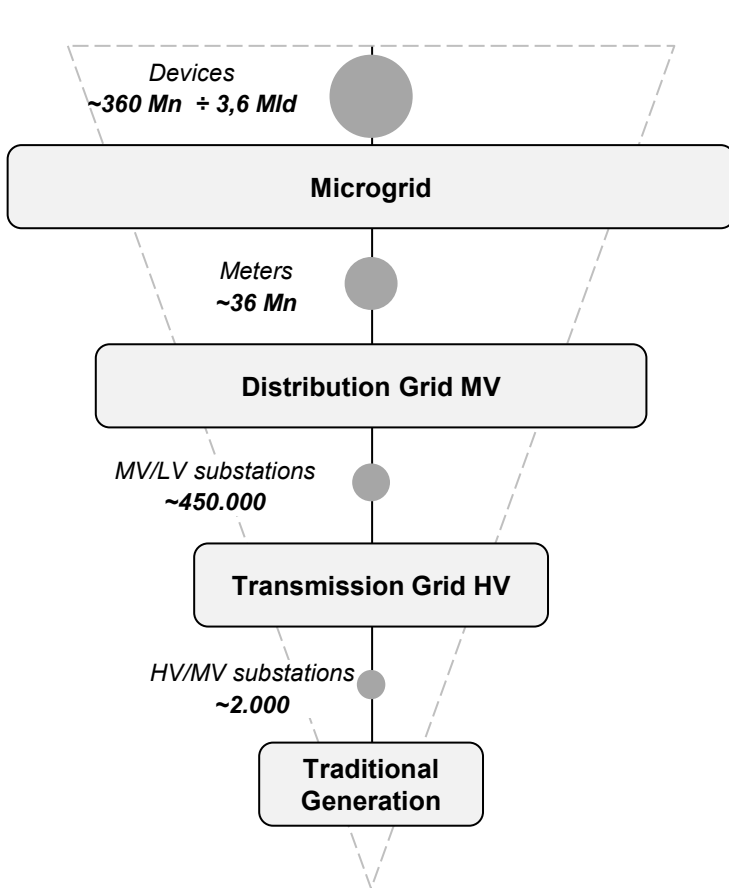
Consumers

| <i>Voltage level</i> | <i>Number</i> | <i>[GWh]</i> |
|----------------------|---------------|--------------|
| HV | ≈ 1.000 | 26,5 |
| MV | ≈ 106.000 | 92,5 |
| LV | ≈ 37.000.000 | 128,4 |

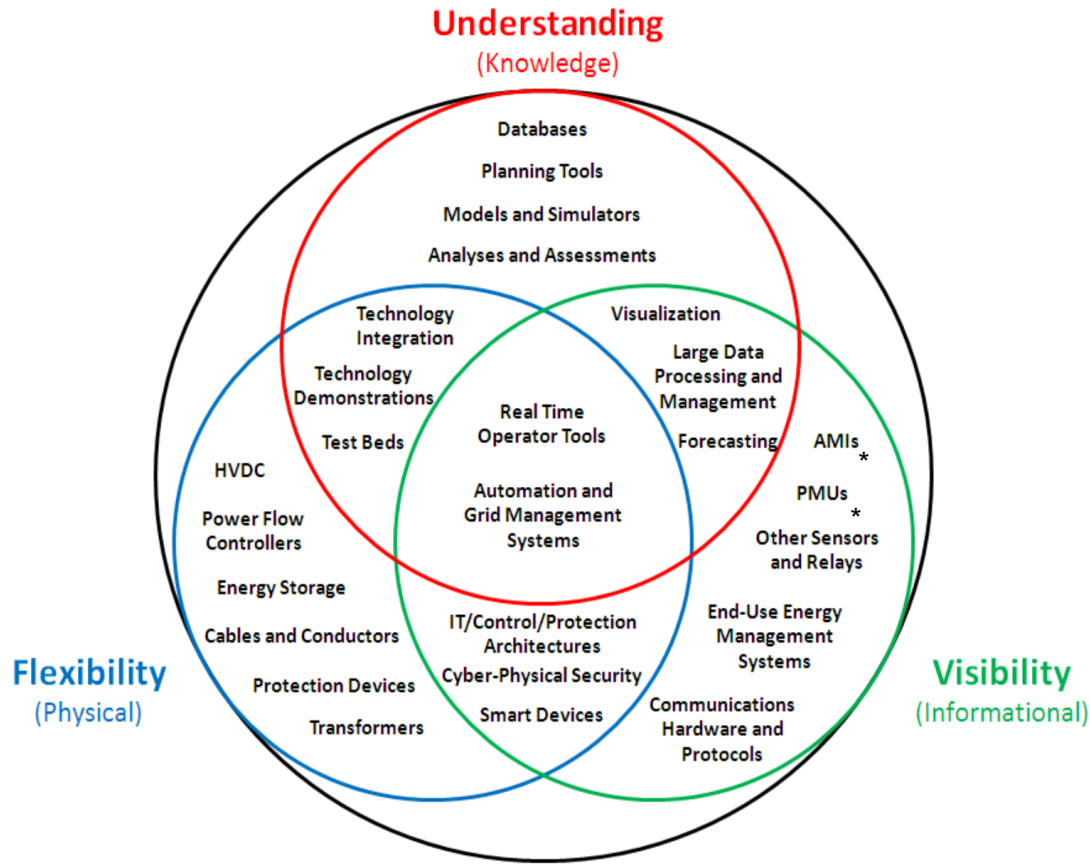
Alternative flexibility resources are already available today.

The big challenge is the dramatic increase in the potential number of resource suppliers.

Data Evolution Scenario



The electrical system is witnessing an exponential growth of available data to be managed



Source: DOE

Simultaneously integrating new technologies and granting a safe, resilient and economic system will be the greatest challenge for grid operators