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RSE Ricerca Sistema Energetico

The evolution of the Italian power system in 2030 to support more than 55% of renewables on electricity consumption

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Scenarios of the Italian government

In order to support the Italian government for the definition of the **National Energy Climate Plan (NECP)** two scenarios have been built by **RSE**:

1) Reference Scenario (BASE): describes a baseline evolution of the Italian energy system from a policy point of view.

2) Policy scenario (NECP) is an optimized scenario based on **these objectives**:

- **Renewable Energy Sources**: **30% RES share** on Gross Final Energy Consumption in 2030, more than **55% RES share in Electricity**
- **Energy Efficiency**: reduction of final energy consumption of 0.8% per year in the period 2021-30 according to the new EED Directive
- **Coal**: complete phase-out of coal in power generation from 2025

RSE Ricerca Sistema Energetico

Presidenza del Consiglio dei Ministri

Ministero dello Sviluppo Economico

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

Power generation mix in 2030 (TWh)

Source	Statistic Data	"BASE" Scenario	"NECP" Scenario
	2017	2030	2030
Natural Gas	143	142	118
Coal	33	34	0
Oil and others	16	7	7
RES	104	132	187
Photovoltaic	24	34	72
Concentrated Solar Power	-	0.7	3
Onshore wind	18	25	37
Offshore wind	-	0.3	3
Geothermal	6	7	7
Hydroelectric	36	51	49
Bioenergies	19	14	16
Total production	296	314	312
Net Import	37.8	28.5	28.5
Gross Domestic Consumption of electricity (GDC-E)	332	341	338
% RES-E/Total Production	35%	42%	60%
% RES-E/GDC-E	31%	39%	55.4%

Analysis of the impact of the «NECP» scenario on the power system

- High RES development mainly due to **intermittent (non-programmable) renewable sources**, which today have dispatching priority. **Reduction of dispatchable generation plants**, the only ones currently able to provide the reserve and balancing services essential to ensure a secure operation of the system.

- **Power systems** are characterized by many **complex technical constraints** that have significant implications and are only partially represented in long-term energy system models (e.g. network transport constraints, flexibility of generation plants, etc.)

- The **development of network infrastructures** requires **large investments and long implementation times**: it is necessary to "anticipate" future needs during the planning phase and to carry out an accurate cost-benefit analysis

- *New technologies database*
- *Generation development potentials*

Long term energy system model (TIMES)

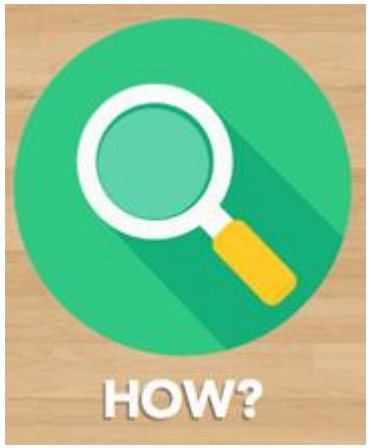
Power generation

Electricity demand

- *Fuel and CO_2 prices*

Power system simulator (sMTSIM)

Hourly dispatching, fuel consumption, CO_2 emissions, electricity prices, etc.



- *Detailed power plant technical characteristics and operating constraints*
- *Network constraints*
- *Bidding strategies*

Results: Market simulations

Electricity Balance	Unit	BASE	NECP	Delta
Thermoelectric production	TWh	148.6	97.8	-50.8
Pumped storage (consumption)	TWh	0.3	5.5	+5.2
Overgeneration	TWh	<0.05	3.7	+3.7
CO_2 emissions	$MtCO_2$	-	-	-35.5

Results: Power system simulations

Electricity Balance	Unit	NECP	NECP_RSV
Thermoelectric production	TWh	97.8	109.0
Pumped storage (consumption)	TWh	5.5	9.2
Overgeneration	TWh	3.7	10.8
Reserve Not Available	TWh	0	0.1
CO_2 emissions	$MtCO_2$	-	-

- Market analisys
- Identification of criticalities

In NECP_RSV" simulation, the reserve constraints (RSV), calculated with a specific algorithm, are added to have a simulation closer to the actual operation of the power system

Need for new electricity infrastructures…

In the "BASE" scenario there is already the need to develop electricity transmission and distribution networks capacity in 2030, according to 2017 TSOs plans.

Reaching NECP target will require additional investments:

- Further **development of the Transmission Network** (+1000 MW* - compared to 2017 TSO development plan) to reduce the power flow limitations from South to North.
- Interventions for the development of **distribution networks** (also with a view to Smart Grid) concerning new primary and secondary stations, new MV and LV lines, measurement systems, remote control, etc…
- New **storage capacity** by means of pumping plants and electrochemical systems in central-southern and island regions.

Investments (billion €)	Cumulated investement in the BASE scenario (2017-2030)	Additional investment In the NECP scenario (2017-2030)
Transmission Network development	8.5*	+ 2.0*
Distribution networks development	21.4	+ 4.3
New storage systems	-	+ 10

* Other network interventions are still under evaluation

Focus on new storage solutions (1)

Storage solutions are very effective in reducing overgeneration and providing greater reserve availability.

In our analysis we considered:

- new **hydroelectric pumping** plants (pSTG): with a capacity/power ratio of 10 hours, which also contribute to the reserve supply, in particular the tertiary reserve (RR);

- **electrochemical storage** systems (eSTG): with capacity/power ratio = 8 hours, exercises at 60% of capacity (in order to leave a guaranteed margin for reserve services) operating on the network and located in areas with greater overgeneration (mainly South, Sicily and Sardinia); they also contribute to the secondary reserve (aFRR).

Results of the analysis

Need of **6 GW** of new storage systems in Southern Italy
Two different configurations were analysed:
“NECP_RSV_A”: 1,5 GW of eSTG and 4,5 GW of pSTG
“NECP_RSV_B”: 3 GW of eSTG and 3 GW of pSTG

Focus on new storage solutions (2)

For the **potential and the location** of new pumping plants, the results of a **working group on storage**, established in 2018 by the **Italian Ministry of Economic Development** and which saw the collaboration between **RSE and TERNA**, were used.

The study allowed the identification of 5.8 GW of new pumping plants on lake basins and about 0.9 GW of new marine pumping systems in the southern regions of Italy for a total new pumping power of about 6.7 GW.

Type	Market zones	Pumping Power (GW)
Marine	South	0.50
	Sardinia	0.25
	Sicily	0.15
	Total	**0.9**
Lake	Center-South	0.4
	South	2.8
	Sardinia	1.8
	Sicily	0.8
	Total	**5.8**

…but infrastructures are not enough

Future power systems with high share of variable renewables require the involvement of new resources for the provision of reserve services, traditionally provided by dispatchable thermoelectric groups.

These **regulatory interventions** were explored by the possible **participation in the services markets** both of **demand side resources** (in particular for electric vehicles) and **supply side resources** (the participation of RES plants in the ancillary services market - MSD).

MSD: Mercato Servizi Dispacciamento, i.e. Dispatching Services Market.

Results: simulations without and with interventions

Electricity BALANCE

Electricity Balance	Unit	NECP_RSV	NECP_RSV_A	NECP_RSV_B
Thermoelectric production	TWh	109.0	96.3	96.3
Pumped storage (consumption)	TWh	9.2	11.1	11.0
Overgeneration	TWh	10.8	1.2	1.2
Reserve Not Available	TWh	0.1	<0.05	<0.05

About 1 TWh is limit value of the residual overgeneration to guarantee the respect of the % of RES share in the scenario.

Day-ahead market PRICES (€/MWh)

	BASE	NECP	NECP_A	NECP_B
PUN	74.9	65.8	68.9	68.7
NO	75.8	69.3	69.6	69.5
CN	73.7	59.7	66.1	65.8
CS	72.4	59.3	66.2	65.9
SU	72.3	58.7	65.0	64.7
SI	72.8	58.2	65.0	64.7
SA	71.8	58.3	65.7	65.2

in addition to the reduction of overgeneration, other expected benefits are the reduction of the zonal price spread between the north and southern areas and the reduction of thermoelectric production.

Conclusions

- **Significant critical issues**, such as overgenerations, congestions and lack of reserve margins.
- **Identification of solutions** (either technological and regulatory) and quantification of investments required.
- **Large investments in new infrastructures, especially for TSO and DSOs** -> increase of remuneration in the electricity bill will partially counteract the reduction of the day-ahead market price determined by the large share of production from renewable sources.
- Is necessary to **rethink the rules of the electricity markets** to allow, for example, the participation of renewables in the ancillary services market and to **encourage operators to invest in new storage systems.**

Thank you for your attention!

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