# The Italian power system: evolution towards the targets of the National Renewable Energy Action Plan and over

Authors: Fabio Lanati, Alberto Gelmini, Michele Benini, Santi Vitale
Company: RSE S.p.A (Ricerca sul Sistema Energetico)
Power System Development Department
*Power System Scenarios and Energy Efficiency Research Group*

Event: IEA-ETSAP Workshop
Location: Stanford University, July 9, 2011



## Objective

This study has been carried out to analyze four different development scenarios of the Italian power system up to 2030, achieving in 2020 the RES-E target foreseen by the National Renewable Energy Action Plan (NREAP).

How the selection of different technology options would impact the dependency on fossil fuels and $CO_2$ emissions of the Italian power system?

## Agenda

- The motivation

- The model “MATISSE”

- The scenario analysis



## Motivation

**EU Directive 2009/28**

$$\frac{\text{RES}}{\text{GDC}} = 20\%$$

**National Renewable Energy Action Plan**
**2020 Target**

$$\frac{\text{RES}}{\text{GDC}} = 17\%$$

What next?

## Scenarios

1. The "**Base**" scenario, refers to a projection of the Italian electricity demand and of RES-E production according to the targets set in the NREAP, while keeping the current set of generation technologies – Carbon Tax 43 $\$_{2008}$/t in 2020 and 54 $\$_{2008}$/t (WEO 2009 – "Reference scenario")
2. The "**CCS**" scenario integrates the "Base" one with the possibility to install coal-fired power plants equipped with Carbon Capture and Storage (CCS) technology;
3. The "**Nuclear**" scenario integrates the "Base" one with the possibility to install nuclear power plants;
4. The "**CCS&Nuclear**" scenario includes all the assumptions characterizing the previous three scenarios.



## National Renewable Energy Action Plan (NREAP)

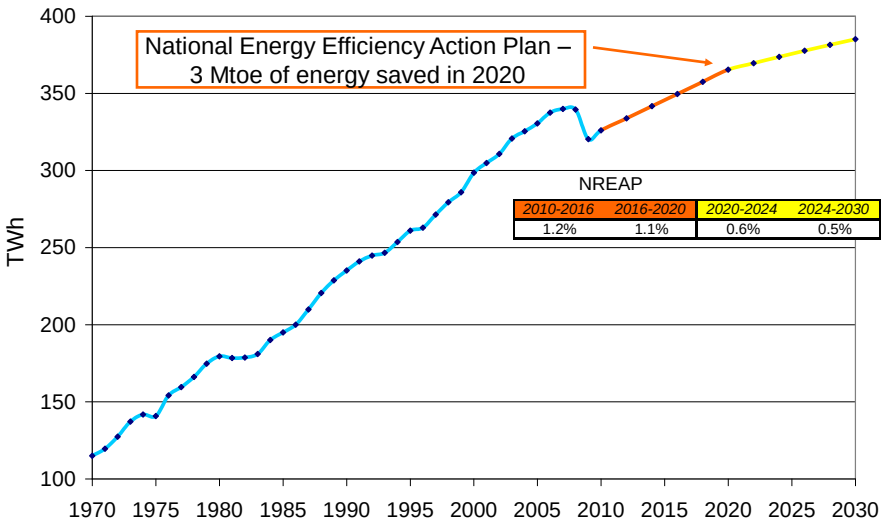
$$\frac{\text{RES}}{\text{GDC}} = 17\%$$

1 Step – Define Gross Domestic Consumption of Energy (**GDC**)

**National Efficiency Target**

**Evolution of energy demand:**
- **Heating and cooling**
- **Electricity**
- **Transport**

## Demand of electricity in Italy






## National Renewable Energy Action Plan (NREAP)

$$\frac{RES}{GDC} = 17\%$$

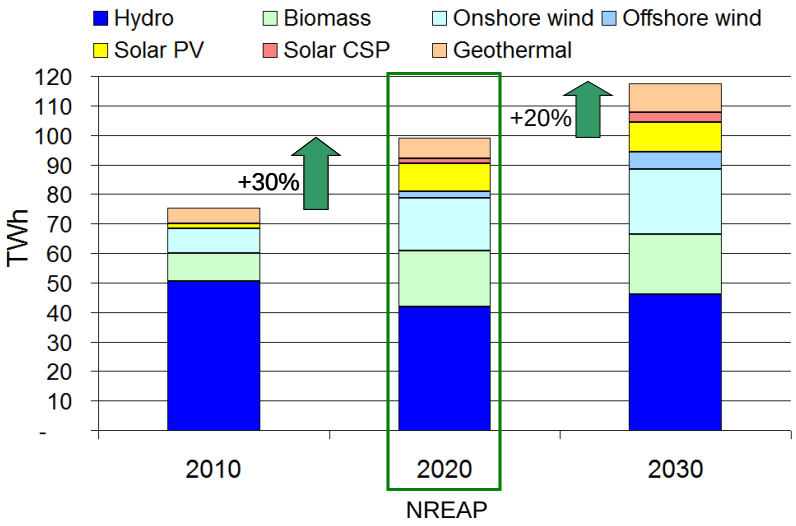
2 Step – Define RES Share (**RES**)

**National RES Target**

**Development of RES:**
- **RES-H**
- **RES-E**
- **RES-T**

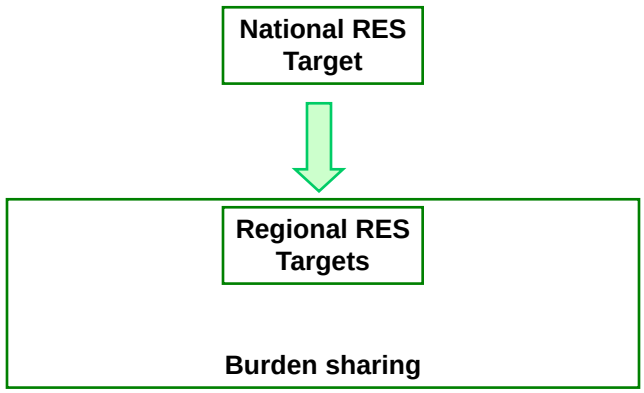
$$\frac{RES\text{-}E}{GDC\text{-}E} = 26\%$$

## RES-E development potential





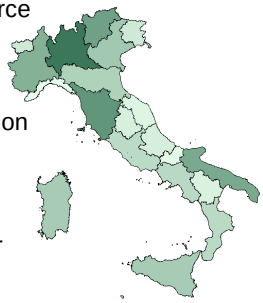

## National Renewable Energy Action Plan (NREAP)



## MATISSE

MATISSE is a multiregional (20 Italian regions) model (based on the Markal-TIMES model generator by ETSAP-IEA) of the Italian Power System for analyze developing scenarios over a long term time horizon

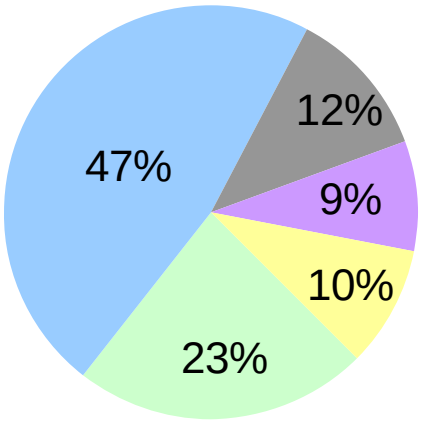
- Regional distribution of the **Renewable potential** by source and by type
- Regional detail for **Demand and Supply**;
  - ✓ geographical identification of the loads and generation plants;
- **Trades of energy** among the regions;
  - ✓ interconnection capacities among regions and intra-regional grids



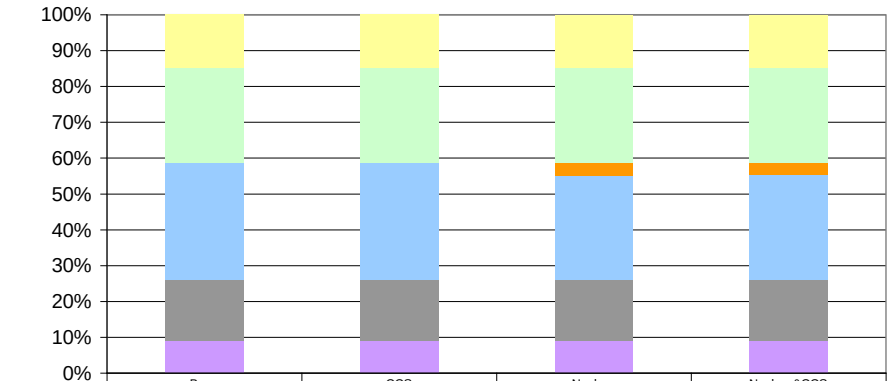


## Final consumption of electricity by source - 2010

| Source | TWh |
|---|---|
| RES | 75 |
| Natural Gas | 154 |
| Coal | 38 |
| Other | 28 |
| Import | 31 |



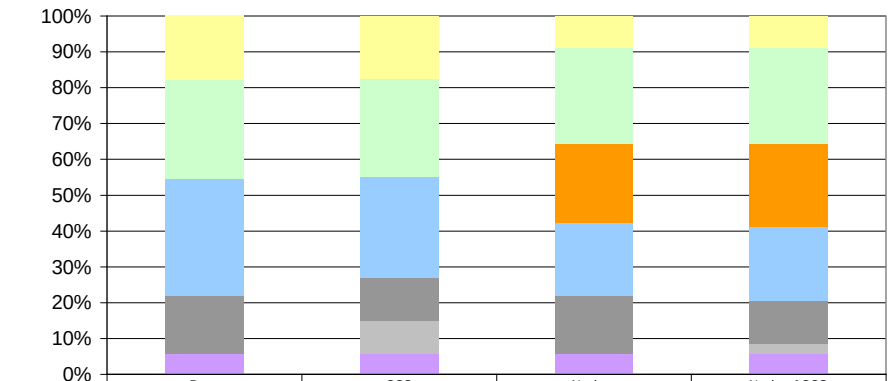
## Results
## Final consumption of electricity by source - 2020




| TWh | Base | CCS | Nuclear | Nuclear&CCS |
|---|---|---|---|---|
| Import | 54 | 54 | 54 | 54 |
| RES | 97 | 97 | 97 | 97 |
| Nuclear | 0 | 0 | 13 | 13 |
| Natural Gas | 119 | 119 | 107 | 107 |
| Coal | 62 | 62 | 62 | 62 |
| Coal with CCS | 0 | 0 | 0 | 0 |
| Other | 33 | 33 | 33 | 33 |

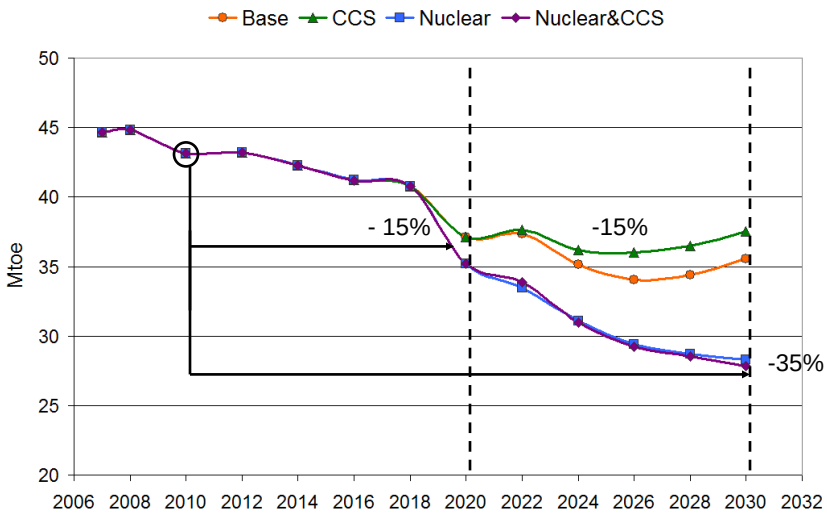


## Results
## Final consumption of electricity by source - 2030



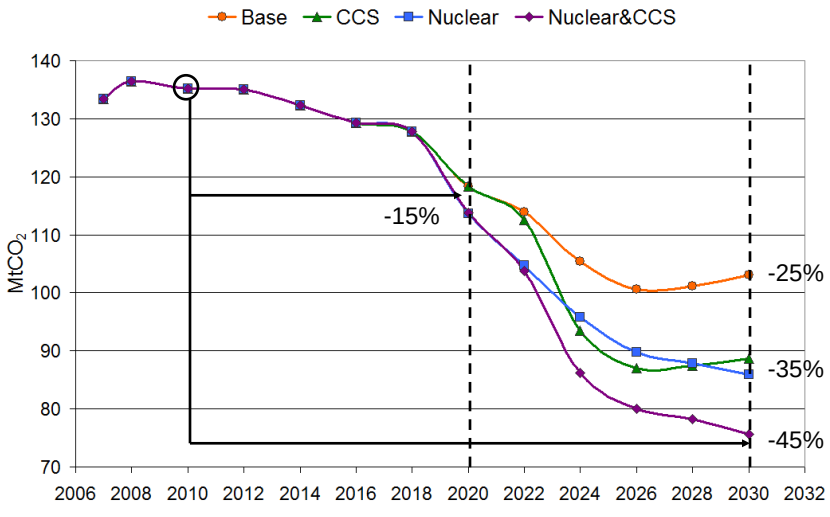

| TWh | Base | CCS | Nuclear | Nuclear&CCS |
|---|---|---|---|---|
| Import | 69 | 67 | 34 | 34 |
| RES | 106 | 106 | 104 | 103 |
| Nuclear | 0 | 0 | 84 | 89 |
| Natural Gas | 126 | 109 | 79 | 80 |
| Coal | 62 | 46 | 62 | 46 |
| Coal with CCS | 0 | 35 | 0 | 11 |
| Other | 22 | 22 | 22 | 22 |

## Results
## Fossil fuel consumption






## Results
## $CO_2$ emissions



## Conclusions

- ✓ The scenario analysis shows that a more balanced generation mix allows to decrease fossil fuel consumption and $CO_2$ emissions of the Italian power system;
- ✓ In particular the development of RES technologies is needful to respect the bindings EU targets and allows cutting in 2020 $CO_2$ emissions and fossil fuel consumption of the Italian power system by 15% with respect to the current levels (2010);
- ✓ However, RES generation, for the still high costs and the related necessity for subsidies, has to be considered as one of the options to be pursued together, such as increasing energy efficiency in end-uses, developing Carbon Capture and Storage technology, as well as nuclear energy.



## Conclusions

- ✓ The return to nuclear generation was in the plans of the Italian government because, despite some criticalities in relation to acceptability and sustainability (doubts about long-term waste management solutions), it would helped to reduce dependency on fossil fuels and $CO_2$ emissions;
- ✓ CCS can be a promising technology option for the sustainability, even if it is still in its infancy (at the moment is too expensive and not economically sustainable for a large scale integration). Moreover, coal is widely available all over the world, even in politically stable countries, and it is characterized by significantly lower costs than natural gas.

## Conclusions

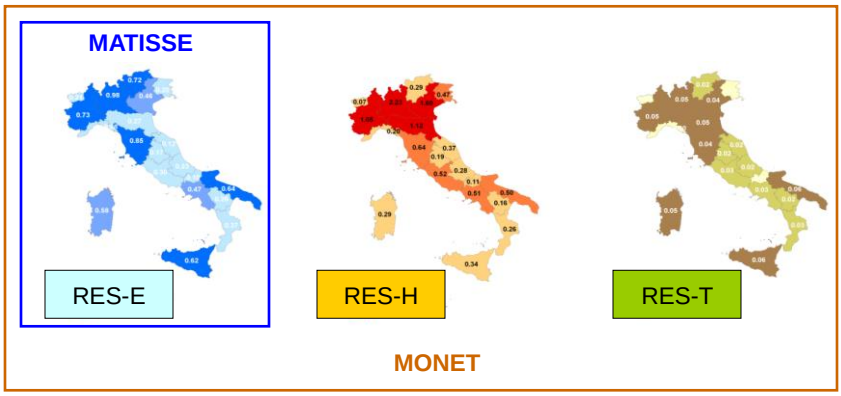
- ✓ However, after Fukushima's accident, the success of the referendum of June 2011 has stopped the plan of a return to the production of nuclear energy in Italy.

- ✓ CCS can be a promising technology option for the sustainability, even if it is still in its infancy (at the moment is too expensive and not economically sustainable for a large scale integration). Moreover, coal is widely available all over the world, even in politically stable countries, and it is characterized by significantly lower costs than natural gas.



## Next steps

- ✓ Complete the multiregional energetic model **MONET**
- ✓ Provide scenario analysis for local and national decision makers in order to evaluate the effectiveness, in the medium-long term, of local policies for all the energy sectors

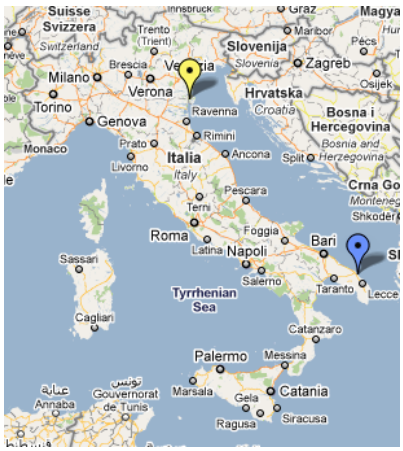


# Thank you for your attention!

Fabio Lanati
fabio.lanati@rse-web.it
R.S.E. S.p.A.
Power System Development Department
Power System Scenarios and Energy Efficiency Research Group
Milan, Italy



## CCS projects in Italy




**Largescale Power Plant CCS Project**


**Pilot CCS Project**

## Fuel and $CO_2$ prices

- Fossil fuel prices in Italy for the period taken into account have been calculated as **indexed** to crude oil and coal prices of the **WEO 2009 "reference" scenario** (World Energy Outlook 2009) by IEA (International Energy Agency);
- The assumed **nuclear** fuel prices are the ones corresponding to the historic peak occurred in July 2007 ($ 135 / lb $U_3O_8$);
- **$CO_2$ emission** allowance prices are the same as in the WEO 2009 "reference" scenario.

| | 2020 | 2030 |
|---|---|---|
| Crude Oil [$$_{2008}$/bbl] WEO 2009 | 100 | 115 |
| Coal [$$_{2008}$/t] WEO 2009 | 104.2 | 109.4 |
| Gas [€$_{2008}$/GJ] Italy | 10.9 | 12.4 |
| Coal [€$_{2008}$/GJ] Italy | 3.1 | 3.2 |
| Fuel oil [€$_{2008}$/GJ] Italy | 9.5 | 10.9 |
| Nuclear [€$_{2008}$/GJ] | 0.8 | 0.8 |
| $CO_2$ [€$_{2008}$/t] | 29.3 | 36.7 |