A power generation scenario with the MATISSE model for Italy and how to move from MATISSE to MONET

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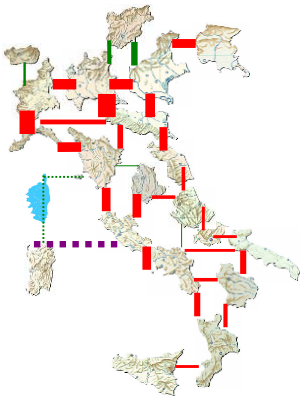
The MATISSE model

Multi-regional *electricity* model: 20 Italian Regions

Regional detail for Demand and Supply;

- Geographical identification of the loads and power plants (about 350 power plants);
- Regional distribution of the Renewable potential by source and by type
- Interconnection capacities between regions and intra-regional grid
- Only electricity demand split by energy service demand with an exogenous competition between electricity and fossil fuels (e.g. heating demand)
- Exogenous Combined heat and power penetration



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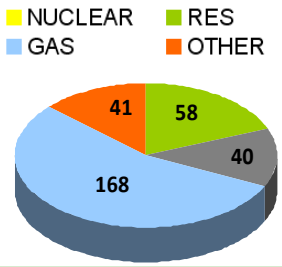
Nuclear power scenario with MATISSE for Italy

Objective of the study

- Analyse the impact of a "**return**" to **Nuclear generation** in CO2 emissions and fossil fuel consumption for the Italian electricity system;
- The economic implications (***Competitiveness***).

The Italian generation portfolio in 2008 (TWh)



Total production 2008: 307 TWh of which

- Nuclear 0%
- RES 20%
- Fossil 80%

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Nuclear in Italy

In the mid-sixties of the past century Italy was the **third** country in the world for nuclear power production, after the USA and Great Britain

↓

Four operative plants and others ambitious National Energy Plans that never started

↓

Three Mile Island, March 28th, 1979
Chernobyl, April 26th, 1986

↓

Referendum, November 1987

↓

Shut down all the operating plants

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A challenging energy policy

The **medium-long term** target of the Italian government, in terms of electricity energy production, can be summarized with the slogan *"25-25-50"*, i.e. **25% nuclear**, **25% renewable** and **50% fossil fuel** production (in 2008 it was 0-20-80).

As for nuclear plants, the first objective is to build about 10 GW, that could reasonably and progressively go in operation starting from 2020 (the rather optimistic target is to start construction of the first unit in 2013).

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Scenarios

1. The "**Base**" scenario is the reference for building alternative scenarios and refers to a projection of the evolution of the Italian electricity demand and supply system according to "business as usual" trends including CO_2 reduction targets for 2020 and 2030 .

2. The "**Nuclear**" scenario, integrates the "Base" scenario with the possibility to install up to 7 EPR nuclear plants with a size of 1600 MW each;

Scenario assumptions Fuels & CO_2

- 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

Nuclear assumptions

EPR nuclear plant in MATISSE		
Size	1600	MWe
Efficiency	35%	MWe/MWt
Average Burnup	60	GWd/t
Technical life	40	years
Overnight cost	2.9	M€/MWe
Construction time	6	years
Decommissioning cost	0.8	M€/MWe
Operation & Maintenance	55	€/kW/y
Insurance	13	€/kW/y
Financial parameters	50 % equity @ 12 %/y 50% debt 15 years @ 7%/y	

LEC: Levelized Electricity Cost

NUCLEAR$_{2020}$
LEC 79 €/MWh

CCGT$_{2020}$
LEC 89 €/MWh
CO_2 13 €/MWh
TOT 102 €/MWh

USC COAL$_{2020}$
LEC 47 €/MWh
CO_2 28 €/MWh
TOT 75 €/MWh

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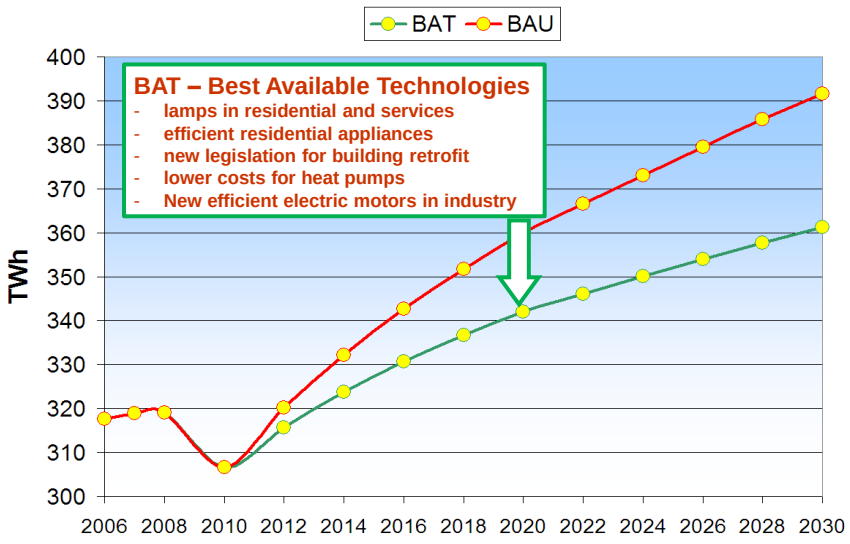
Electricity demand



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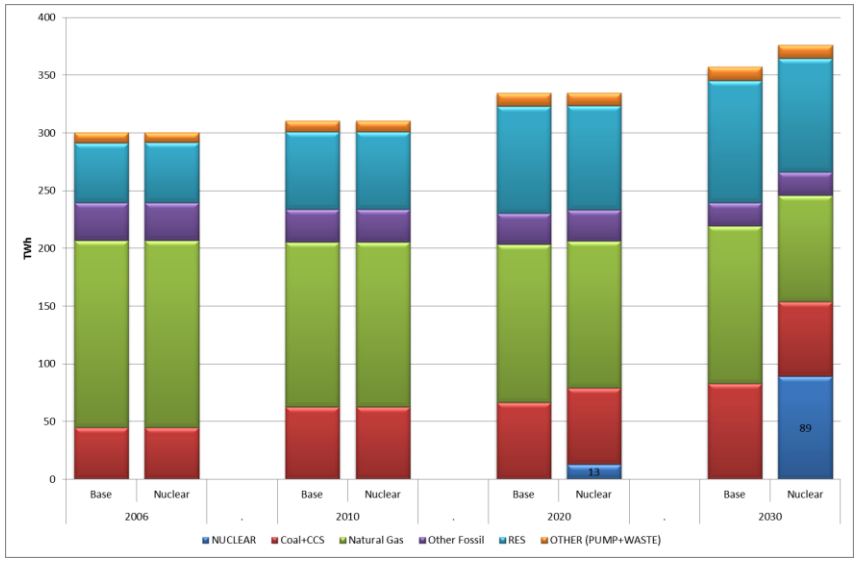
Results
Italian Generation Portfolio



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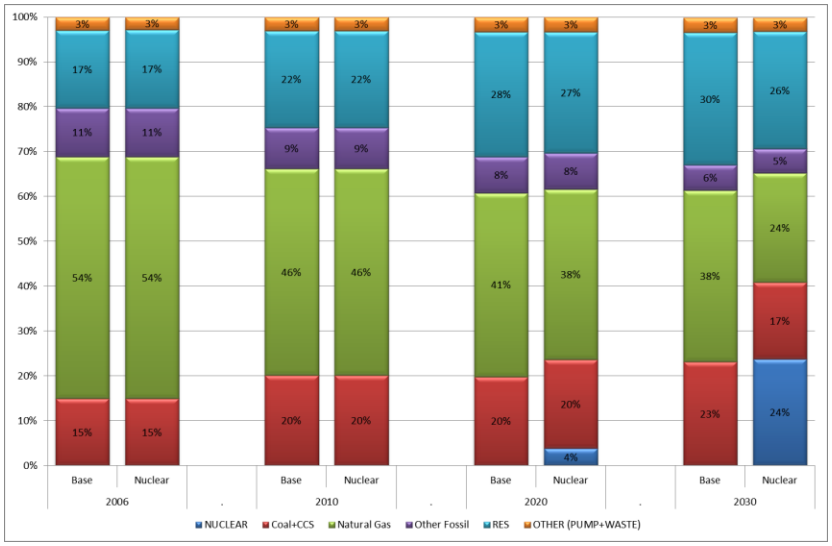
Results
Italian Generation Portfolio [%]



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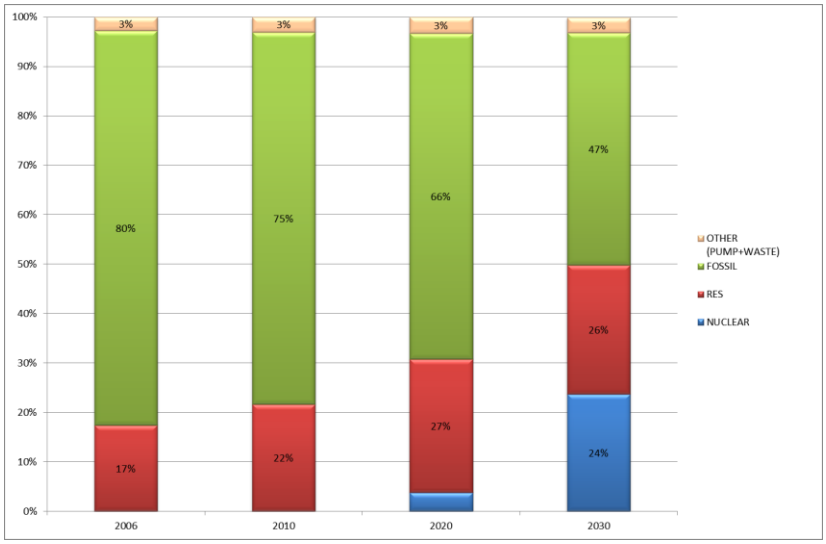
Results
Italian Generation Portfolio [%]



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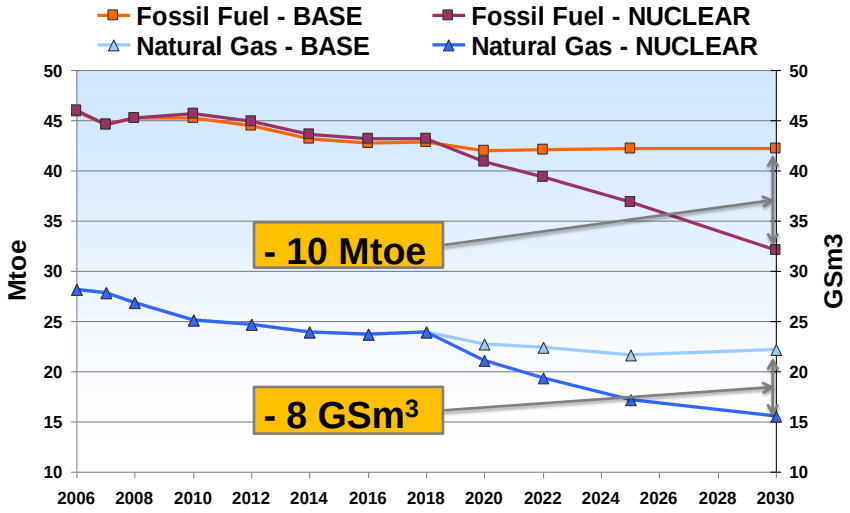
Results
Fossil fuels consumption



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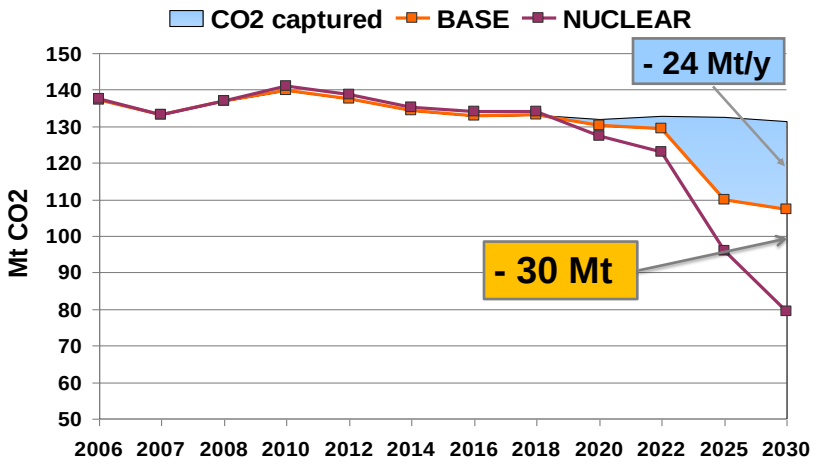
Results
CO_2 emissions



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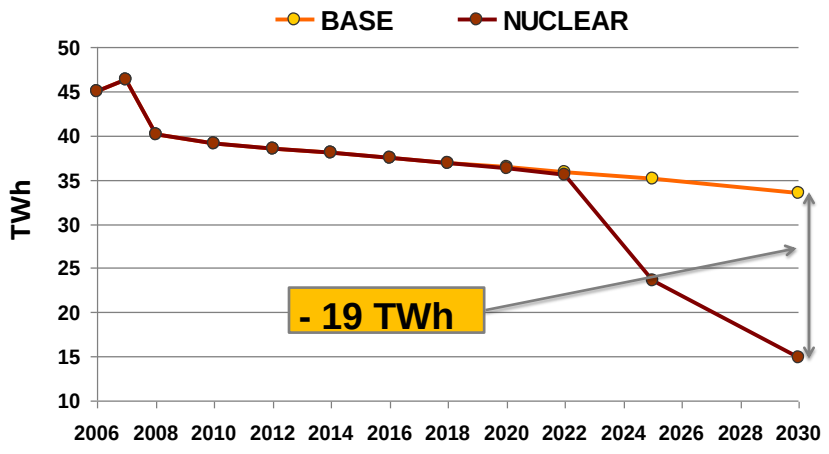
Results
Import-Export



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Conclusion (1/2)

The results of the scenario analysis show that the introduction of nuclear power plants in the **Italian electricity system** allows to:

1. **diversify the supply sources**;
2. **produce energy at a lower cost** than the one generated by fossil fuelled and RES plants
3. **significantly reduce emissions** of greenhouse gases

		2020	2022	2025	2030
€/MWh	BASE	70	71	69	70
	NUCLEAR	69	70	68	69
toe/GWh	BASE	126	124	122	118
	NUCLEAR	122	116	103	85
gCO2/kWh	BASE	389	381	318	300
	NUCLEAR	381	362	268	211

Lower cost reduction due to the "pessimistic" assumptions concerning the nuclear costs

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Conclusion (2/2)

- **NUCLEAR** is **just one** of many options to be pursued together (development of renewable sources, increase of energy efficiency in end-uses, carbon capture and storage) and it must not be considered as an alternative;
- The achievement of a so **high share (25%)** of nuclear generation inevitably implies significant changes in the balance of the Italian power system, i.e. a reduction of net imports from abroad and a dramatic reduction of investments in new large fossil fuelled power plants;
- Moreover, if policies to reduce demand by **increasing energy efficiency** in end-uses are successful, it will be difficult to sustain a so ambitious level of development of renewable sources and nuclear in the electricity sector.
- From MATISSE (electricity sector) to MONET (energy sector) to analyse the Italian regional energy system and the impact at the regional level.

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From MATISSE to MONET

1. Italian Regions written down the “Regional Environmental and Energy Plan” where the targets of energy efficiency and production from renewable energies are be analysed. The next step is to review and updates the plans including scenario analysis.

3. The main purpose of MONET is to provide scenario analysis for local and national decision makers in order to evaluate the effectiveness, in the medium-long term, of local policies.

4. The MONET model is under construction and first working version should available around the middle of 2011.

The MONET model

Multi-regional Energy model : 20 Italian Regions

Regional detail for Energy Service Demand and Supply;

- Geographical identification of the loads and power as in MATISSE;
- Description of the whole Reference Energy System for each of the 20 regions
- Regional distribution of the Renewable potential by source and by type
- Interconnection capacities between regions and intra-regional grid
- Existing and new buildings in the Residential sector characterized with different energy consumption by building and by region
- Exogenous Combined heat and power penetration

Multi-regional Electricity Model

Multi-regional Energy Model

The MONET model Industry

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CommName	*CommDesc	Timeslice	Attribute	*Unit	ABR	BAS	CAL	CAM	EMR	FVZ	LAZ	LIG	LOM	MAR	MOL	PIE	PUG	SAR	SIC	TAA	TOS	UMB	VDA	VEN
*Nome vettore di Domanda	Descrizione della Domanda	Gestione timeslice	Dichiarazione attributi	Unità di misura	Regions																			
DINMET	Domanda regionale Industria Metallurgia		Demand	ME		612					300		12944			2086							459	4550
DINMET	Domanda regionale Industria Metallurgia	SP	COM_FR			0.24					0.24		0.24			0.24							0.24	0.24
DINMET	Domanda regionale Industria Metallurgia	SU	COM_FR			0.23					0.23		0.23			0.23							0.23	0.23
DINMET	Domanda regionale Industria Metallurgia	FA	COM_FR			0.24					0.24		0.24			0.24							0.24	0.24
DINMET	Domanda regionale Industria Metallurgia	WI	COM_FR			0.29					0.29		0.29			0.29							0.29	0.29
DINMEC	Domanda regionale Industria Meccanica		Demand	ME		936					1854		20637			10995							34	8178
DINMEC	Domanda regionale Industria Meccanica	SP	COM_FR			0.24					0.24		0.24			0.24							0.24	0.24
DINMEC	Domanda regionale Industria Meccanica	SU	COM_FR			0.23					0.23		0.23			0.23							0.23	0.23
DINMEC	Domanda regionale Industria Meccanica	FA	COM_FR			0.24					0.24		0.24			0.24							0.24	0.24
DINMEC	Domanda regionale Industria Meccanica	WI	COM_FR			0.29					0.29		0.29			0.29							0.29	0.29
DINAGR	Domanda regionale Industria Agroalimentare		Demand	ME		277					918		3732			2550							59	2770
DINAGR	Domanda regionale Industria Agroalimentare	SP	COM_FR			0.18					0.18		0.18			0.18							0.18	0.18
DINAGR	Domanda regionale Industria Agroalimentare	SU	COM_FR			0.27					0.27		0.27			0.27							0.27	0.27
DINAGR	Domanda regionale Industria Agroalimentare	FA	COM_FR			0.29					0.29		0.29			0.29							0.29	0.29
DINAGR	Domanda regionale Industria Agroalimentare	WI	COM_FR			0.26					0.26		0.26			0.26							0.26	0.26
DINTAB	Domanda regionale Industria Tessile e abbigliamento		Demand	ME		214					308		8893			3265							2	3318
DINTAB	Domanda regionale Industria Tessile e abbigliamento	SP	COM_FR			0.23					0.23		0.23			0.23							0.23	0.23
DINTAB	Domanda regionale Industria Tessile e abbigliamento	SU	COM_FR			0.21					0.21		0.21			0.21							0.21	0.21
DINTAB	Domanda regionale Industria Tessile e abbigliamento	FA	COM_FR			0.23					0.23		0.23			0.23							0.23	0.23
DINTAB	Domanda regionale Industria Tessile e abbigliamento	WI	COM_FR			0.32					0.32		0.32			0.32							0.32	0.32

Tecnologie di domanda per il settore industriale

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*Nome Tecnologia	TechName	*TechDesc	Comm-IN	Comm-OUT	TimeSlice	Year	LimType	Other_Indexes	Attribute	*Unit	ABR	BAS	CAL	CAM	EMR	FVZ	LAZ	LIG	LOM	MAR	MOL	PIE	PUG	SAR	SIC	TAA	TOS	UMB	VDA	VEN
	*Nome tecnologia	Descrizione tecnologia	Nome vettore consumato	Nome vettore prodotto	Gestione timeslices	Gestione anni	Gestione vincoli	Indici aggiuntivi	Dichiarazione attributi	Unità di misura	Regions																			
IMETAPPCA01	IMETAPPCA01	Tecnologia calore INDMETAPP	INDAPP						Input	PJ		1.220					1.220		1.220			1.220							1.220	1.220
IMETAPPCA01				ICATMET					Output	PJ		1.000					1.000		1.000			1.000							1.000	1.000
IMETAPPCA01									Stock	GW		0.000					0.000		0.000			0.000							0.000	0.000
IMETAPPCA01									Life	Anni		25.000					25.000		25.000			25.000							25.000	25.000
IMETAPPCA01									Cap2Act	PJ/GW		31.536					31.536		31.536			31.536							31.536	31.536
IMETAPPCA01									AFA			0.750					0.750		0.750			0.750							0.750	0.750
IMETGNACA01	IMETGNACA01	Tecnologia calore INDMETGNA	INDGNA						Input	PJ		1.150					1.150		1.150			1.150							1.150	1.150
IMETGNACA01				ICATMET					Output	PJ		1.000					1.000		1.000			1.000							1.000	1.000
IMETGNACA01									Stock	GW		0.025					0.122		0.860			0.430							0.000	0.201
IMETGNACA01									Life	Anni		25.000					25.000		25.000			25.000							25.000	25.000
IMETGNACA01									Cap2Act	PJ/GW		31.536					31.536		31.536			31.536							31.536	31.536
IMETGNACA01									AFA			0.750					0.750		0.750			0.750							0.750	0.750
IDMET	IDMET	Tecnologia di domanda Industria metallurgica	IELMET				FX		Share			0.700					0.158		0.552			0.330							0.980	0.679
IDMET			ICATMET				FX		Share			0.300					0.842		0.448			0.670							0.020	0.321
IDMET				DINMET																										
IDMET						2007			EFF			290.355					83.824		229.046			136.816							406.209	286.525
IDMET						2050			EFF			290.355					83.824		229.046			136.816							406.209	286.525
IDMET									Life	Anni		50.000					50.000		50.000			50.000							50.000	50.000
IDMET									Cap2Act			1.000					1.000		1.000			1.000							1.000	1.000

Thank You!