SOGIN

THE DECOMMISSIONING PROGRAM IN ITALY: PAST, PRESENT AND FUTURE ACTIVITIES

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Contents

Our Sites have a long history

1934 Starting from the studies of **Enrico Fermi** and his team on nuclear physics, irradiating around 60 elements with neutrons, …

1946 Applied nuclear research in Italy was marked by the foundation of the ***Research and Experimentation Information Centre*** (CISE). Milan, November 19, 1946.

1951 **CISE** had achieved important results, building a pilot plant to make heavy water and creating an experimental uranium metallurgy.

E. Fermi in his physics lab, Rome, 1935

1952 The decree establishing the **National Committee for Nuclear Research** (CNRN, later CNEN and ENEA) was signed. Rome, June 26, 1952.

1957 The Treaty establishing the European Atomic Energy Community **(EURATOM)** was signed, Rome, March 25, 1957.
At the same time began the Italian participation in the project for the reprocessing of irradiated fuel elements, Eurochemic, Mol (B).

Reactors building

1955

Ispra: The research reactor CP-5 for the nuclear center was purchased by the US.

1958

Latina: A 210 MWe GCR-Magnox was constructed ('58 -'63) by ENI. Starting in May 1963, it has produced 26 TWh of electricity during its lifetime.

1959

Garigliano: A 160 MWe BWR was constructed ('59 -'63) by Società Elettronucleare Nazionale. Starting in April 1964, it has produced 12,5 GWh of electricity during its lifetime.

CP-5 construction, ISPRA 1956

1961

Trino: A 270 MWe PWR was constructed ('61 -'64) by a consortium of Italian enterprises. Starting in October 1964, it has produced 26 TWh of electricity during its lifetime.

1970

Caorso: A 860 MWe BWR was constructed ('70 –'77) by ENEL and Ansaldo Meccanica Nucleare. Starting in December 1981, it has produced 29 TWh of electricity during its lifetime.

Fuel Cycle Facilities

1962

OPEC (Casaccia-Rome): A facility for spent fuel post-irradiation testing was constructed ('62) by CNEN.

1965

EUREX (Saluggia-Vercelli): The Enriched URanium EXtraction pilot plant was constructed ('65 -'70) by CNEN, for MTR spent fuel reprocessing.

EUREX tanks, Saluggia 1966

1965

IPU (Casaccia-Rome): A research plant on manufacturing of fuel based on U and Pu was constructed (’65-’68) by CNEN.

1965

ITREC (Rotondella-Matera): A pilot plant for the reprocessing of spent fuel, based on U-Th, was constructed (’65 -’70) by CNEN.

1972

FN SpA (Bosco Marengo-Alessandria): The industrial plant for nuclear fuel fabrication was constructed (’72 -’74) by Agip Nucleare.

Other Old Nuclear Installations

1963

Galileo Galilei (Pisa): a small nuclear reactor used by the Navy for studies on marine and submarine propulsion.

Galileo Galilei Reactor
CISAM, Pisa

1970

Avogadro: a facility located in the municipality of Saluggia (Vercelli).
It was built in the late '70s in the building of a pool type reactor already decommissioned.
It is used by Sogin as temporary storage for irradiated fuel.

mean while

Throughout the country, **several other nuclear installations**, from laboratories to small research reactors, are in operation (Universities of Pavia and Palermo, ENEA Research Centre of Casaccia) or in decommissioning (University of Milano and ENEA Research Centre of Montecuccolino).

The mission of SOGIN

Sogin is a State-owned company, established following the final decision of Italy to phase out from nuclear power, consequently the referendum of 1987.

It was **created in 1999** by the nuclear division of the national electric company (ENEL), with the **duty to decommission** the old Italian nuclear plants, for environmental remediation of the sites and the **safe management of radioactive wastes**.

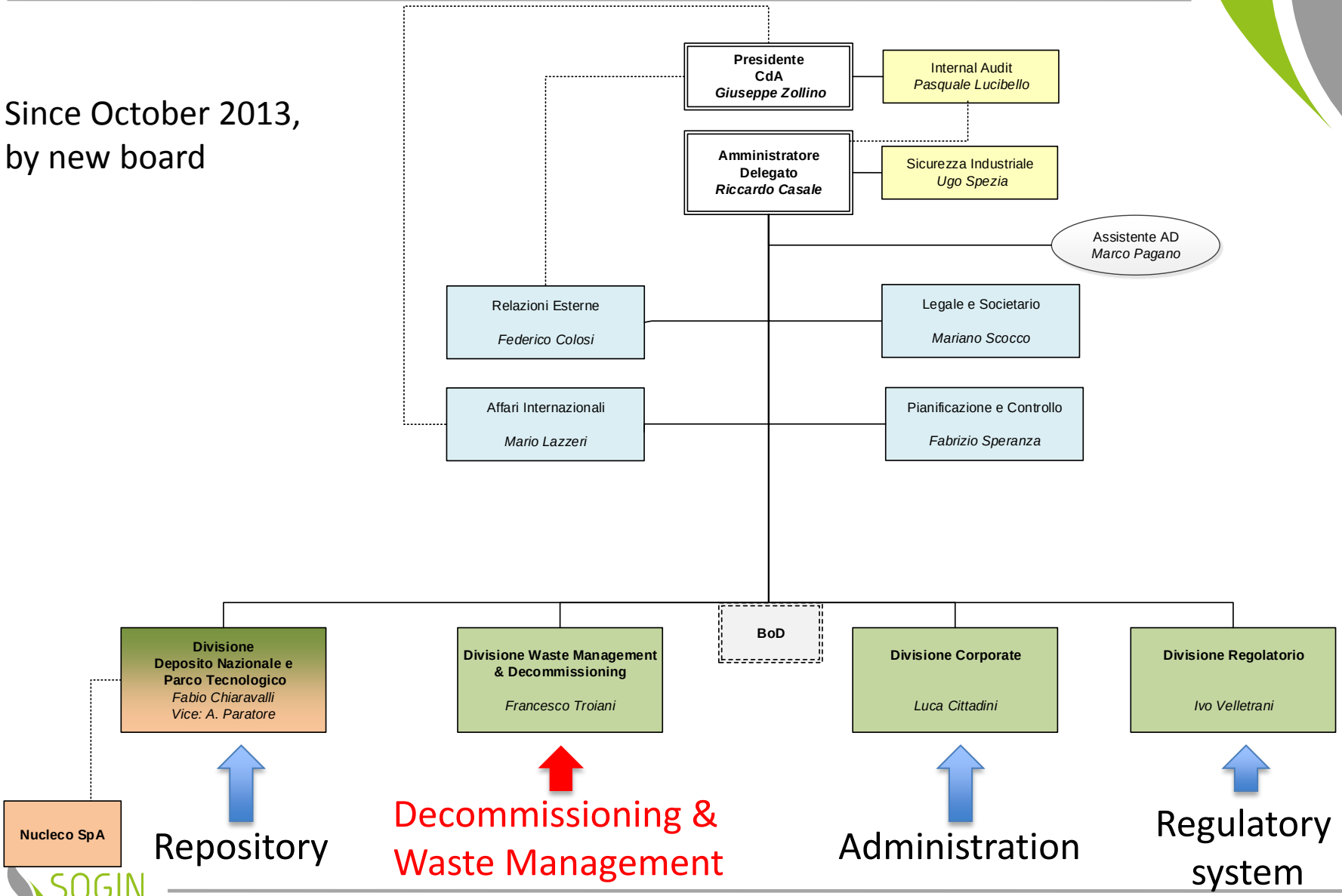
In 2003, Sogin **acquired by ENEA the fuel cycle facilities**, with the objective of their decommissioning.

Sogin, in 2004 acquired the majority stake in **Nucleco SpA** (60% Sogin, 40% ENEA). Nucleco is the national operator responsible for collecting, conditioning and interim storage of radioactive waste and disused sources, arising from nuclear medicine, research and industry.

Sogin has also been assigned the task of locating, building and operating a **Technology Park**, that will include the national **Radioactive Waste Repository**.

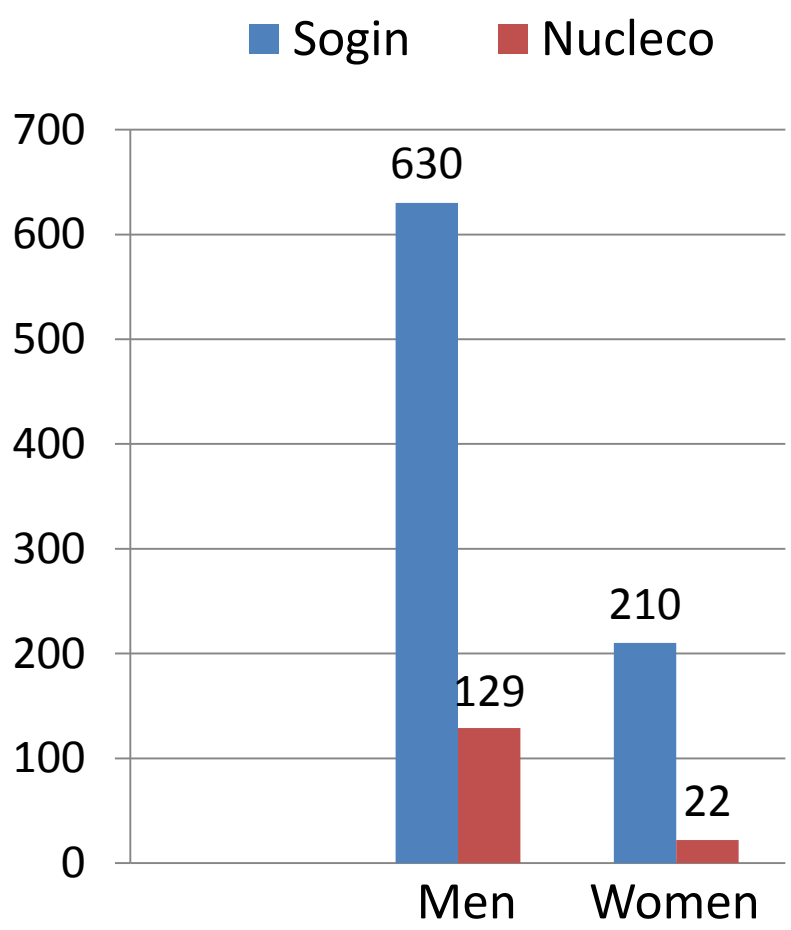
Sogin organisation chart

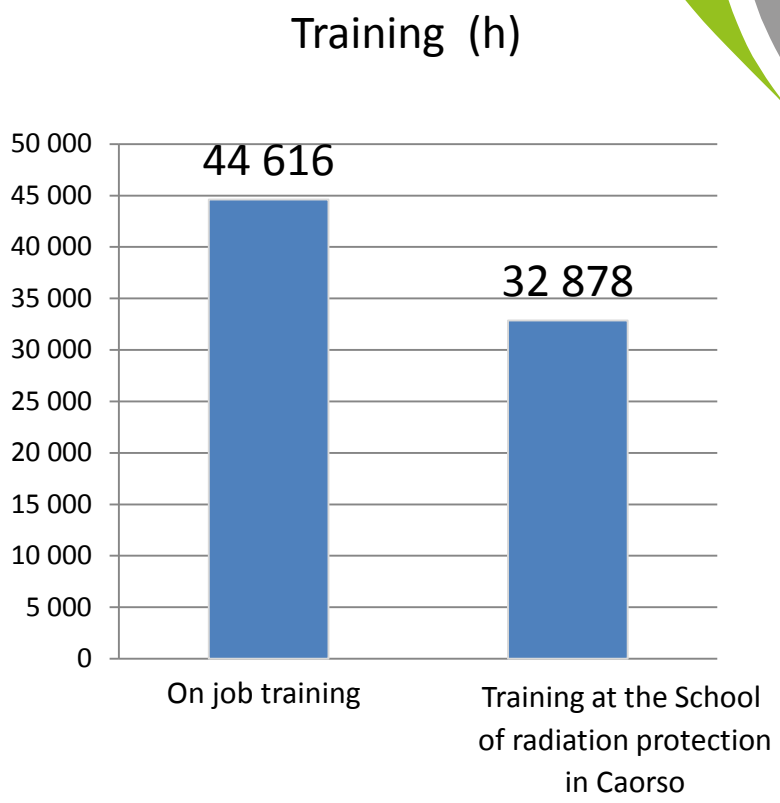
Since October 2013,
by new board



SOGIN

Human resources and training





Organisation criteria

Waste Management
Decommissioning Division

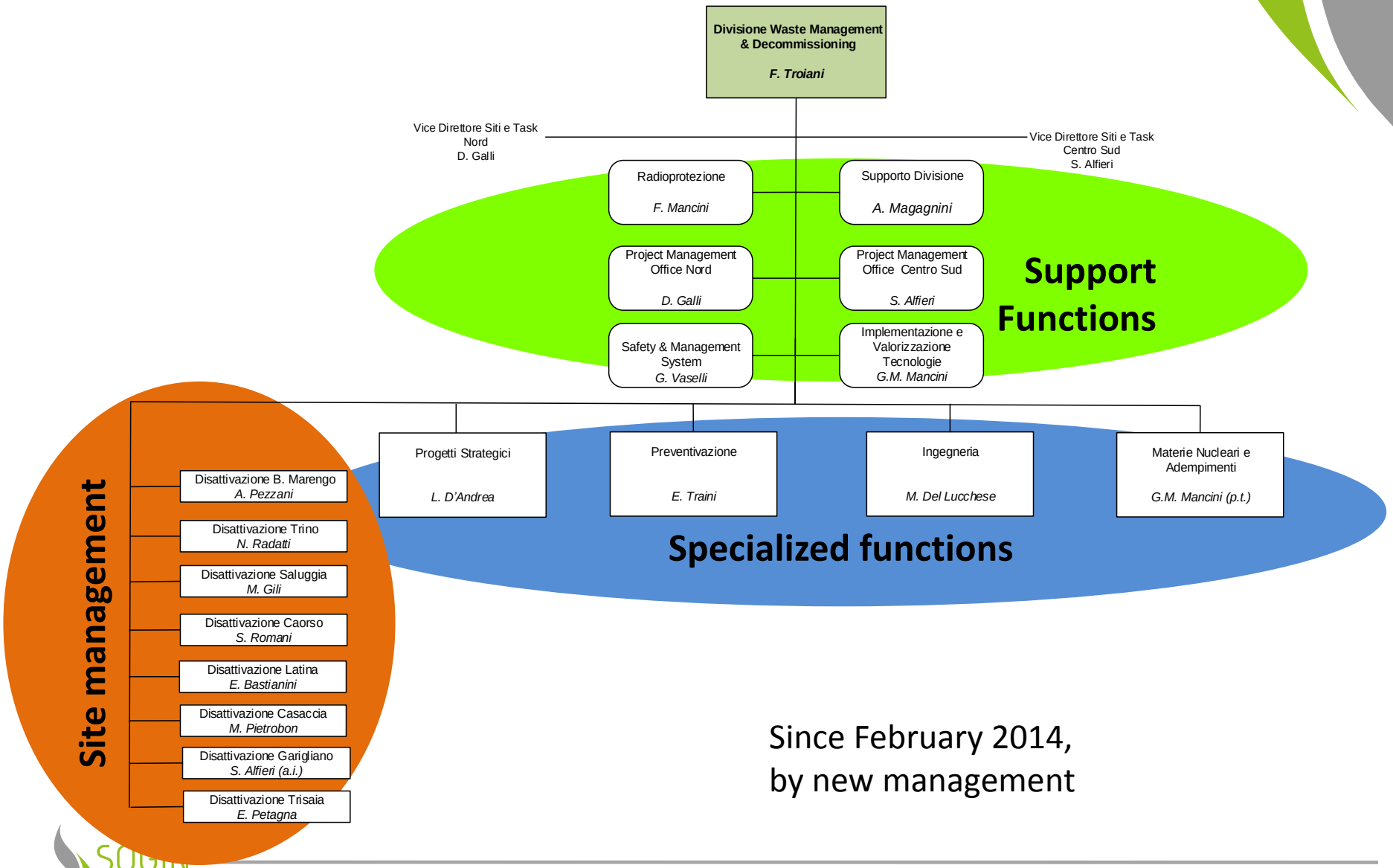
Site management

Support Functions

Project Management

Specialized functions

Waste Management Decommissioning Division



Since February 2014,
by new management

Planning and prioritization

Since its creation, Sogin has taken into account that:

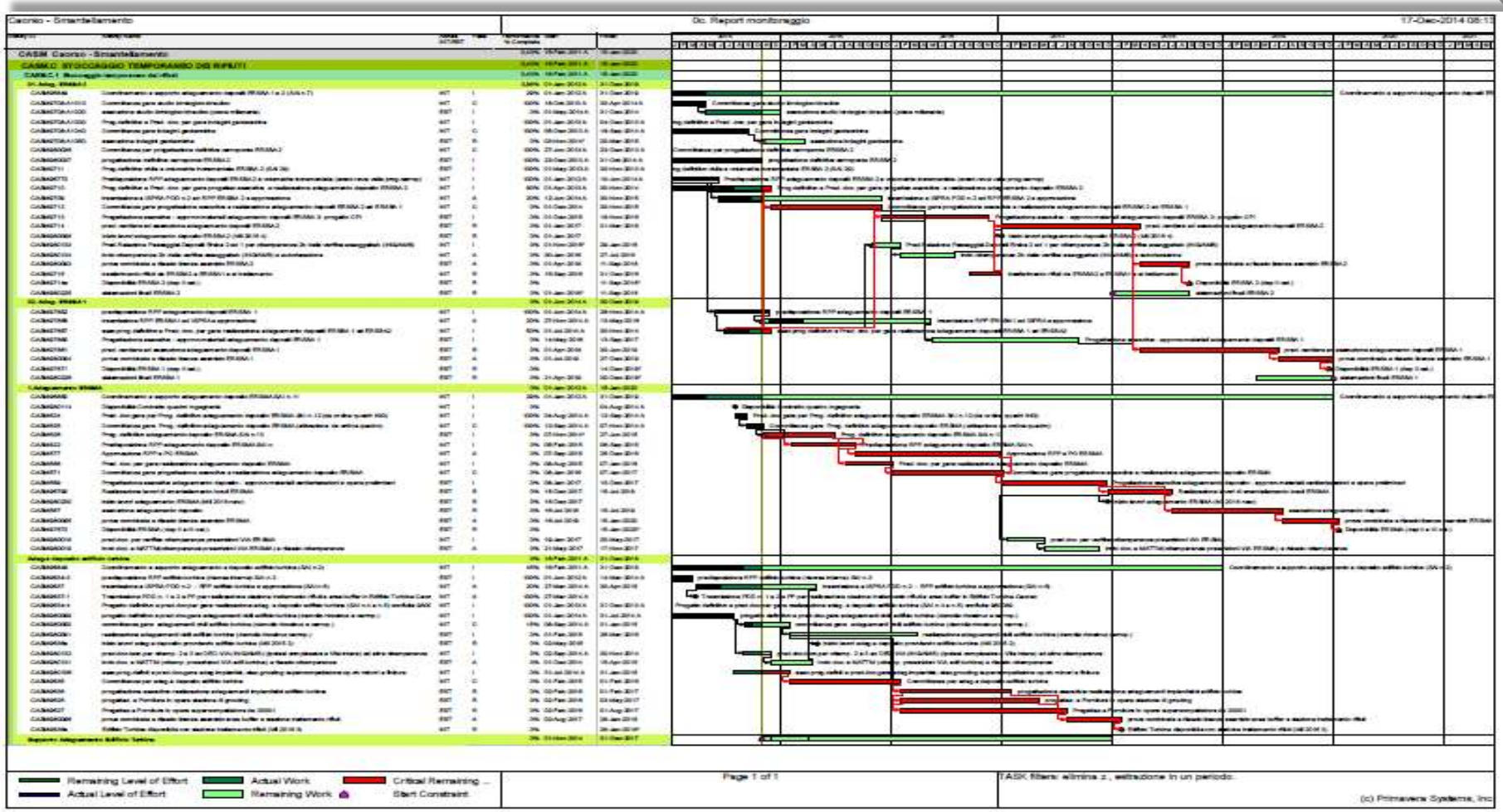
- NPP had been placed in **safe enclosure**, since the 1987 referendum;
- the nuclear **fuel had not been completely removed** from the storage pools;
- the operational **radioactive wastes were not completely conditioned**;
- **national repository** was still unavailable;
- the new government strategy was the **immediate decommissioning**;

developed **a comprehensive program** with the main aim to:

- Up-to-grade the **safety systems**;
- Conduct, **within the current licenses**, the most possible activities;
- Obtain ASAP the **decommissioning licenses** and other national and local permissions;
- Create a sufficient capacity for **waste interim storages**;
- Define a path for the **realization of a national repository**;
- **Optimize the programs** across all the 8 sites and a knowledge building project.

General planning and wbs

On these bases a complete **general plan (PTG)** and detailed **Work Breakdown Structures** for each site was established and relative costs were estimated.



Main achievements to date

In its first 15 years of activities Sogin:

1. Upgraded all the **security and safety systems**, and components needed for D&D, in order to pass from safe enclosure condition to decommissioning operations and after September 11, upgrading of security systems;

2. Submitted to the regulatory bodies the dossiers for the **authorization to the decommissioning,** assessment of the environmental compatibility, emergency management, and the organization during decommissioning phases.

3. Conducted, **within the current licenses** and/or on the basis of special ad-hoc authorizations:
   - the conditioning of the most quantity of the **operational waste** and prepared the construction of new plants for the treatment of the remaining effluent and solid wastes, to be completed within this decade;
   - the removal of **asbestos** from the auxiliary systems, completed;
   - The first **decontamination** of the various sections of the plants;
   - The dismantling of the **conventional structures**, the decontamination and dismantling of selected **weakly radioactive systems and components**.

… and

4. The **removal of the spent fuel**, almost completed.
   The uncertainty on the identification and realization of a national repository and on the annexed facility for the long-term storage of the spent fuel, made necessary to abandon **the strategy** of the dry storage of spent fuel and continue with the reprocessing already initiated in the past by the nuclear operators.

5. Built from scratch or refurbished old existing buildings in all sites for the **temporary storage of radioactive waste**, expanding the storage capacity until the national repository will come into operation (expected for 2024);

6. Prepared and submitted to the competent authorities the national map of areas suitable for hosting the **national repository** for the disposal of low and medium level wastes, and for the long-term storage of high level and long life wastes.
   In 2003, following a request of the government, Sogin proposed a site for the construction of a national repository (Scanzano Jonico), but following a strong contestation of the local people, the project was abandoned.
   A new path has been established by the Government Decree No. 31 of 2011.

Auxiliary activities

The programs have been **periodically revised** on the basis of the real situations of each site, the encountered problems and common needs.
This was an opportunity to optimize the programs of the various sites, exploit mutual solutions and transferring experience gained (**lesson learned**).

It was also made an accurate assessment of **radioactive waste inventory**, arising from the dismantling, their categorization, in compliance with Italian technical norms and the waste acceptance criteria of the planned repository, which today are estimated at **44 400 cubic meters for medium and low activity** and **10 400 cubic meters for high activity**.

A great effort has been made for the adaptation of programs and sites with **environmental legislation**, which in recent years has included nuclear installations, and thus becoming more and more accurate and precise.

In addition, at each site were established the discussion tables with the people living in that particular area and local authorities, so called "**Tables of transparency**".

Projected end of the decommissioning

According to the general plan for decommissioning and relative authorizations (obtained or requested), assuming the exercise of the national repository in 2024, the times of global decommissioning should be the following.

SITE	Approval of decommissioning application	Achieving brownfield site
Bosco Marengo	**2008**	2016 - 2017
Caorso	**2014**	2028 - 2032
Casaccia	*2018*	2023 - 2027
Garigliano	**2012**	2024 - 2028
Latina Phase 1	*2015*	2023 - 2027
Latina Phase 2	*2017*	2035 (?)
Saluggia	*2016*	2028 - 2032
Trino	**2012**	2026 - 2030
Trisaia	*2016*	2028 - 2032

Waste inventory

Inventory at 31.12.2013. Classification according to the technical guide n. 26

	Ist category	IInd category	IIIrd category	
Caorso	**18**	**2.464**	**0**	**2.482**
conditioned		558		558
not conditioned	18	1.906		1.924
Garigliano	**0**	**3.014**	**0**	**3.014**
conditioned		1.695		1.695
not conditioned	0	1.319		1.319
Latina	**421**	**1.220**	**13**	**1.654**
conditioned		294		294
not conditioned	421	926	13	1.360
Trino	**0**	**1.039**	**62**	**1.101**
conditioned		824		824
not conditioned	0	215	62	277
Bosco Marengo	**0**	**410**	**0**	**410**
conditioned		255		255
not conditioned	0	155		155
Casaccia	**0**	**2**	**117**	**119**
conditioned		0		0
not conditioned	0	2	117	119
Saluggia	**1.156**	**1.273**	**342**	**2.771**
conditioned		186	25	211
not conditioned	1.156	1.087	317	2.560
Trisaia	285	2.891	64	3.240
conditioned		1.116		1.116
not conditioned	285	1.775	64	2.124
TOTAL	**1.880**	**12.313**	**598**	**14.791**

Spent Fuel Management

Following the new strategy on reprocessing, the long-term contracts with British operators were continued and new contracts were signed with French operators (2006).

The overall fuel used in the Italian nuclear power plants amounted to 1864 tons.

Of these:

- 913 tons were reprocessed abroad under contracts concluded during the operational phases (by previous operators).
- The remaining 951 tons are within the reprocessing contracts in place with the French Areva (France) and the British Nuclear Decommissioning Authority (NDA).

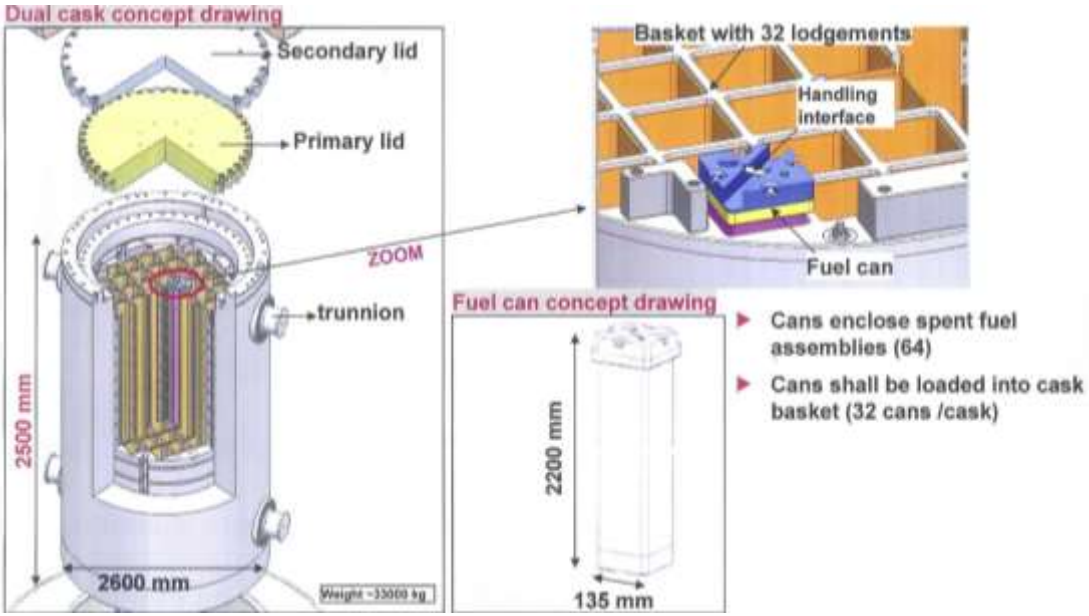
Of these, 922.5 tons have been already shipped in the past years.
The rest (about 64 assemblies from Avogadro and 47 assemblies from Trino) has to be shipped shortly.

Nuclear materials and remaining spent fuel

All other nuclear materials stored abroad have been alienated or re-imported into Italy or under negotiation for their transfer to other nuclear operators.

Part of materials containing fresh plutonium were returned to the United States within the US program Global Threat Reduction Initiative.

For U-Th irradiated fuel from the Elk River US reactor, consisting in 64 fuel assemblies, it has been programmed its dry storage into single bottles.
The project is now under way.



Work in progress - Trino

PWR, Termination: 1987

ACHIEVEMENTS

- Removal of hazardous waste, particularly asbestos, and radioactive technological waste conditioning;
- Partial removal of spent nuclear fuel from the site (47 assemblies remaining);
- Chemical decontamination of the primary circuit;
- Elimination of the systems of water supply and dismantling secondary circuit;
- Removal of non-contaminated materials.

WORK IN PROGRESS

- Final activities for fuel transportation abroad;
- Adjustment of temporary storage (environmental norms);
- Treatment of resins and conditioning of resulting liquids;
- Dismantling the primary system.

Work in progress - Caorso

BWR, Termination: 1986

ACHIEVEMENTS

- Removal of spent nuclear fuel from the site and Radioactive technological waste conditioning;
- Decontamination of the steam circuit;
- Dismantling of Building Towers and systems and components inside of Building Turbine;
- Dismantling of systems and components within the building Off Gas and the complete demolition of the building itself;
- 5 800 ton of metallic scraps decontaminated and free released.

WORK IN PROGRESS

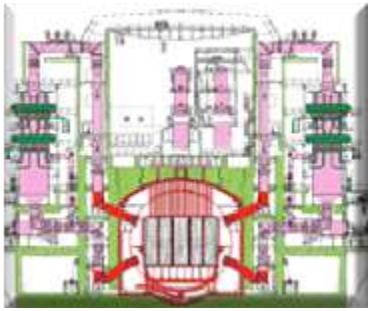
- Decontamination and Dismantling of contaminated materials within the fuel pools and characterization Vessel and Building Reactor;
- Adaptation of Building Turbine to temporary storage;
- Treatment and conditioning abroad of exhausted resins.

Work in progress - Latina

GCR-Magnox , Termination: 1987

ACHIEVEMENTS

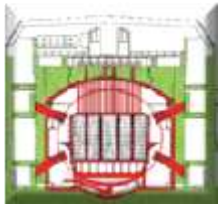
- Conditioning of radioactive technological waste and Temporary Storages;
- Removal of spent nuclear fuel from the site;
- Dismantling Pipelines Primary Circuit;
- Dismantling components and Demolition Building Turbines;



- Remediation of fuel pools n. 2 and n. 3 fuel;
- Elimination of the systems of water supply;
- Dismantling Reactor design.

WORK IN PROGRESS

- Sludge Treatment Plant and Remediation of fuel pools n. 1;
- Station for metallic materials treatment "Cutting Facility»;
- Dismantling carcasses bodies blowers;
- New Effluent Treatment Plant.



Work in progress - Garigliano

BWR , Termination: 1982

ACHIEVEMENTS

- Removal of hazardous waste, particularly asbestos, and radioactive technological waste conditioning and Temporary Storages;
- Removal of spent nuclear fuel from the site;
- Restoration Systems Auxiliary Building Reactor;
- Remediation Trenches n. 2 and n. 3.

WORK IN PROGRESS

- Construction of a new liquid waste treatment system;
- Remediation Trench n. 1;
- Dismantling systems and components of the thermal cycle turbine Building.

Work in progress – Bosco Marengo

Fuel fabrication , Termination: 1990

ACHIEVEMENTS

- Conditioning of radioactive technological waste;
- Removal of all nuclear materials from the site;
- Fabrication cycle entirely dismantled;
- Temporary storages created.

WORK IN PROGRESS

There are only a few remaining activities to end completely dismantling activities.

- Underway, the super-compaction of final waste and their conditioning and the characterization of the last materials for free releases;
- Remediation of the external areas;
- Adjustment of the storage to make it suitable as a temporary storage pending the national repository.

Work in progress – Saluggia

Reprocessing , Termination: 1983
MOX fabrication, Termination 1993

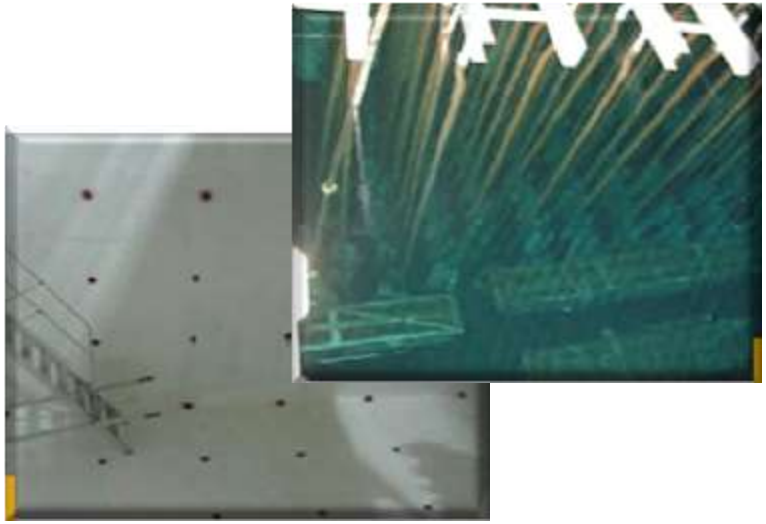
ACHIEVEMENTS

- Conditioning of radioactive technological waste;
- Transfer of liquid waste with higher radioactivity in the New Park Tanks;
- Removal of spent fuel and nuclear materials from the site in the US (GTRI Program).

- Temporary storages created.

WORK IN PROGRESS

- Realization of the plant for conditioning of radioactive liquids with high activity (CEMEX);
- Treatment and conditioning of old waste arising from fuel fabrication plant (already decommissioned).



Work in progress - Casaccia

Fabrication, Termination: 1990

ACHIEVEMENTS

- Conditioning of radioactive technological waste;
- Removal of nuclear materials from the site in the US (GTRI Program);
- Dismantling of the sections of manufacturing plant and construction deposit fissile materials.

WORK IN PROGRESS

- Dismantling of obsolete glove boxes contaminated at a higher level plutonium;
- Adaptation of the building OPEC-2 as storage for radioactive waste plutonium contaminated;
- Dismantling of underground tanks of liquid effluent.

Work in progress - Trisaia

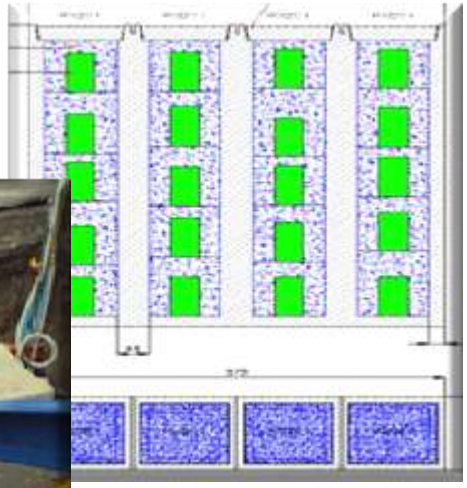
Reprocessing, Termination: 1987

ACHIEVEMENTS

- Conditioning of radioactive technological waste, liquid and solids at low, medium ad high level of radioactivity;
- Removal of nuclear materials from the site in the US (GTRI Program).

WORK IN PROGRESS

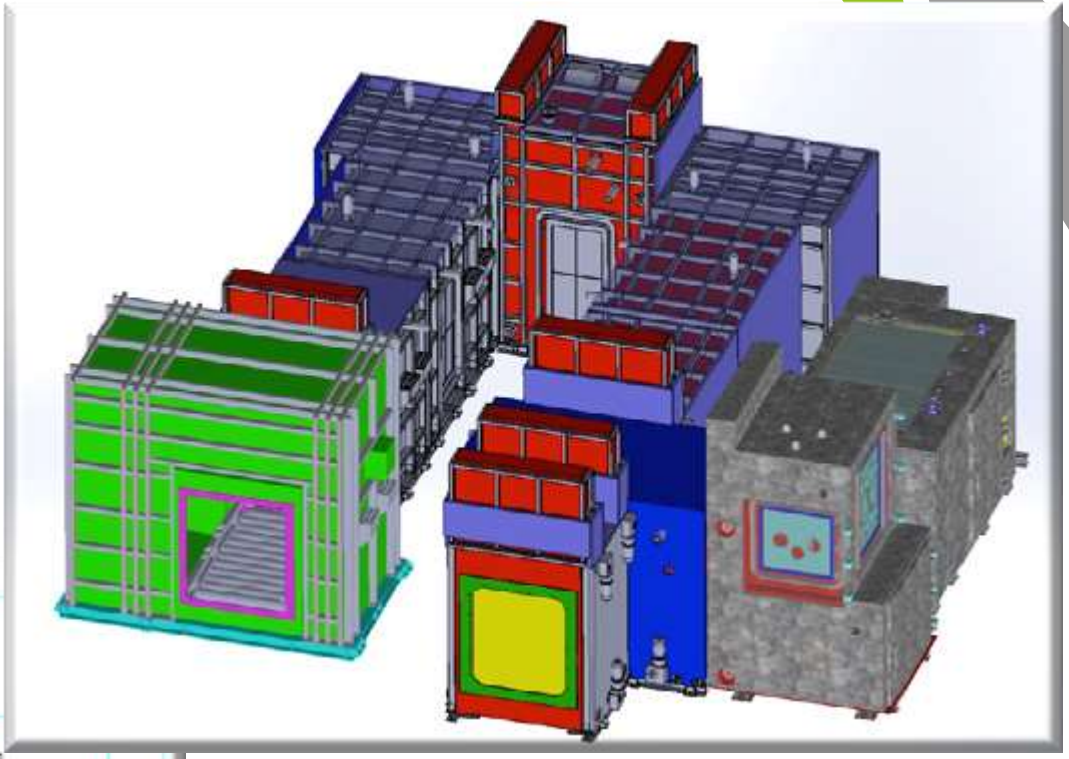
- Remediation of underground storage;
- Realization of cementing plant for U-Th solutions;
- Designing for the dry storage of Elk River spent fuel.

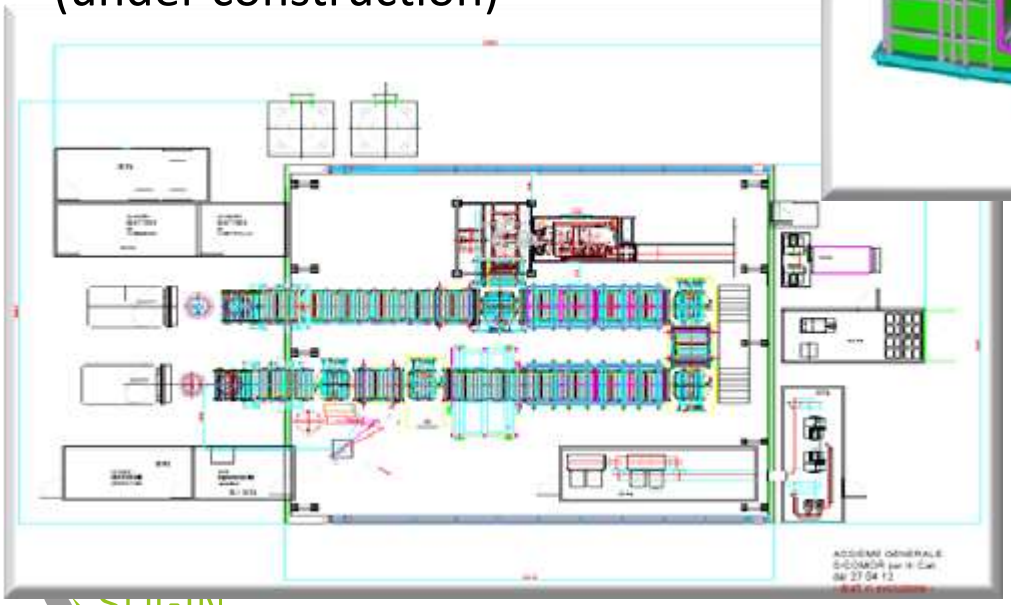


Some Technological investments

Si.Co.Mo.R.
(Sistema Condizionamento Modulare Rifiuti)
It is a system for waste in-drum mixing cementation, modular, easily dismountable and transportable.

(under construction)





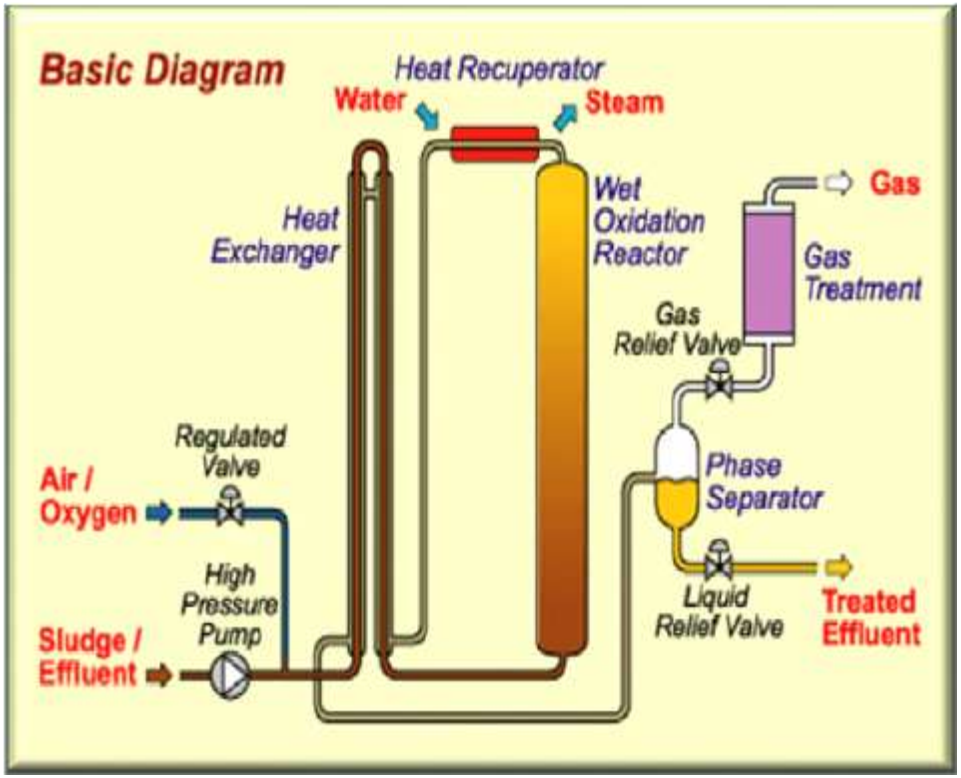
… and

WET OXIDATION SYSTEM

For solid and liquid organic material (ex.: organic resins of Trino).

The oxidation reaction takes place into a reactor with hot pressurized water (300°C – 100 bar). The final aqueous residue (< 15 % of the initial volume for organic resins) is cemented.

- The existing and tested pilot plant is under upgrading for increasing the reactor volume and improve the phase separation;
- The industrial plant is under final designing and construction.



DECO activities for third parties

Prime contractor, in consortium or as partner of major companies in Russia, Armenia, Czech, Slovakia, Romania, Kazakhstan, Bulgaria, Lithuania, Ukraine, France and UK.

ACHIEVEMENTS

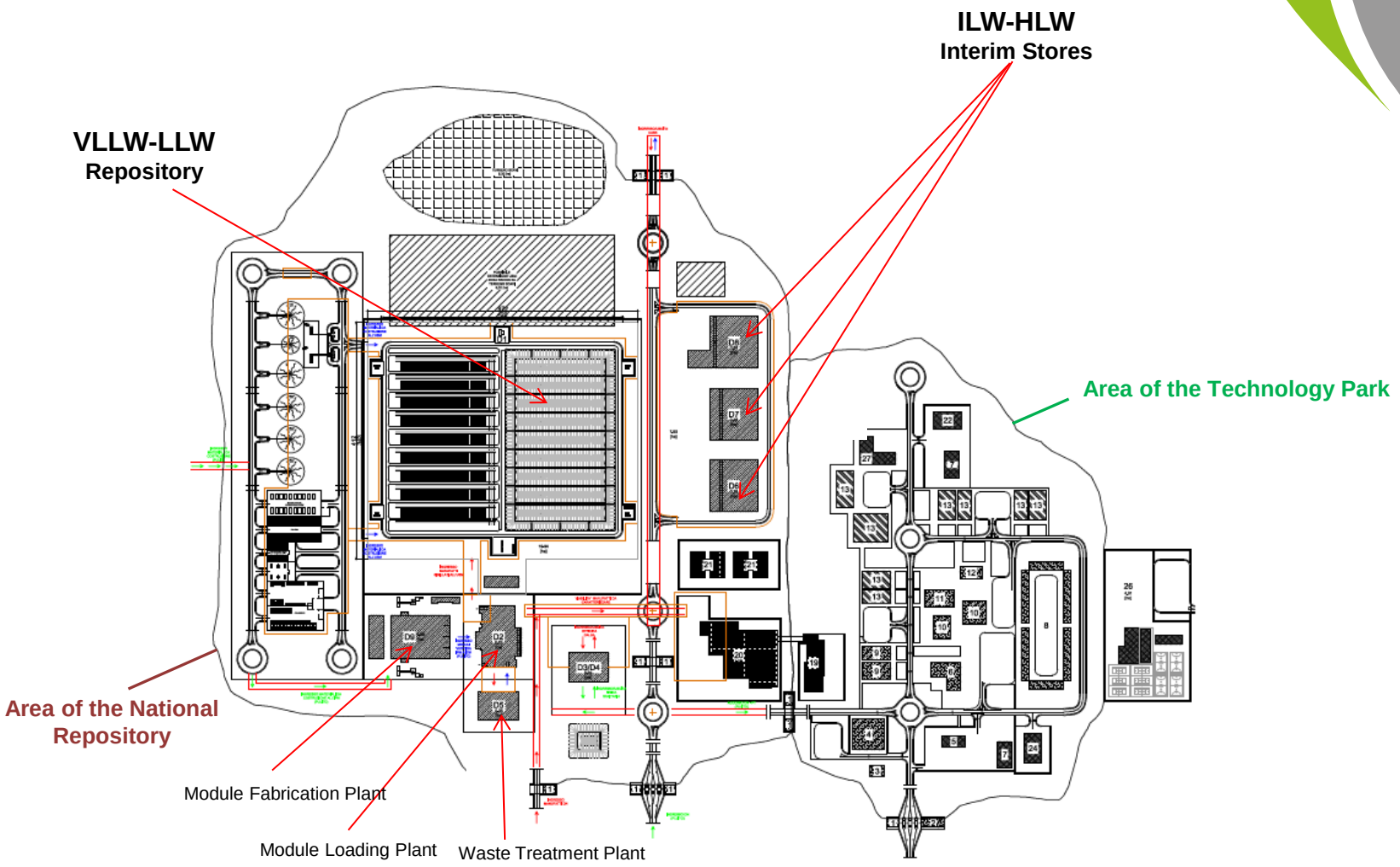
In the framework of the G8 Global Partnership Program, coordinating activities in the Cooperation Agreement between Russia and Italy, established in 2005:

- Dismantled 6 nuclear submarines;
- Construction of the Vessel "Rossita", for the transportation of spent fuel and radioactive waste.

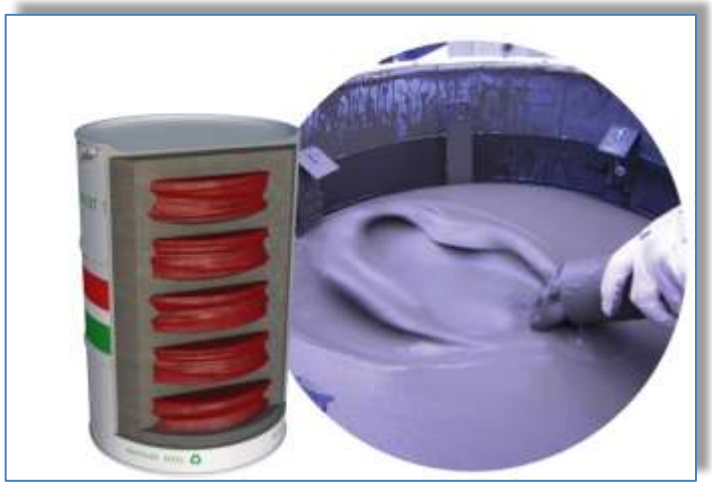
MAIN WORK IN PROGRESS

- **Andreeva Bay (RU):** Design and construction of a treatment and conditioning facility and up-grading of physical protection of shipyards;
- **EURODIF (F):** Engineering support to decommissioning GB-I plant;
- **Bohunice (SK):** Consultancy to JAVIS for the dismantling of the reactor V1;
- **Armenia**: Advisor for the management of radioactive waste and spent fuel;
- **CISE, Segrate (I):** Site remediation.

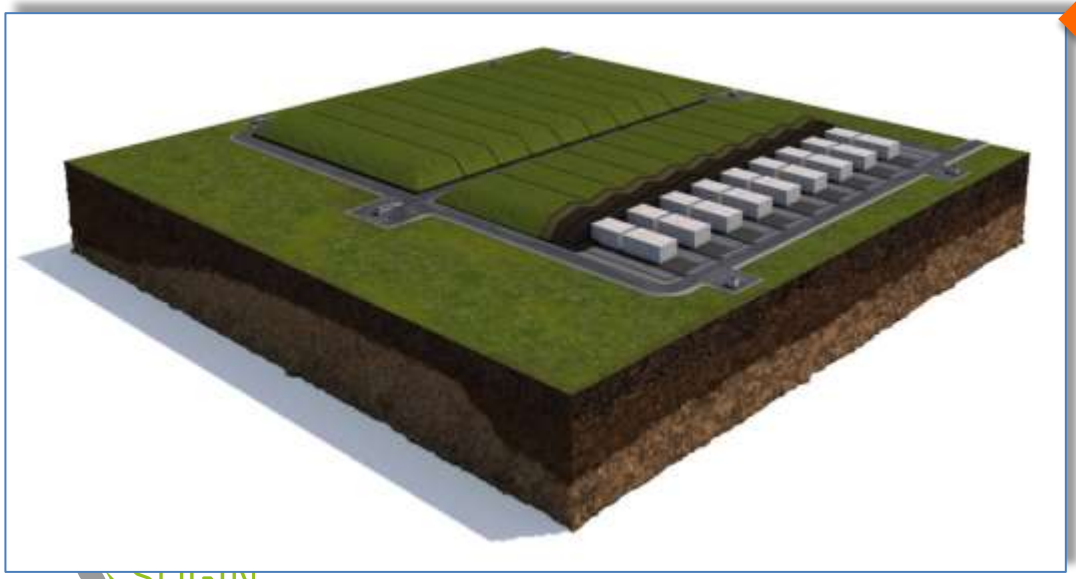
Disposal-National Repository Layout



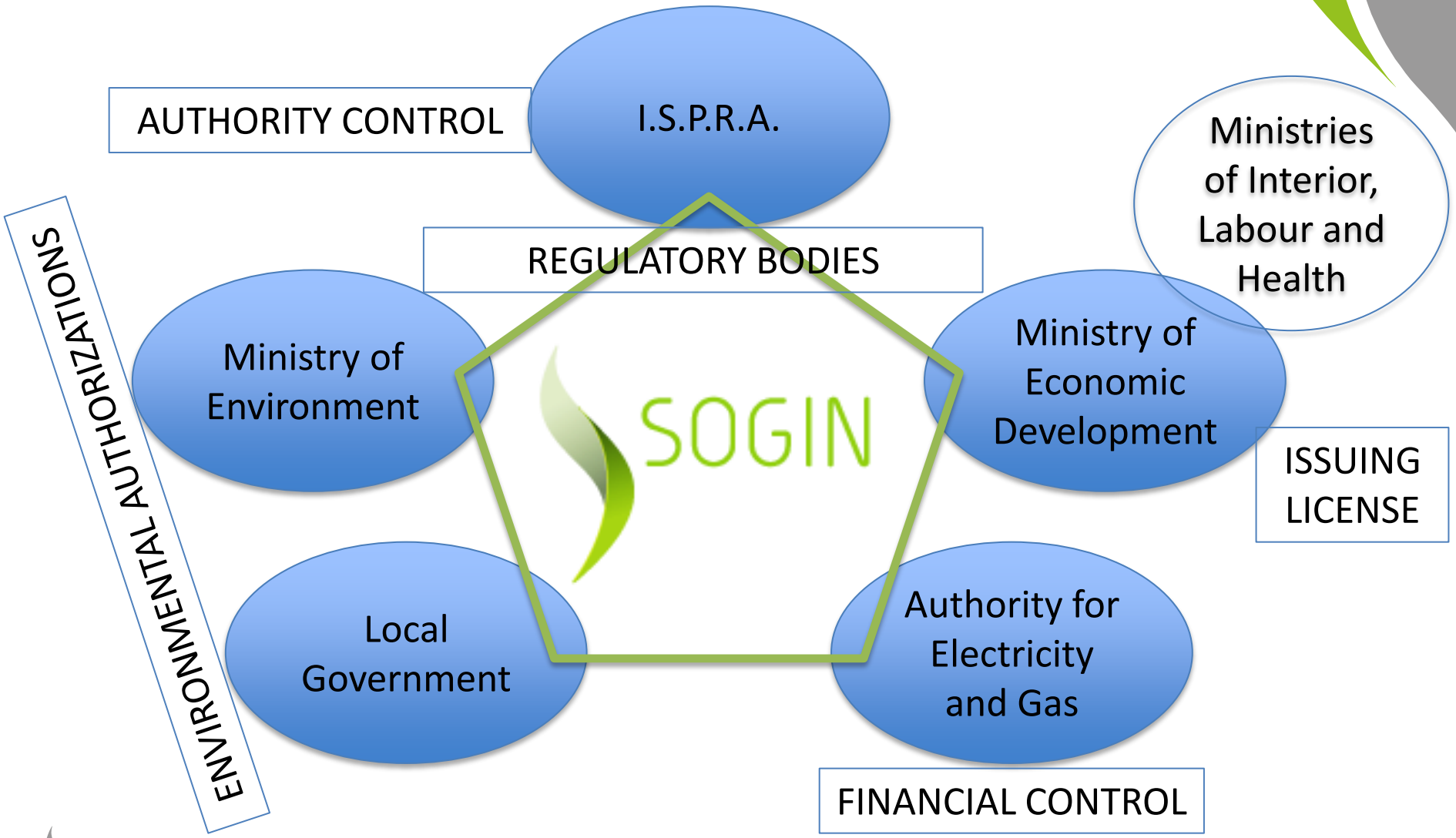
VLLW-LLW disposal scheme



Multi barrier concept

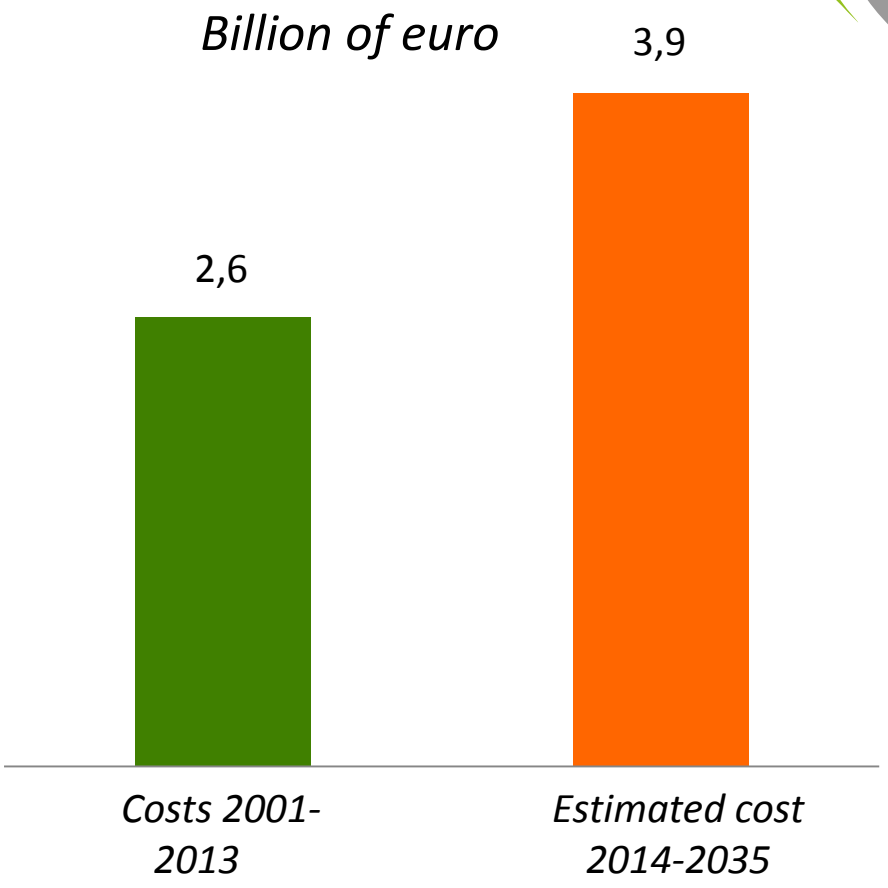


Regulatory System



Costs Estimation

- ✓ The overall cost of the decommissioning of the 4 power plants and 5 nuclear facilities, including the reprocessing of fuel, safety maintenance of equipment and overhead costs, is about of 6.5 billion euro.
- ✓ Since 2001, the beginning of its activity, and until the end of 2013, Sogin has supported activities for a total of 2.6 billion euro.
- ✓ The remaining 3.9 billion euro, are the planned costs for the conclusion of the decommissioning plan, scheduled for 2035.

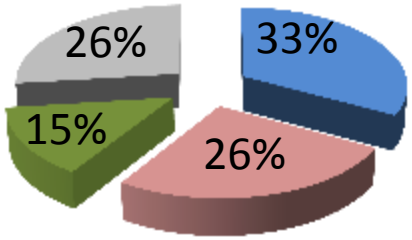


Cost Breakdown

Total costs (2001-2035)	
Decommissioning and waste management	2 140
Spent fuel	1 700
Safe management and Overheads	960
Human resources	1 600
Investments	100
TOTAL	**6 500**

Million of euro

	Estim. Costs (2001- 2035)	Costs up to 2013
Bosco M.	30	22
Caorso	313	74
Casaccia	161	64
Garigliano	330	66
Latina	462	60
Saluggia	404	71
Trino	178	44
Trisaia	261	57
TOTAL	**2 140**	**458**



Financial scheme

Decommissioning costs are financed by two sources:

- funds accumulated by ENEL during operation, of about 800 M€;
- through an additional electricity bill, so called “A2 component”, of about 5 700 M€

Considering:

- Decommissioning time: 30 years
- an annual consumption of electricity of 328 Billion of kWh (Italy 2012)

The additional electricity bill, calculated year by year on the base of annual cost estimation and the actual progress of the activities, is about **0,058 €cent/kWh**

For an annual electricity consumption of 2 700 kWh of an Italian average family, the additional cost on electricity bills is:

Financial Levy: 1,56 €/family/year

Thank you for your attention

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