REFERENCES IN ENVIRONMENT
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1. SEWAGE SLUDGE
Project:

Feasibility study for the incineration of sewage sludge of 3 water and sewage plants located in Turkey. The project was financed by the European Investment Bank (EIB) in collaboration with MESKI, ASKI and TASKI.

Description:

MESKI (Water and Sewerage Administration of MERSIN) is acting together with ASKI (Water and Sewerage Administration of ADANA) as well as TASKI (Water and Sewerage Administration of TARSUS).

These 3 municipalities want to develop a safe, environmentally sound and economical way to dispose of sewage sludge. As the co-incineration of sludge in cement plant is one of the favoured options in western European countries, this Feasibility study should evaluate the possibilities, the advantages and disadvantages as well as the most economical situation for the disposal route under the local conditions.

The client envisaged the utilization of the sewage sludge in two cement plants (CimSA at Mersin and Adana Cimento in Adana).

The development scenario of the project was:

- Step 1: Transport and storage of the dried sludge in the plants
- Step 2: Preparation and introduction of the sludge into the cement burning process
- Step 3: Evaluation and discussion of technical, environmental and economic conditions and effects
Project:

In association with other offices, PEG has participated since 1988 in different parts of the overall study of the sector for the recovery and treatment of sewage sludge from the canton of Neuchatel.

Description:

The last part of this overall study included the studies for final project, the tender, bid evaluation and the selection of a supplier for a plant comprising the drying of dewatered sewage sludge and subsequent incineration. PEG services mainly focused on the different methods of incineration, energy recovery and flue gas treatment.

The proposed plant has been designed to treat 4.5 t/h of digested sludge with dryness between 25 to 35 %, produced by approx. 20 wastewater treatment plants.
Project:

Determination of the influence of sewage sludge on the quantities of fly ash and washed sludge produced during the incineration of municipal waste.

Description:

The aim of the study was to determine the quantities (in tons) of dry matter produced per ton of incinerated municipal solid waste i.e.:
- dry fly ash (before washing)
- washed fly ash
- filter cake

And this, in 2 cases:
- Before the incineration of municipal waste
- Before the incineration of municipal waste and 10% of dried sewage sludge pellets

PEG scope of work included:

- The development of a program of measures, records, sampling and analysis
- The Monitoring and supervision of the tests
- A synthesis report
Project:

Study of Switzerland's sewage sludge incineration options.

Description:

Sewage sludge incineration becomes the most common solution when the agricultural recycling of sludge is unfeasible or difficult due to the problems and restraints linked to their particular use, to the marketplace and to the difficulty of promoting a product that contains sludge.

On the basis of a detailed bibliography, a nationwide survey and inquiries among Switzerland's major equipment suppliers, this study reviewed and compared three sewage sludge incineration options:

- Incineration in cement plants
- Incineration in municipal solid-waste (MSW) incineration plants
- Incineration in special incinerators (generally fluidized-bed)

These three options were compared on the basis of criteria involving:

- Technology: Scheduled equipment, plant operation, pretreatment of sludge (thermal drying prior to incineration in cement plant or municipal solid waste plant, mechanical dehydration prior to incineration in special incinerators).
- Environment: Quantities and characteristics of exhaust gases, liquid and solid residues, options for residue elimination and treatment, induced pollution, overall energy balance, etc.
- Energy: Energy requirements and recovery of energy contained in sludge.
- Costs: Investments and operating expenses.
The main conclusions were the following:

- Sludge incineration in household waste incineration plants or in special incinerators requires exhaust gases to be treated with gas scrubbers. As a result, the quantity of residual pollutants discharged into the atmosphere is small and comparable for the two options.

- Incineration in the cement plant is interesting due to the fact that it produces neither liquid nor solid wastes (the sludge pollutants are trapped in the cement). In addition, there is an improved breakdown of organic matter. In contrast, it may produce a more significant discharge of mercury together with the exhaust gases.

- From an energy point of view, the balance sheet is in favor of incineration in the cement plant.

- From a financial point of view, incineration in special incinerators is in principle the most costly (necessity of special discharge treatment installations).

However, we concluded that the advantages of any one system were not sufficient to endorse one over the other. The situation must be studied on a case-by-case basis in order to identify the best option.
Project:

The Environmental Protection of the Canton of Neuchatet entrusted PEG with a study whose aim was to propose concrete solutions for agricultural recovery and / or disposal of sewage sludge and define the required treatment. The production of dry sludge was of 5,500 tons per year.

Description:

The main scenarios were the following:
- Agricultural use
- Incinération conjointe avec les ordures ménagères en UIOM.
- Incineration in cement plants
- Kiln incineration

A total of 9 variants were analyzed within the frame of this study.
Project:
Solidification of galvanic sludge mixed with washed ash from waste incineration plant.

Description:
This study aims to establish the basis for treating galvanic sludge in view of its disposal in landfills compatible with the environment and in compliance with the Waste Treatment Ordinance (OTD).

Cement-based fixation tests were conducted on mixtures containing household waste incineration plant ash in proportions equivalent to the Swiss output of these 2 types of wastes.

Tests revealed very promising results even though a relatively significant proportion of cement is required to guarantee compliance with leaching regulations.
Client: Syndicat Intercommunal d'Epuration des Eaux et de traitement des Gadoues (SIEG)
Country: Switzerland
Date: 1988

**Project:**

PEG carried out an environmental impact study of the thermal drying unit of sewage sludge at SIEG - Vevey-Montreux.
Project:
Purpose of the project was the implementation of a new plant for the treatment of sewage sludge by thermal drying.

Description:
The existing sludge treatment plant of Roche, operational in 1975, had been designed to dispose of the sludge from the two sewage water treatment plants of the SIEG Vevey-Montreux Intermunicipal Water and Sewage Treatment Association, l'Aviron in Vevey (60,000 IE Inhabitant Equivalent) and le Pierrier in Montreux (45,000 IE). Until 1991, the sludge was digested, mechanically dehydrated and incinerated in a fluidized-bed incinerator using biogas.

In view of the new legal provisions governing air quality that prescribe an advanced and costly treatment of exhaust gases, and due to the aging of the installations, other treatment alternatives were studied. Finally, digestion, mechanical dehydration and thermal drying were selected.

Market study:
- As agricultural fertilizer with the possibility of adding fertilizing agents as required.
- As cement-plant fuel, with impact study on finished products and the environment.

Details:

Preliminary project study:
- Comparison of the principal sludge thermal drying processes (advantages and disadvantages, energy balance)
- Selection of a process to obtain dried sludge without harmful effects and whose properties (dryness, granulation) correspond to the requirements of potential markets
- Implementation in existing equipment
- Estimated costs and completion schedules
Environmental impact study.

Definition of final project with overall estimate and permit application procedure.

Preparation of implementation including requests for tender, review of tender documents, contract award recommendations and scheduling.

Actual implementation including conclusion of contracts with builders and suppliers, project specifications and overall project management.

Final acceptance including final statement, plan revisions and preparation of operating specifications.

The new installations have been operational since the summer of 1991.

The chosen process is direct in that drying takes place thanks to an air-steam mixture in direct contact with the sludge and circulating in a closed circuit. But it is also an indirect process since this fluid is heated thanks to a hot gas/air-steam heat exchanger. The vaporized liquid is extracted from the circuit through condensation.

Digested-sludge biogas constitutes the energy source.
2. WASTE MANAGEMENT
The Geneva Industrial Services and the State of Geneva expressed the intention to start a reflection on the waste issues in the medium and long term (household waste, special waste, sewage sludge, green waste, slags, etc.) on a scale either cantonal or regional (including neighboring France).

For urban and industrial waste, the overall environment in Switzerland is dependent of areas that will deeply change by 2006, with the commissioning of new incineration plants. These developments will lead to some competition.

For special waste, the decreasing quantities on Swiss territory and the potential for recovery allow industries to have other options than the final disposal solution proposed by the Cheneviers plant. A strong competition in this area required the repositioning of the activities of the Cheneviers Plant.

The sewage sludge from the canton of Geneva was dried at the STEP d’Aïre, before being co-incinerated with household waste within the Cheneviers plant. This solution was source of many technical problems and thus was not acceptable anymore; another solution to remove sewage sludge was necessary.

Thus, PEG has been mandated to assist the Geneva Industrial Services and the State of Geneva as part of the strategic reflection that should lead to a technical and economic evaluation of possible scenarios for the future of each activity at the Cheneviers plant.
The Municipality of Bullet has appointed PEG for a decision support mission regarding the legal, technical and financial consequences for the registration of the old Municipal solid waste landfill of Crosats in the register of polluted sites of the Canton of Vaud.

A scientific support was provided by PEG for the understanding of the environmental situation of the landfill which includes a buried part and an open sky part.

**Description:**

PEG services included:

- Analysis of the legal situation on the basis of the regulation in force
- Analysis of existing hydrogeological studies
- Analysis of the preliminary investigations’ results
- Monitoring program of the downstream sources
- Coordination for the final program preparation of the detailed investigation
- Determination of the final budget of the investigation and financial request for participation of the canton
Project:
PEG took part to the Waste management – "Ecology at work", Workgroup for healthcare waste.

Description:
In the framework of the interdepartmental workgroup "Ecology at work" which had as mission to propose internal regulation to the Administration as regards the State's wastes management, PEG has been mandated to animate the workgroup No. 6 "Hospitals".

The mission of this workgroup carried on one part on the elimination of all medical wastes produced by the University Hospitals of Geneva (HUG) and on the other part on hospital material purchase.

Efforts have mainly been centred on the HUG; therefore a diagnosis of the actual organisation of the wastes elimination in four old people's home (the Vessy home, the Joli-Mont clinic, the old people's home of Petit-Saconnex and the Geneva clinic of Montana) also has been made.

In the same time, the ordinary wastes organisation and management have been inspected.

In the study framework of the existing situation in studied establishments, it was a matter of checking how the cantonal regulation on medical wastes elimination was applied – code ODS 3270 of 1st January 1995.

From the whole of those reflexions, the new regulation for medical wastes elimination could be elaborated taking notice of the whole of the highlighted criteria's.

It has been established in conformity with the actual legislation and the aimed objectives.
Study for the municipal waste management of Algiers (Urban area: about 1,500,000 inhabitants in 1990).

PEG, in collaboration with a local partner, has been mandated to set up the methodology and perform the preliminary studies in order to establish the Municipal Waste Management Plan of the urban area of Algiers.

The following steps were done by PEG:

- Partial financing arrangement of the project with the direction of cooperation to development and humanitarian aid.
- Relations with the different participants (authorities, associations, etc.).
- Analyse of current legislation.
- Redaction of the questionnaire for the collection of the most important information:
  - Geographic, demographic, social and economic data
  - Nature and amount of urban waste
  - Infrastructure and organisation of the existing urban waste collection system
  - Characteristics of existing landfills (sanitary and dump)
- Definition of the sampling and the analyses methodology for urban waste of the Alger area.
Project:
Study of hazardous waste management in main cities of Nigeria.

Description:

In Nigeria, like in so many other developing countries, hazardous wastes pose particularly critical problems in big cities and industrial areas in terms of environmental protection and of public health.

As part of Switzerland's program of assistance to these countries for the purpose of financing environmental protection, a specific study on the current situation of hazardous wastes in Nigeria was conducted.

An on-site survey conducted for more than 50 days of major industries in Lagos and other large cities allowed to establish a diagnosis of the existing situation.

The study defined the objectives and constraints of a waste management plan. On this basis, it proposed a short-term plan of action to address local priorities and conditions.
3. WASTE TRANSPORTATION
Project:

PEG carried out a study to seek and analyse the modification to be made in order to protect the barges during the operations of unloading, to evaluate the technical and financial aspects and to propose the most appropriate solution.

Description:

Two-thirds of the Geneva municipal waste which correspond to an approximate capacity of 100'000 tpy, are transported by the Rhone river.

A convoy comprising a pusher barge with a capacity of 170 tons (equivalent to 20 to 30 trucks) performs the journey of 12km between the loading dock of Jonction and the Cheneviers plant several times per day.

Once at the Cheneviers incineration plant, the convoy enters the channel for barges. The barge is then towed inside the plant through a carriage which is positioned under it.

The barge can then be rising under the openings for unloading or in the pits of Cheneviers III or Cheneviers II.

When the grabber was introduced in the barge via these openings, it happens that the teeth of the grabber hang the upper part of the barge and damaged it. Once damaged, the sliding metal curtains closing the barge during the navigation cannot be unrolled anymore.

The aim of the project was thus to find a solution to this problem.
**Project:**

The preliminary study carried out involved the adaptation of the waste unloading facilities at the Jonction Dock, in order to support the strong arrivals without loss of time for collection vehicles.

**Description:**

The preliminary study included:

- Collection of the data necessary for the execution of implementation studies
- Examination of the possibilities of achievement, taking into account the environment, laws and regulations
- Definition of the provisional program of the installations and works
- Appreciation of the problems linked to the existing installations, examination of the problems of river transport and the problems of exploitation during the period of work
- Development, analyzes and composition of alternatives with a first cost estimation
4. STORAGE, DISPOSAL AND WASTE INCINERATION
Project:
Adaptation of reception, transport and primary crushing of garden and park waste of the composting unit of the châtillon site.

Waste treatment: 17,000 t/y

Description:
Within the framework of the composting unit adaptation of the Chatillon Site, it was decided to revise the mode of reception and treatment of waste and stumps.

PEG has been mandated to realise a study, specifying:

- In an exhaustive way, means to implement and the organisation to set out in order to achieve the following goals:
  - Reinforcement of the performances installations
  - Renewal of some of the equipment
  - Release of space in order to rationalise exploitation and for the placing of new equipment
  - Rationalisation of the stumps treatment
- A costs estimate to be elaborated.

Various scenarios of adaptation were proposed and quantified by PEG, in order to give the Building Owner an effective aid to the decision-making.

The planned equipment will respond to the following criteria’s:

- Compatibility of operation of the new installations with the existing industrial process.
- Integration on the existing management system of the new project control equipment allowing a total and rigorous supervision.
- Realised installations respecting the Standards and Orders in use (Instructions, Standards VSM, CNA, OCIRT.)
- Largely dimensioned installations allowing a safe, reliable and secure functioning.

In addition, the installation of coarse treatment being daily in service, the installation will have to be carried out while preserving the reception of compost able waste and its exploitation continuously.

**Equipment:**

- **Coarse treatment:** The capacity of the existing coarse treatment installations is of 10’000 t/an. The new projected installation must have a higher capacity from 20 to 30%, that is to say 13’000 t/an.

- **Transport of the digesta resulting from methanisation.** The transport facilities (screw + conveying belt) are dimensioned for 4 t/hour. This capacity will have to be preserved by the new equipments.

- **Stocks:** The quantity of stocks to be treated will have to pass from 700 t/an to approximately 1000 t/an. The dimensioning of this equipment will have to make it possible to burst approximately 5 tons of stocks per hour, that is to say 20 tons weekly exploded views in a half working day.

Within the framework of this mission, PEG also proposed means of reorganising and adapting the transport of the digesta resulting from methanisation.
Project:

PEG carried out a technical expertise of the biogas unit.

The biogas plant for organic waste with a processing capacity of 10,000 tpy, was commissioned in late 1999. After 2 years of operation, the facility could not operate at its rated capacity. Therefore, the insurance company ALLIANZ mandated PEG to conduct investigations.

Description:

The biogas plant of Châtillon is divided into 5 distinct parts:

- Reception and storage hall for organic waste (from kitchen and garden), sorted at source
- Preparation and charging of waste to be treated in the digester
- Anaerobic digestion process of waste
- Recovery, treatment of biogas and energy production
- Extraction and processing of the digested material

Les difficultés d'exploitation concernaient principalement la capacité des équipements d'introduction des déchets et d'extraction de la matière, ainsi que la production et la valorisation du biogaz. The operating difficulties were mainly related to the capacity of the equipment used for the waste introduction and extraction of the material as well as the production and recovery of biogas.

As part of this mission, PEG proposed a number of solutions focusing on the adaptation of feeders and on changes operating conditions of the boiler.
Project:

Change of mechanical air extraction system by a natural extraction system.

Description:

PEG carried out all phases of the project:

- Project management
- Basic engineering
- Civil, Mechanical, Electrical engineering
- Tender and evaluation
- Site supervision
- Start-up and commissioning
WASTE INCINERATION PLANT IN THE TESSIN
GIUBIASCO - SWITZERLAND

Client: CSD Ingénieurs Conseils SA
Country: Switzerland
Date: 2001-2002

Project:
PEG has developed the specifications for electrical works for the construction of a plant project incineration of household waste (Termodestruzione Giubiasco) in Ticino.

PEG has also provided technical support for some equipment (fireplace).
Project:
Construction of a new and second shredding line for bulky household waste and Industrial Waste.

Description:
The scope of work included:
- Strengthening of the existing shredder in the sorting hall by the installation of a new one to be installed in the unloading hall
- Replacement of the sectional door of the sorting hall
- Adaptation of the roads and networks
The Cheneviers plant mandated PEG to diagnose the flow networks in the environment of the rotary kiln No. 4.

**Description:**
Investigations were also made under the lean-load preparation of kiln 4 and along the road of slag.

The concerned networks were:
- Storm water
- Industrial water
- Polluted water
- Wastewater
- Gutters
CHENEVIERS – CONTROL ROOM, KILN 4

GENEVA - SWITZERLAND

Client: Département des Travaux Publics (DTP)
Etat de Genève

Country: Switzerland

Date: 1999-2000

Description:
Installation of a new control room for the rotary kiln and integration of the existing equipment.
Project:

Description:
Two 25 t/h lines ensure the pre-incineration shredding of bulky wastes such as refrigerators, stoves, freezers, mattresses, furniture, bicycles and motorbikes, tires, carpeting, tree stumps, plastics (packaging, wrapping, rollers, etc.) up to 6 m. long.

Equipment consists of low-speed rotary cutters, a grapnel to handle certain wastes, dedusting and transportation systems (conveyors). The entire assembly is remotely controlled from adjacent cabins.

Start-up of the equipment in late 1993.
Project:
Pre-incineration shredding of confidential waste at the Cheneviers Waste-to-Energy plant. Waste shredding: 2.5 to 4 t/h.

Description:
The 2.5 to 4 t/h installation allows for the safe disposal of files and documents from law and medical offices, banks, corporate offices, public agencies, diplomatic missions, etc.

Located in a low-noise structure, the installation is composed of conveyor equipment, confetti shredder and dedusting unit.

Operation is 100% automated.

This is a self-service facility that is easy to use by the public after sign-up and vehicle weighing at the plant entrance.

Start-up in late 1993.
Project:
PEG was mandated to conduct a study on the stabilization of special waste, in view of its storage in appropriate facilities.

Description:
The main phases of this study were:
- Comparative study of the centralized and decentralized stabilization concepts in western Switzerland
- Feasibility study
Project:
The aim of the mandate was to study the feasibility for the incineration of organic solvents within the existing sewage sludge incineration facilities at Roche.

Description:
The following points have been taken into consideration:
- Applicable federal laws and ordinances
- The characteristics of used solvents from the chemical industry
- The required technical modifications to bring to the existing facilities and to the operating system
Project:

PEG carried out a preliminary study for the establishment of a waste incineration plant in Lausanne.

Description:

The new plant project included 2 lines of 27 Gcal/h. Moreover, a study for site comparisons was also carried out.
By 1985, because of the level reached by the tonnage of household waste to treat (300,000 tpy) and due to the necessity of replacing the two obsolete kilns N°1 and 2 (operating for more than 20 years) and the change in the air protection legislation and treatment of waste, an extension and an adaptation of the existing installations of Cheneviers became necessary.

Description:

This project enabled the incineration plant to reach a total incineration capacity of about 300,000 tpy of household waste and to meet the requirements for the air protection, protection against the noise and the waste legislation.

Adaptations made:

Thermics: installation of two new kiln (N° 5 et 6) with a capacity of 20 t/h each (50 Gcal/h), with a boiler for heat recovery allowing to generate up to 68 t/h of overheated steam (32 bar and 365°C) each.

Treatment of emissions: Each of the two new lines was equipped with an electrofilter and a dry flue gas cleaning system. Moreover, a wet flue gas cleaning system was installed on the existing incineration line N°3. The one for the incineration of special waste was put at the standards.

Wastewater treatment: A centralized system was set up allowing treating the various liquid rejections.

Other installations: A treatment facility for the solid rejections before their final disposal in landfill, a treatment facility for slag, a shredder for bulky waste, an installation for confidential waste,
Civil works: 4 new buildings have been built

Electricity: A new turbo group of 18 MW was installed in order to convert the vapor produced by the new installations into electricity. A controlled vapor extraction low pressure (4.8 will bara and 148°C) was envisaged within the framework of a possible future project of Remote heating.

Control: A centralized monitoring system was installed.

PEG was in charge of the design, contracting procedures, the follow-up of the studies, work supervision, commissioning and warranties of perfect completion for the whole of the installations.

The project was carried out according to a precise schedule in order to avoid prolonged shutdown of the existing facilities. The commissioning of two lines began in June and August 1993.
Project:

An expertise of hazardous waste incineration equipment of the Cheneviers plant was done by PEG.

Description:

The expertise focused on all the equipment of the incineration line no. 4:

- Kiln feed system: liquid, solid and pasty residues
- Rotary kiln
- Boiler
- Cleaner
- Dust analyzer from purified gas
5. RESIDUES FROM INCINERATION
Project:

PEG was mandated to make adjustments related to the treatment, management and storage of slag produced from the incineration of household waste at the Sidefage plant.

Description:

The objectives of this project were:

- To install the electromechanical equipment allowing to improve the treatment of slag coming out of incinerators and thus allowing a better recovery of the slag
- To stop sending slag leachate, containing significant amounts of heavy metals, to the wastewater treatment plant of Bellegarde-sur-Valserine.

After the necessary adjustment, the processing capacity of slag has been doubled, from 4 to 8 t / h.

The services provided by PEG covered all phases of study: sketching studies, preliminary design and final design and drafting tender documents and evaluation of bids, but also all phases of implementation, namely the monitoring of performance studies, site supervision, commissioning and withdrawal of reservations.

PEG scope of work covered all phases of the project: studies, design, tendering, evaluation of offers, supervision of work and commissioning
Slag treatment: 90'000 t/y.

Description:
In compliance with the Waste Treatment Ordinance, slag (solid residue from incinerators) must be pretreated and stored in order to be used in construction.

In view of the expansion and upgrading of Geneva's incineration plant, the treatment of slag, separated from fly ash (20 t/h), took place in 2 stages:

Pretreatment: At the incineration plant after immersion in incinerator ash pit water, this takes place in a covered building and includes scrap removal by magnetic drums, prescreening of parts less than 200 mm in diameter, and intermediate storage, all in round-the-clock operation.
Coarse residue (10 to 12%) is landfilled, and scrap (12 to 15%) is sold.

Final treatment: In 10,000 m2 covered hall at Bois-de-Bay for 0-30 mm screening in 2 stages, and final scrap removal, also in 2 steps.
The plant operates workdays, 8 h/day.
Coarse residue (0 to 2.5%) is landfilled, and scrap (5 to 8%) is sold.
Storage capacity of pretreated and treated slag exceeds 1 month of plant operation and complies with Swiss legislation governing the use of slag in construction.
Transportation of pretreated slag from incineration plant to Bois-de-Bay (about 3 km) is by truck.
CHENEVIERS - CARL 2 WORKS
GENEVA - SWITZERLAND

Client: Département des Travaux Publics (DTP) – Etat de Genève
Country: Switzerland
Date: 2000-2003

Project:
Replacement of storage tanks for combustible liquid residues at the hazardous waste treatment center of the Cheneviers Waste-to-Energy plant.

Description:
In 1999, PEG has conducted a feasibility study for the replacement of storage tanks for combustible liquid residues. For this project, PEG was in charge of the design, general specifications, procurement, supervision of studies, construction management and commissioning, guarantee of perfect completion for the entire facility, as well as monitoring and control of invoices.

The project’s aim was to dismantle the existing cisterns and to replace them by cisterns of bigger size, while reinforcing the security and respecting the federal standards and ordinances.

The 3 new steel tanks with a storage capacity of 200m$^3$ each were installed in the retention basin.
## Projet:
Civil engineering works for the setting up of a silo for fly ash with a capacity of 100 m³.

## Description:
PEG scope of work included the following:

- Project management
- Civil engineering
- Tender and evaluation
- Site supervision
Client: Office Fédéral de l'Environnement, des Forêts et du Paysage (OFEFP)
Country: Switzerland
Date: 1992-1993

**Project:**

Study of the assessment criteria for the re-use of the waste incineration slag.
Project:

Use of household waste incineration slag in road construction: Study on conduit corrosion.

Description:

For many years, slag has been used in construction, especially in France, Switzerland, Germany and the Netherlands, but this development has slowed down, essentially due to the potential risks of environmental pollution and corrosion of conduit.

The study reviews the current situation in terms of slag use in road construction, especially involving the problems linked to corrosion of underground conduits and possible environmental pollution, and defines the prospects for this application in view of applicable waste treatment legislation.

This study comprised the following parts:

- A general bibliographical search and summary of existing studies.
- A survey among slag producers and users in France, Switzerland and Germany with an overview of major sites and experience.
- A summary of results with detailed description of the characteristics of slag and its behaviour in civil engineering, specifically in terms of its impact on underground metal and concrete conduits, and on the environment.
- A specific study on the prospects for "new" slag that complies with the requirements of Swiss legislation (elimination of fly ash).

From a civil-engineering point of view, the slag appears to present some very interesting characteristics: some properties are similar to those of gravel (granulometry, bearing capacity, frost resistance, etc.).

A major inconvenience of slag is its relatively high humidity, which makes for cumbersome application in rainy weather. An interesting solution for solving this problem is cement-based fixation.
Due to its characteristics, slag belongs to those soils that are corrosive in terms of underground metal conduits.

As a result, the use of this material as backfill is most often expressly prohibited. However, tests have shown that protective measures customarily applied in corrosive soils (plastic coating, cathode protection, etc.) could be used effectively. From an environmental point of view, especially the heavy metals contained in the slag may pose a problem. Generally speaking, however, only a very small portion is able to dissolve in water. From this perspective, the risk of pollution by heavy metals is, therefore, in fact limited.

Waste treatment legislation prescribes quality criteria and special conditions governing the use of construction slag in order to avoid all risks of harmful impact on the environment.
PEG was mandated to conduct an assessment of the tennis courts built with slag from the incineration of household waste and which have caused swellings.
Characteristics of Slag

Bern - Switzerland

Client: Office Fédéral de l'Environnement, des Forêts et du Paysage (OFEFP)

Country: Switzerland

Date: 1989

Project:

PEG carried out a study and testing in order to determine the characteristics of slag coming from household waste incineration plants, and with the view to using it as building materials.
The objective of the study was to lay the foundations for a proper treatment of ash produced from the incineration of sewage sludge, for final storage in a landfill in a compatible way with the environment, i.e. immobilization of the harmful components.

**Description:**

The first phase of the study consisted of the realization of tests to define the characteristics and the behavior of a typical sample of ashes.

The second phase consisted of the study of the possible sectors of ash elimination, let it be landfill disposal or its use in cement plant with all the criteria and necessary treatment and adaptations to do.
Client: City of Lausanne
Country: Switzerland
Date: 1986

**Project:**

The aim of the study was to define the terms of use of the slag produced from the incineration of household waste for the construction of forest roads, and to estimate the risk of water and soil pollution.

**Description:**

The study was divided into various phases:

- Sampling and analysis of slag
- Determination of the optimum Proctor by compaction of slag, recommendations for optimal use of moisture.
- Leaching tests

Along with this test, the soil pollution resulting generated by the leaching of soluble salts and micro-metal pollutants near a forest road built a year ago with slag was estimated.

The results of this study were published in the journal "Swiss Engineers and Architects" No. 8, pp. 133-138 (1987).
6. ATMOSPHERIC EMISSIONS
Project:
Dioxin and furan treatment at SIDEFAGE Waste-to-Energy plant.
Waste incineration: 120'000 tpy.

Description:
The SIDEFAGE waste-to-energy plant was commissioned in 1998. It consists of two incineration lines with a nominal capacity of 8 t/h and a thermal capacity of 23 MW. Since commissioning, the efficient installations for treating emissions have ensured that atmospheric emissions are inferior to the standards in force (Government act dated 25 January 1991). SIDEFAGE wishing to maintain this equipment at today's highest technical level, has decided to install a unit for the treatment of dioxins and furans to conform to the standards of the future European directive of December 4, 2000, in preparation.

The adaptation of the existing flue gas treatment – wet process without waste water – consisted in the addition of an activated carbon injection in the evaporation reactors of the waste water from flue gas scrubbers situated in the existing filter area.

Electromechanical equipment:
A storage silo of 40 m³ allowing the delivery of activated carbon in bulk was installed inside the existing buildings. The reclaiming and dosing systems allow an automatic, stable and continuous operation with a controlled output which is transported by a pneumatic system.

Civil engineering and structures:
Concrete foundations were placed in the existing building to maintain the existing waterproofing of the block. The coal silo is placed on a metallic structure 6 meters from the ground to allow the passage of trucks to the adjacent silos. (fly ash).
Electricity and control automation:
Power supply of the new installations as well their regulation has been totally integrated into the electric network and the existing control automation systems.

Security:
The installations were designed to avoid all risk of explosion caused by electrostatic charges from the metallic parts. The silo is protected by a blast valve with discharge outside the building.

Mandate:
PEG operated as Assistant to the General Contractor for the design, contracting for supplies and works, execution studies, commissioning, industrial market, performance controls up to the fulfillment of guarantees for all the installations.

The installations were commissioned in August 2000.
Project:
Adaptation to the Swiss atmospheric emission standards of the Cheneviers Watse-to-Energy plant.

Description:
The project's aim was to reduce emissions of dust (9 mg/Nm3 dry 11%O2), lead and zinc (0.9 mg/Nm3 dry 11%O2 in total), nitrogen oxides (65 mg/Nm3 dry 11%O2) and dioxins and furanes from the 3 incineration lines (lines 3, 5, 6) of Cheneviers waste to-energy plant.

The works, staggered over 3 years, were undertaken during the yearly maintenance periods of each line in order to maintain at least two lines in service.

Particular care was taken in the numbering of equipment and in the final documentation, which is a requisite for reliable operation.

FLUE GASES TREATMENT:
In order to reduce the investment and the running costs, the choice was made to put in place, on each line, a catalytic reactor in raw gases, between the electrofilter and the scrubber, and not after the scrubber which would have necessitated the construction of new buildings and the use of fuel oil to reheat the exhaust gases.

Ammoniacal water to reduce nitrogen oxides is injected directly into the flue gases before the catalysts layers. Truck unloading, storing and distribution installations for the ammonia were situated in an explosive rated area, in a new building located in the Hazardous Waste Centre of the plant.
Concerning dust emissions, the electrofilters of lines 5 and 6 were extended by 2 supplementary fields, whilst for the line 3, only one supplementary field was necessary. Dioxins and furanes are destroyed by catalytic oxidation.

![Diagram](image.png)

*Line 3: in red, the modified and new equipment.*

**CIVIL ENGINEERING:**
The integration of new equipment into the existing buildings necessitated the destruction of an old concrete duct and a platform, foundation reinforcements and the creation of new structural supports. The necessary replacement of old rusted steel ducts allowed to optimize the flue gas path and to set free space for the new equipment of line 3. The only new building was erected for the storage of ammonia.

**THERMAL ENGINEERING:**
The boilers had to be modified in order to permanently maintain the flue gas within an optimal temperature range (260°C-280°C) for the reduction of nitrogen oxides, at the same time protecting the catalyst as much as possible, the boilers were modified. On lines 5 and 6, the internal economizers were modified. On line 3, a feed water external heater was installed, in parallel to the internal economizer feed tank. Three-way valves allow to regulate the flue gas temperature by routing of feed water. In order to recuperate a maximum of heat from the flue gas at the exit of the catalytic reactor, an external economizer has been added to each of the lines and the temperature of the flue gas has been lowered. The performance of the 3-line incinerator was therefore raised very significantly. To avoid any future problems of corrosion, steel ducts situated between the fan and the chimney were replaced with fibreglass reinforced polyester ducts.

**ELECTRICITY:**
The installations were fed at 400 V level, from various 18/0.4 kV transformers. The LV and MCC installations are controlled from main panels which feed the various cabinets and secondary panels of the electrical equipment. Each motor or other consumer was provided with a local command box equipped with a push-button and a lockable security switch which is used during equipment maintenance.

**CONTROL-AUTOMATION:**
The integration of the new installation’s control-automation system to the plant’s existing system, was mainly composed of ABB components. This integration took into consideration the installation of new operator stations and programmable logic controllers, the creation and implantation of new graphics in the monitoring system and the modification of the graphics and existing software affected by the project.

**CLIMATIC ENGINEERING:**
To reduce the impact of heat loss of new equipment at a temperature level in the buildings, roof openings, allowing heat to escape, and facade opening to allow incoming fresh air, were carried out on 2 buildings. The system is automatically regulated. These works gave the opportunity to review the entire ventilation of these zones.

PEG operated as General Contractor for the design, the general estimate, contracting of supplies and works, follow-up of studies, site management and start-up, until the final taking over of the installations as well as the follow-up and control of all invoices.

Line 5 was commissioned in September 2000, line 6 in September 2001 and line 3 in June 2002.
**Project:**

PEG carried out the ammonia storage facility, used for the catalytic reduction of nitrogen oxides contained in the gas of the 3 incineration lines.

**Description:**

The storage is done in two stainless steel tanks of 50 m³ each with an installation for the capture of ammonia vapors. The supply of ammonia to the three incineration lines takes place according to the principle of feeding at constant pressure, with return of the excess ammonia in the tank in service.

Security facilities were also provided.
Project:

The aim of the project was the energy optimization of the flue gas cleaning system of the 3 municipal waste incineration lines.

Electrical economy: 1,900 MWh/year.

Description:

PEG’s recommendations allowing decreasing the average power consumption of each fan from 290 to 200kW. The annual operation life of the installations is on average of 7'200h, the saving in electrical energy represented 1'944 MWh/year for the 3 steam production lines.

As the steam produced in the Cheneviers Plant is in priority assigned to the production of electrical energy, the annual incomes for the sale of electrical energy could be increased.
Description:

The project consisted in the replacement of electrofilters of kilns 1 and 2 from the Cheneviers incineration plant.
7. ENERGY RECOVERY
Project: District heating plant using incinerated household waste from Cheneviers

Description:

The purpose of the project was to give an increased importance to the energy produced by the Cheneviers household waste incineration plant. A steam outlet was put into force at Cheneviers as well as the installation on the plant's thermal cycle of a water/steam network of three heat exchangers in order to allow the production of overheated water.

The distribution network made up of two canalisations carrying overheated water (to and from) was built between the plant and the apartment blocks of city of Onex and Petit-Lancy. Connection of apartment blocks to the main network is made by means of heat exchanger substations (replacing the existing fuel boilers). As to date, 23'000 inhabitants are heated by the new Cadiom district heating.

The result shows in a simplified operation, reduced running costs, global energy savings and an improvement in air quality resulting from the absence of individual chimneys.

CIVIL ENGINEERING:

The technical equipment is housed in an industrial type building, covering an area of 450m2. The internal height is 16m. The structure is essentially of a metallic frame. The foundations and internal paving are in reinforced concrete. The facades are metallic. The building contains an internal overhead travelling crane with a capacity of 6.3 tons.

The distribution network consists of iron underground piping as well as substations to connect customers.
THERMAL EQUIPMENT:

The heat is transferred from 4.8 bar steam to hot water at the Waste-to-Energy Plant, and conveyed through 10km water pipes at 122°C to the substations. The total capacity of the heat transfer is 66 MWth at 110 m³/h water flow.

On the other side, 23 substation distributed in the suburbs of Geneva transfer the domestic hot water according to the real time demand. The system, based on two-way valves, maintain a very steady temperature in the return pipe, e.g. 70°C.

In the Waste-to-Energy plant, the thermal equipment is composed essentially of 3 vertical heat exchangers with a total power of 66 MWth as well as the piping, valves, expansion vessels and instrumentation necessary for the operation of the installation.

ELECTRIC INSTALLATIONS AND EQUIPMENT:

The installations are fed by 0.4 kV, from a transfo. 18/0.4 kV installed in the plant's transfo section.

The BT installations are fed from a main panel which feeds the different boxes et secondary panels of the electrical equipment.

CONTROL-COMMAND INSTALLATIONS:

The heat exchanging system (66 MW in total) in the Waste-to-Energy plant is controlled by two SAIA PLC's PCD4, implemented by PEG. The system maintains a water temperature in the outgoing pipe, and adjusts the level in the exchanger by open / close action on the condensate regulating valve.

Water flow is adjusted by the frequency converters driving water pumps. These pumps maintain also a sufficient differential pressure to allowed proper function of the valves in the substation. The water temperature set point is fixed by the outdoor ambient temperature in winter, and fixed in summer.

All substations and Les Cheneviers PLC's are inter networked, and connected to the city fibre optic network, which ensure a proper operation of the system. 4 different control rooms have been dispatched along the pipes and in the owner’s office for the operating staff to run the District Heating.

In the Waste-to-Energy plant, a process station is specially dedicated to the steam outlet. This station communicates with the CCDE installations of the Cheneviers plant. A supervisory post on the panel surveys the installation, visualises the alarm list, and dialogues with the process.

PEG operated as General Contractor for the turnkey realization for the steam equipment at the Cheneviers plant, the electrical and control installations as well as for the building housing the installations.

PEG assured project management and the co-ordination of intervening parties until final taking over and gave assistance in operation.

Heating of the connected apartment buildings is in function since September 2002.
Project:

Feasibility study for the valorization of the thermal energy produced in the Cheneviers for CADIO M district heating.

Description:

Since September 2002, the Cheneviers waste to energy plant feed the district heating CADIOM, which has a design capacity slightly higher than 60 MW th. The energy is given by steam produced from the incineration of urban waste.

As the low pressure steam currently available amounts for only about 43 MW th, PEG has been mandated in order study the optimization possibilities of steam production and consumption.

Main objectives were:

- To establish a heat balance of the waste to energy plant (high and low pressure steam).
- To perform a statistical study relating to the main current operation modes.
- To draw up a list of possible adaptations allowing, either to increase the production or to reduce the internal consumption of low pressure steam.
- To study in a simplified way these adaptations, from the technical and economic point of view, and thus to identify the most efficient ones.

Results:

The adaptations of the exploitation and the equipment identified by PEG allowed increasing the available power for the district heating from 43 to 70 MW th and to increase the global energetic efficiency of about 6 to 7%.
8. POWER STATIONS
Project:
Expertise of the electrical power station with combined cycle turbine of Cornaux. Electricity production capacity: 37 MW.

Description:
The turbine of Cornaux (canton of Neuchâtel) was brought into service in 1988. It replaced a turbine of 19 MW going back to 1966. Doted of a 37 MW power, it was used at the time of the study, like appoint unity and help and only entered 12,000 hours on a total of 200,000 hours envisaged with full mode.

The expertise entrusted to PEG consisted of a technico-economic analysis in order to proceed to a future evaluation of the Cornaux Factory. The following points were discussed in particular:
- Historical remind of the factory and conditions that lead to its realisation.
- Summary description of the turbine's technical aspects and its way of working with gas and steam.
- Evaluation of the actual and future profitability.

Inventory of technical modifications to take into consideration to valorise energy production at its best. Several scenarios have been established (dismantling, partial renovation, total renovation...), with investments figures and realisation's delays.

Equipment:
The installations are divided in five groups:

1. The power station of energy production: composed of a gas turbine Bi-fuel Alsthom (natural fuel light/gas), coupled to an alternator of a 36.6 MW maximum power ensuring the simple cycle and a turbine Echer-Wyss steam coupled to an alternator of 7.2 MW ensuring the combined cycle.

2. The station of coupling to the electrical supply network: a transformer with 3 rollings up of 62 Mva power.

4. The station of water pumping of Thielle.

5. The gas pressure regulator station and counting of natural gas: including 2 principal stations of relaxation of 25 and 5 bar and a counting. The equipment installed in the power station allows using a flow ranging between 0 and 14'000 natural gas Nm³/h for the turbine.
Project:
Steam production and distribution for pharmaceutical industry.
Saturated steam production: 5 t/h.

Description:
Within the framework of the site extension of an important pharmaceutical production centre, PEG was mandated as prime contractor for the conception of a new centralized industrial power plant, producing and distributing the necessary steam to the different process of medicines production.

The main technical requirements were the following:
- Entire compatibility of the energy production with the existing manufacturing process (steam properties).
- Integration into the existing control-automation system.
- Installations realized in conformity with the standards and regulations in force (VSM, ASIT, OPair, DEP,…).
- Largely dimensioned installations in order to assure a reliable and safe operation, and leaving the possibility for new extensions.

The installation consists mainly of:
- A 5 t/h saturated steam generator with an internal economizer and including a fully automatic boiler operation with 72 hour monitoring (BOB 72).
- Boiler feed pumps, a 10 m³ deaerator feed water storage tank and a 10 m³ condensate tank.
- Fuel burner plus its regulation system.
- Steam, condensate and fuel pipes, including connection to the existing equipment.
- Boiler feed-water production by reverse osmosis.
- The chimney.

The PEG services have covered the entire studies phases: preliminary drafts, simplified projects and the definitive project studies, as well call for tenders documents redaction and the bids analysis.
8. ENVIRONMENTAL IMPACT STUDIES
Environmental impact study on the upgrading of the SATOM Watse-to-Energy plant.

**Description:**

In 1992, upgrading and improving the plant proved necessary due to the aging of the incineration facilities (in operation since 1976), and the enactment of the new Air Quality Ordinance.

In essence, the project involved the replacement of one of the two aging incinerators with a new incinerator/boiler unit and the installation of an exhaust gas denitrification system (NOx reduction) on each of the two lines. During a second phase, the second incinerator would have to be replaced around the year 2005.

The capacity of the new incinerator was defined in order to remain compatible with that of the existing installations shared by the two incineration lines. In addition, the project modified relatively little the outer appearance of the plant.

**Impact study:**

In conjunction with the implementation of this project, an environmental impact study was conducted in compliance with the Environmental Impact Study Ordinance (OEIE):

- First, a preliminary survey was conducted for an initial assessment of the project's potential impact on the environment and for identifying the areas of the environment that might be affected.

- An impact report was then prepared on the basis of predetermined specifications.
In essence, the evaluation of the project’s impact was based on a comparison between a reference situation (without project implementation) and a future situation (with project implementation), taking into account forecasts of waste volume to be incinerated and maximum plant capacity.

Overall, the project proved to have a rather positive impact on the environment due to the replacement of an old incinerator with a modern unit (better combustion, decrease in carbon monoxide emissions, decrease in slag incombustibles) and to the installation of NOx reduction systems (decrease of more than 80% in nitrogen oxide emissions).

Since emissions into the air and water of other residual pollutants are a function of the quantity of incinerated wastes, and since operations of exhaust gas scrubbing and water treatment remain unaffected, the project will not in and of itself modify the plant’s impact on the environment.
**Project:**

PEG conducted a preliminary project study and an environmental impact study for a processing center of household waste to be located at Yverdon.

**Description:**

These studies involved more precisely an incineration plant of 30'000 tpy and the recovery of 20'000 tpy of household waste.
PEG has conducted a facility study and environmental impact study of a household waste incineration plant.

**Project:**

PEG has conducted a facility study and environmental impact study of a household waste incineration plant.

**Description:**

The project included two incineration lines of 14 Gcal / h and a capacity of 70,000 t / year.
9. ENVIRONMENTAL AUDITS
Client: Ministry for Environmental Protection and Natural Resources of the Russian Federation (NPAF)

Country: Russian Federation
Date: 1996

**Project:**
Pre-investment study for the Pollution Abatement Program of NPAF.

**Description:**
Technical, environmental and economic audit of a new process for pretreatment of heavy metal scraps.
**Project:**
Pre-investment study for the Pollution Abatement Program of NPAF.

**Description:**
Audit for the replacement of an old cooling equipment of a storage facility treating of the environmental benefits, the technical feasibility and the economic feasibility.
Client: Ministry for Environmental Protection and Natural Resources of the Russian Federation (NPAF)
Country: Russian Federation
Date: 1996

Project:
Regeneration of heavy metal spent catalyst out of the chemical industry.
Characteristic: 100 tpy of catalyst

Description:
PEG scope of work included the feasibility study and technical expertise.
**Project:**
Reduction of sulphur oxides emissions produced by iron ore sintering.

**Description:**
In partnership with KPMG Fides and Ecoling, PEG has performed the technical, economical and environmental audit of the AO Nosta project for the reduction of the sulfur oxides emissions of the iron ore sintering operation. With a annual production of 2 to 3 millions tons of steel, this manufacturer situated in Novotroïsk (Orenburg region) is the fourth biggest iron and steel producer of Russia.

The aim of the project presented by AO Nosta was to reduce by 80 % the sulfur oxides emitted by the four sintering units with a annual capacity of 800'000 tons each. The off-gas washing towers planned for the treatment of 1.5 million Nm³/h were supposed to catch yearly between 3'000 to 8'000 tons of sulfur oxides mostly released by the thermal decomposition of the sulfate present in the iron ore.

The audit was performed with the financial support of the swiss federal office for cooperation with Eastern Europe within the World Bank Environmental Management Programm for the Russian Federation.
Project:
Extraction of rare earths out of phosphogypsum waste resulting of fertilizers production.

Description:
In partnership with KPMG Fides and Ecoling, PEG has performed the technical, economical and environmental audit of a project for the extraction of rare earths (lanthanide) out of residues from the production of phosphoric acid using ore from the Kola Peninsula. With a yearly production of 300,000 t of Ammophos (ammonium phosphate), Voskresensk Mineral Fertilizers JSC is one of the most important fertilizer producer of Russia.

Based on the reuse of 135,000 t/y of phosphogypsum waste as raw material, the project presented by Voskresensk Mineral Fertilizers expects the production of 250 t/y of lanthanide oxides, the recovery of 650 t/y of phosphate and the purification of 100,000 t/y of gypsum. The high value of the lanthanide oxides used as polishing agent in the optical industry and the recycling of purified gypsum in the construction industry should procure enough revenue to cover the cost of this project for a sustainable use of natural resources.

The audit was performed with the financial support of the Swiss federal office for cooperation with Eastern Europe within the World Bank Environmental Management Program for the Russian Federation.