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# GrDF asset-management strategy:
# New tools for ranking risk-based investments

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# ABSTRACT

Gaz réseau Distribution France (GrDF) is a subsidiary of the GDF SUEZ Group and is responsible for distributing natural gas throughout France. GrDF operates a gas distribution network of over 192,000 kilometers long, consisting of a wide variety of materials and age, and more than 7 million equipments and assets (pressure-reducing stations, network valves, service lines, etc. to end customers' meters). GrDF network is thus the longest in Europe, GrDF itself is one of the five largest natural gas DSOs in the world.

In a context marked by the end of the grey cast-iron pipelines renewal programme in 2007 and a strengthening of regulation rules, GrDF faces many choices concerning the renewal of concession assets, whose nature and age vary. Thus, some 3,000 investment projects have to be prioritised and approved for a national budget closed to €210 million per year.

Having consolidated its knowledge about the condition of its network in technical and performance terms, GrDF set about mapping critical assets (facilities whose criticality was lower than the one of grey-iron pipelines) and drew up details of methods and tools to be used to help manage risks and investments efficiently :

- identify target facilities, within the pool of critical assets, and determine the most effective way of dealing with them based on the associated risks, safety considerations, costs and GrDF external commitments;
- support steering of GrDF investments in renewing these assets to ensure that they operate at optimum efficiency.

This article presents the process and the tools developed by GrDF and the Gas and New Energies Research Centre of the GDF SUEZ Research and Innovation Division (CRIGEN-DRI) for steering of GrDF renewal and reinforcement investments. It focuses particularly on the GSI tool, integrated in a cartographic application, which is currently used by regional consultancies (local network) and the GrDF Asset Management National Department for helping to prioritize investment projects.

The approach presented seeks first and foremost to provide a set of standardised tools to all operators involved in managing GrDF assets with a view to optimising the efficiency of the latter's investment and maintenance policies at all levels. Widespread use of the GSI tool, simplified by its pragmatic and practical characteristics, has given GrDF a broader view of its multiannual investment programmes and enables it to allocate budget resources appropriately. The quality of GrDF asset management practices has been recognised as Best Practices by the WOC4 Distribution working group of IGU at the 2009 World Congress.

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# Paper

## 1. Presentation of Gaz réseau Distribution France

### a. GrDF – a subsidiary of the GDF SUEZ Group

*Gaz réseau Distribution France* (GrDF) is a subsidiary of the GDF SUEZ Group and is responsible for distributing natural gas throughout France. GrDF is a single entity responsible for its own economic stability and whose business activities mainly revolve around gas transmission. GrDF performs the following tasks:

- independently transmitting natural gas throughout France on behalf of all suppliers in a non-discriminatory manner;
- designing, building, operating and managing the natural gas distribution system by guaranteeing the safety of the real estate and people and providing high-quality coverage;
- connecting customer installations to the network;
- providing services related to the supply of natural gas;
- developing the natural gas network in a sustainable and profitable way so as to provide access to natural gas to as many people as possible;
- taking care of the delegated management of the public gas distribution service via concession contracts.

These tasks are fulfilled within a specific framework:

- GrDF operates the network on the basis of concession contracts concluded with the local licensing authorities (the asset owners);
- GrDF is answerable to the French regulator: the French Energy Regulatory Commission (CRE) is the market "watchdog", guaranteeing transparent and fair operation of the energy market ;
- GrDF is also under the aegis of the French State in terms of its obligation to observe the technical regulatory stipulations and requirements related to its activities as a natural gas distributor.

**Development of GrDF**

The development of GrDF is involved in the following context:

- determining a regulated economic framework;
- building up assets (investments);
- capitalising on these assets by providing services;
- developing the market;

- ensuring that the network operates efficiently in terms of both economic and industrial performance.

Today, the GrDF project *Entreprendre pour réussir* (Success through enterprise) focusses on safety as the top priority in terms of economic and industrial performance.

### b. GrDF key figures

The key figures for GrDF are as follows:

- a natural gas network with a length of 192,100 km. GrDF network is thus the longest in Europe, GrDF itself is one of the five largest natural gas DSOs in the world;
- serving 9,423 municipalities (77% of the French population);
- 11 million customers in France;
- €638 million in investments;
- regulated asset base of approximately €13.2 billion.

GrDF currently invests €1 million a day on improving network safety. This amount is dedicated to three main activities:

- 50% on modernising the network;
- 30% on maintenance and troubleshooting;
- 20% on monitoring the network, training professionals and improving mapping.

### c. GrDF industrial assets

The natural gas distribution system is GrDF industrial tool. Its industrial assets operated via concession contracts are used to transmit natural gas to end customers' meters (concession limit) and cover many and varied facilities (see table below).

| Facility category | Facilities (number of units) |
|---|---|
| Pipelines | 192,100 (km) |
| Network pressure-reducing station | 17,600 |
| Customer pressure-reducing station | 270,000 |
| Individual service line | 6,330,000 |
| Collective service line (real-estate facilities) | 670,000 |
| Network valve | 285,000 |

Table 1 : Industrial assets operated by GrDF

The specific types of facility also vary widely within each facility category in terms of age and technical features. The pie chart below illustrates the variety of materials in the case of network pipelines :

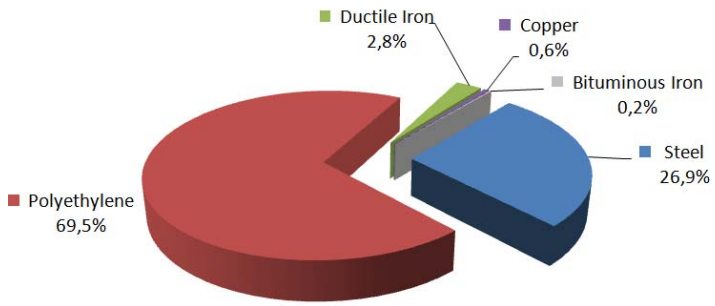


Figure 1 : Range of materials used across the GrDF distribution network

The pipelines operated by GrDF also vary considerably in terms of the following:

- material used (69% of network pipelines are made of polyethylene);
- age (average age of a pipeline is 20 years but age can vary substantially depending on the materials used);
- operating pressure (94% of pipelines operate at average pressure (between 4 and 25 bar), with approximately 11,700 km operated at low pressure).

## 2. Development of GrDF asset-management strategy

Since 2005, ahead of the completion of the programme to reduce grey-iron pipelines (2007), and against the backdrop of an increasingly regulated environment, GrDF drew up a specific asset-management strategy. At that time, three main priorities were identified and the corresponding action plans launched:

- consolidating asset-awareness;
- carrying out high-quality maintenance on facilities;
- managing renewal investments.

This strategy entailed defining methods for making choices between the various renewal investments and maintenance programme options for its concession assets. A number of issues are involved when allocating funds for such investments given the wide range of assets covered and the substantial annual budgets involved:

- an annual renewal investment budget of approximately €210M (excluding relocation of facilities), distributed across over 3,000 annual investment projects;
- an annual preventive-maintenance budget of approximately €50M.

GrDF efforts have focussed first and foremost on building up a more detailed overall picture of the condition of its network in technical terms and of the performance of the network based on its condition.

**Consolidating the fundamental principles of asset-management**

Since 2005, GrDF has taken the following measures:

- keeping an ongoing inventory of assets. Being familiar with its technical assets addresses two challenges:
    - Enhancing GrDF strategies of industrial risks management and ensuring that these facilities remain safe;
    - the value of GrDF assets is a major core component not only of its own revenue but also of the GDF SUEZ Group's accounts.
- enhancing its geographical information system (GIS) and system for mapping its facilities. This modern and effective system plays a key role in GrDF technical information system since it provides a representation of gas networks and service lines by positioning them spatially;
- establishing a national CMMS (Computerized Maintenance Management System). This tool includes a description of the data from the technical reference document listing concession gas facilities and meets the need for maintenance-activities management and information about the costs involved in operating and maintaining such facilities;
- developing an effective feedback procedure: GrDF has shored up the organisational structure, processes and tools used for managing collection of feedback data and analysing event feedback within a solid framework.

  Such analysis focusses specifically on:
    - the impact of the installations on the safety of people, public and private goods (gas leaks, potentially critical incidents, accidents);
    - the quality of the gas supply provided to customers.

## 3. Methods and tools developed for asset management

Having consolidated its knowledge as presented above, GrDF set about mapping critical assets (facilities whose criticality was lower than the one of grey-iron pipelines) and drew up details of methods and tools to be used to help manage risks and investments efficiently. The tools are designed to fulfil three main requirements:

- identify target facilities, within the pool of critical assets, and determine the most effective way of dealing with them based on the associated risks, safety considerations, costs and GrDF external commitments;
- compile and update this list of target facilities and build a plan for reducing risks
- support steering of GrDF investments in renewing these assets to ensure that they operate at optimum efficiency.

Management of asset renewals is coordinated via the Industrial Safety Gains (GSI) tool, which is designed to provide indicators to local and national investments planners involved in:

- taking decisions in respect of each investment project ;
- building annual and multiannual investments programmes.

Developed by GrDF and the Gas and New Energies Research Centre of the GDF SUEZ Research and Innovation Division (CRIGEN-DRI), the GSI tool is currently used by regional consultancies (local network) the GrDF Asset Management National Department.

### a. Aid to establishing a hierarchy of investments: GSI tool

Each region draws up its own investments programme based on the priorities defined by the GrDF Asset Management National Department in terms of the works plan and in respect with the allocated budget. Now it is a matter of prioritising these requests at regional level, using a national homogeneous method shared by everyone.

**GSI tool: designed to enhance industrial safety**

The GSI tool is a key one in GrDF asset-management strategy since it quantifies a decision-making indicator enabling to prioritise facility renewals and distribution capacity enhancement.
It aims to quantify, as comprehensively and objectively as possible, the capacity of an investment to reduce the risks of operation the natural gas distribution system. The figure below shows the position of the GSI tool within the process of drawing up GrDF annual investments programmes.

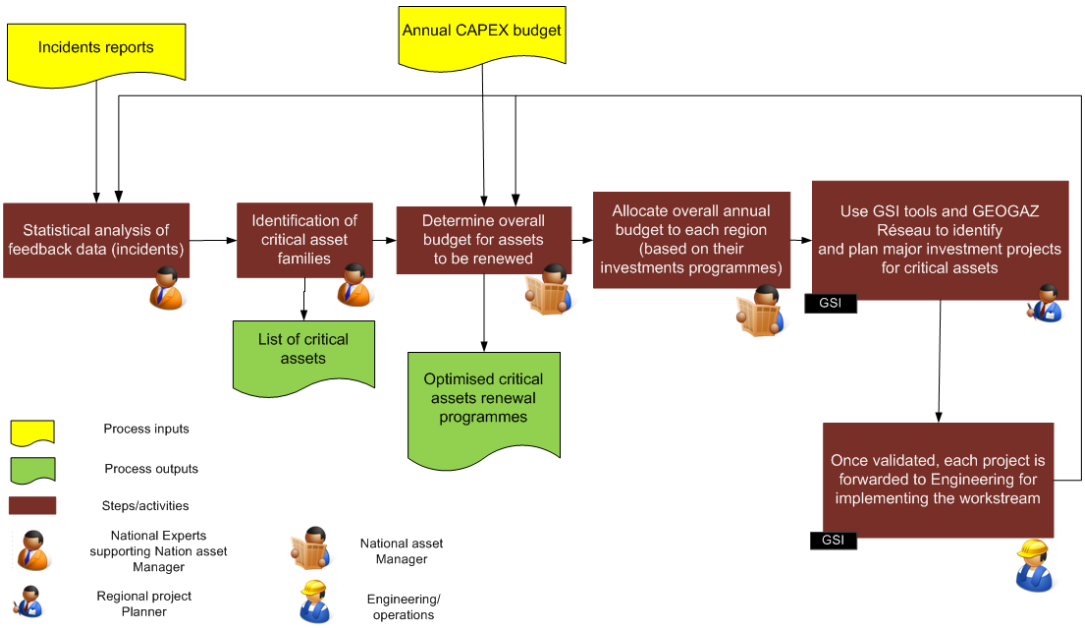


Figure 2 : GrDF annual investments programmes process

Based on a full-costs approach, the GSI tool helps to guide GrDF investments strategy with a view to meeting two key objectives:

- improving the reliability of the network facilities and achieving gains in terms of safety and of keeping those facilities operational;
- improving the quality of supply by enhancing network infrastructure (reducing the risk of loss of gas supply).

**Principles of the GSI**

The GSI is calculated using two basic principles:

- the principle of avoided costs over the service life of a facility;
- the full-cost approach to evaluate these avoided costs.

The GSI is calculated on the basis of a comparison between these avoided costs, due to the renewal or enhancement of existing distribution system facilities, and the investment needed for installation of new facilities:

$$\text{GSI} = \frac{\text{Avoided costs}}{\text{Investment}}$$

The calculations carried out by the GSI tool are based on a reference period of 45 years, which is consistent with the reference period used to calculate the regulated asset base (RAB) according to which the transmission tariff is determined.

These avoided costs are estimated on the basis of the direct, indirect and induced costs entailed by network facilities:

- direct costs: these include the operating and maintenance charges (equipment, workforce, subcontracting) which are directly recorded on the units, and the cost of accidents (compensation for damage to goods and injury to people, including the cost of insurance). These costs are estimated using basic accounting principles.
- indirect costs: these are generally structural and administration costs. Estimating such costs is a more complex process and requires specific analysis of a range of factors;
- induced costs: these are all the other costs related to notions like safety, regulatory changes, customers' satisfaction, local authorities, etc.

  The broad range of factors influencing such costs makes estimating them a complex process: loss of reputation, tightening of the regulation, industrial nuisance, commercial and institutional impact, loss of production of industrial companies, etc.

  Special care must be taken when estimating induced costs. The induced costs are of fundamental importance to the method because in many cases they are greater.

The full-cost approach aims to assess as extensively as possible the financial implications of each event avoided as a result of effective investment decision-making.

**Nature of the workstreams investigated**

The GSI tool can be used to investigate two families of workstreams covering GrDF industrial assets:

- network renewal workstreams: the purpose of these workstreams is to replace a set of existing facilities due to their state of deterioration and/or risks they pose to third parties, the distribution system and its material environment.

- network upgrading workstreams: the purpose of these workstreams is to improve supplies for customers who face the risk of local interruptions to distribution due to incidents or cold weather.

**Evaluating the investment**

The GSI tool uses a parametric model to estimate accurately the investment required for each project. The model includes two specific features:

- the parameters used are defined by geographical zones, smaller than or equal in size to a region, based on GrDF feedback data. These values can be updated each year, this ensures that the model remains sustainable;

- users can adapt the estimates generated to reflect the framework of each individual investment project via adjustment coefficients. However, users must submit details of why they are using such coefficients when they do so beyond certain predetermined threshold values.

**Quantifying gains (value of avoided costs)**

The avoided costs are estimated for each type of workstream. These costs reflect the expected economic benefit of replacing or upgrading part of the network. This involves comparing the behaviour of existing facilities with the expected behaviour of a technical solution offered by the system operator.

Four categories of gains are evaluated in economic terms:

- safety gains: economic value reflecting the effect of the investment on the occurrence of incidents that are potentially critical for the part of the network in question;

- continuity-of-distribution gains: economic value of the effect of the investment on the occurrence of interruptions to gas distribution and the resulting inconvenience to customers;

- operational gains: economic value representing the effect of the investment in terms of keeping the operated part of the network operational (OPEX);

- opportunity gains: economic value representing two types of opportunity:

    - capitalising on roadworks to anticipate an investment decision;

    - other gains related to the local workstream situation.

Specific models are used to estimate each of these gains.

- Assessing safety gains

Safety gains are estimated if a renewal workstream is being investigated. The facilities taken into account for calculating safety gains are as follows: pipelines, individual and collective service lines, internal pipes, risers, specific branch lines and pressure-reducing stations.

Accordingly, the computational model for safety gains uses the following as input data:

- the annual frequency of occurrence of potentially critical incidents, which is quantified on the basis of analysis of feedback about incidents;
- parameters describing the nature of the population near to facilities: these parameters are obtained on the basis of external reference databases which detail the population density and the type of home (data taken from the French census);
- the average full cost incurred by the occurrence of a potentially critical incident.

- Assessing continuity-of-distribution gains

The computational model for supply gains is based on four key elements:

- the annual frequency of interruptions in distribution for the various types of facilities, based on feedback;
- the nature and structure of the local network being investigated;
- the number and type of the customers connected to the part of the network being investigated;
- the economic parameters associated with deterioration in the gas supply.

The economic valuation includes three types of cost:

- loss of transmission revenue;
- once an incident has been resolved, the labour costs for restoring gas to customers who were cut off;
- assessment of the inconvenience to customers.

- Assessing operational gains

Operational gains are calculated on the basis of the following data :

- the annual frequency of incidents by families of facilities (incident generating corrective maintenance costs);
- the average full cost of corrective maintenance work defined as a function of each type of facility.

- Assessing opportunity gains

  Opportunity gains can be used to the following:

  - forward-planning of works which may be required specifically as a result of roadworks carried out by a local authority or another underground network operator;
  - other considerations including, in particular, the effects of an investment on the local structure of the distributor.

The GSI approach can easily be adapted to suit other applications. Accordingly, other types of risks can be incorporated into evaluations, e.g. emerging risks. **The first version of the GSI tool, an Excel spreadsheet, has been used since September 2005 by all GrDF regional operators responsible for drawing up investment studies.**

### b. An operational cartographic tool within the *GEOGAZ Réseau* application

Since 2008, the GSI tool has also been integrated into the *GEOGAZ Réseau* cartographic application, developed using Smallworld GIS. The application is currently used by over 250 users responsible for investigating regional investments projects.

The cartographic application can be used to:

- instantaneously display a visual representation of the data regarding assets and incidents available in the various GrDF databases (CMMS, feedback database, customer data, etc.);
- display zones with a high investment value for safety, in descending order of GSI (which is calculated automatically);

  The figure opposite shows an example of geographical prioritisation.

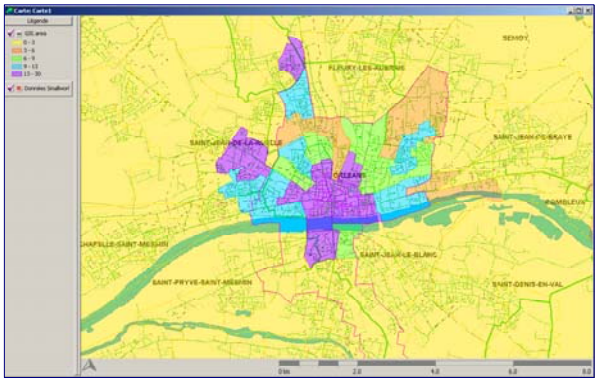

Figure 3 : Example of geographical prioritisation

- provide a computational model for the GSI indicator for regional users. It can also be used to determine how an investment project is performing.

  Having identified a zone with a high investment value, users can select a road or set of roads they consider relevant or an investment project. They select one or more pipelines and launch the GSI application within *GEOGAZ Réseau*.

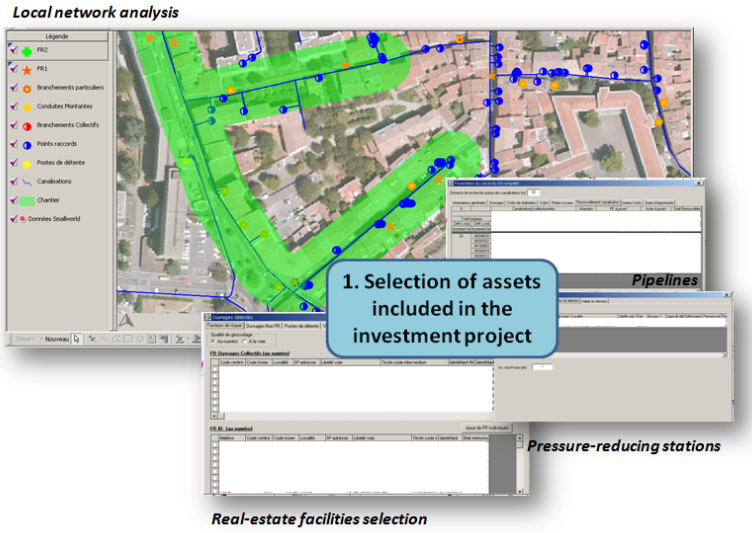


Figure 4 : Selection of assets included in the investment project

Based on the pipelines selected, the computational model automatically identifies all those facilities that can theoretically be included in the draft study (green-marked section in the figure above). Users can then select the specific facilities they want to include in their investment project (see sample tabs above).

They must then validate the technical and economic parameters used to calculate the GSI indicator of the project being investigated (see figure below).

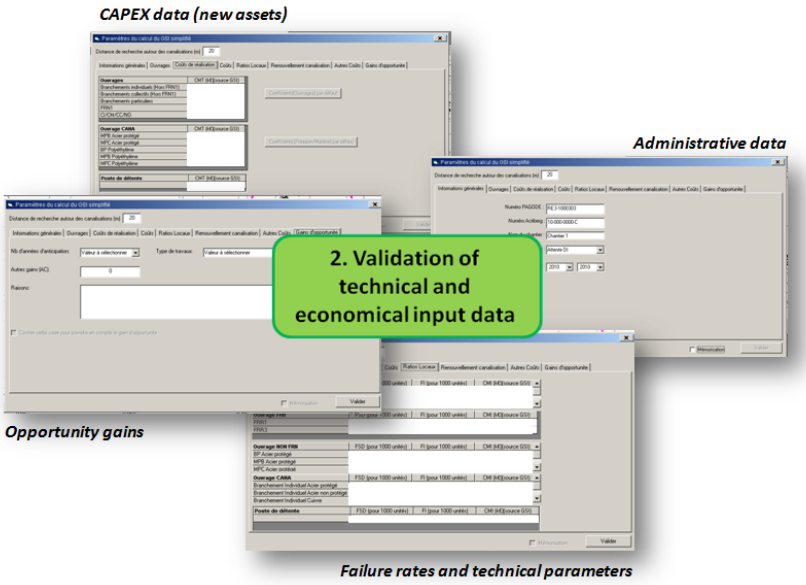


Figure 5 : Validation of technical and economical input data

Users can therefore find out the GSI indicator value for the project almost immediately. The computational model also generates a standardised Excel output file containing the following (see figure below):

- the GSI worksheet for the workstream in question;
- a cartographic representation of the selected facilities;
- the data related to renewed facilities;
- a physical document containing the data required to monitor implementation of the work by the engineering department;
- a financial breakdown of the investment project, which helps to create the file within GrDF accounting application.

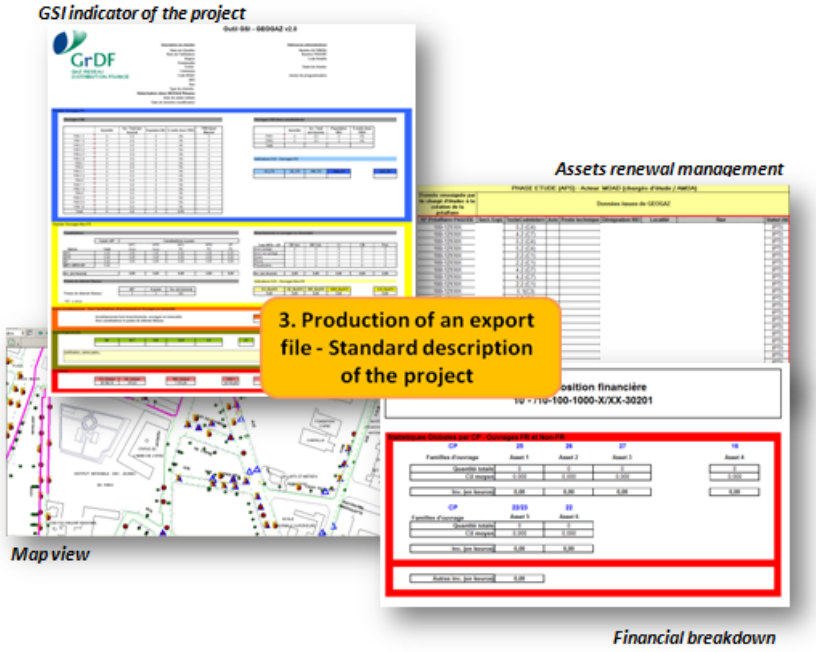


Figure 6 : Production of an export file

Section **Erreur ! Source du renvoi introuvable.** outlines future developments in connection with the GSI tool.

## 4. Significant and quantifiable gains

### a. Improving relevance and objectivity when building annual investments programmes

The GSI tool is the most advanced decision-making tool developed to date. Both the tool itself and the methods it uses have enabled GrDF to improve the relevance and objectivity of its facility renewal investments programmes.

A number of gains have been identified:

- major progress in terms of assessing the gains related to a given investment project thanks to the introduction of a full-cost approach. The GSI tool ensures that all regions are dealt with fairly in terms of safety-management;
- anticipated gains in terms of risk-management by identifying high priority zones. The GSI approach contributes to GrDF industrial-safety strategy of zero casualties as a result of an incident or accident on its distribution systems (third parties, own employees and staff working for service providers);
- support in building annual renewal-investments programmes. This tool has improved visibility of the structure of these investments.

The in-depth analysis of investment requests presented by the GrDF regions enables the factors determining the performance in each annual investments programme to be identified (e.g. allocation of regional investments funds) and their special features to be understood.

The figure below shows an example of results of analysis based on these data:

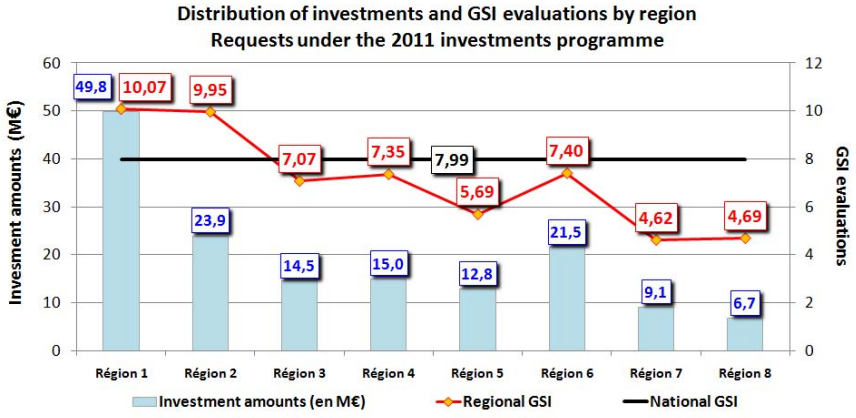


Figure 7 : Example of results of investment priorisation based on GSI

**Today, the entire annual investments programme is subject to a GSI study.** The studies carried out are based on an annual budget of approximately €210 M distributed across 3,000 investment projects and cover a large number of facilities each year:

- 24,000 collective service lines;

- 6,000 real-estate facilities;
- 150 km of pipelines;
- 140 pressure-reducing stations.

**Proven effects on regional practices in terms of investment projects**

The performance criteria within the GSI tool help the regions to draw up and build their annual investments programmes. Since 2008, these criteria have also been a source of objective and relevant information for the Asset Management National Department in setting and allocating regional investments budgets.

The GSI tool thus helps to integrate managerial policy into practice within the various focus areas of the annual investments programmes (priority is given to renewals of the most critical facilities).

The figure below illustrates the trend between 2008 and the present:

- distribution by priority of regional investment projects between the 2008 and 2011 annual programmes;
- national GSI indicator values (average weighted value) across these two years.

The features of annual investments programmes have been significantly modified between 2008 and 2011. This figure shows:

- the substantial rise in the national GSI indicator value (average weighted value);
- a considerable increase in the part of investments allocated to renewing facilities which were to be reduced as a priority.

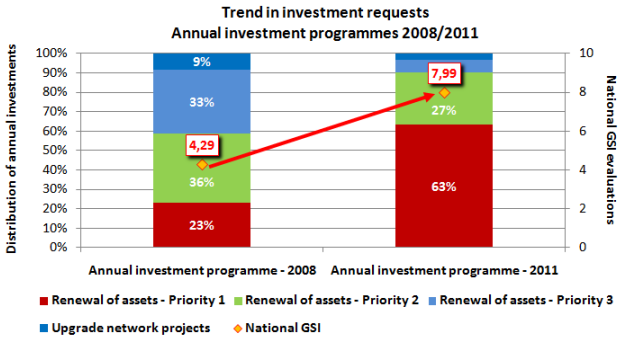


Figure 8 : Trend in investment requests 2008 / 2010

**b. Significant time saved in conducting investment studies**

Developing the *GEOGAZ Réseau* application and integrating functionalities geared specifically towards GrDF internal practices has meant that a significant deal of time has been saved for the 250 regional users.

The application makes it much easier for regional project planners to generate preliminary investment studies since it contains all GrDF main technical and economic data required for the draft study.

### c. A gain for GrDF image

GrDF asset-management practices and associated tools are widely recognised outside the GDF SUEZ Group. They were acknowledged as **Best Practices at the IGU's World Gas Conference held in Buenos Aires** in 2009. The functionalities and cutting-edge software offered by the *GEOGAZ Réseau* cartographic application received special commendation.

This strategy is a channel through which GrDF can demonstrate to both the French regulator (CRE) and the local and national authorities its expertise in highly efficient management of regulated revenue.

## 5. Future developments

Future developments over the next years will focus on the following:

- ongoing improvement of assets and their operational performance;
- innovative steps for modelling facility reliability;
- maximum use of the functionalities afforded by the cartographic application.

These works will, in particular, help to shore up the steps taken to put in place multiannual investments and maintenance programmes, which are currently outside the scope of the GSI tool. Accordingly, GrDF and CRIGEN-DRI are working on developing tools to help ensure that current assets are able to continue operating for as long as possible by:

- optimising decision-making around the choice between adapted maintenance strategy and renewing assets;
- developing optimum renewal policies: adjusting the number of assets renewed, and the associated investment budgets, and incorporating such projects into multiannual programmes.

These tools will help regional project planners to simulate multiple investment plans and to assess their effects over the medium term. The figures below illustrate indicators adapted for comparing two multiannual investments programmes:

- trend in reliability of facilities concerned by a renewal programme;
- multiannual distribution of budgets allocated for such renewals.

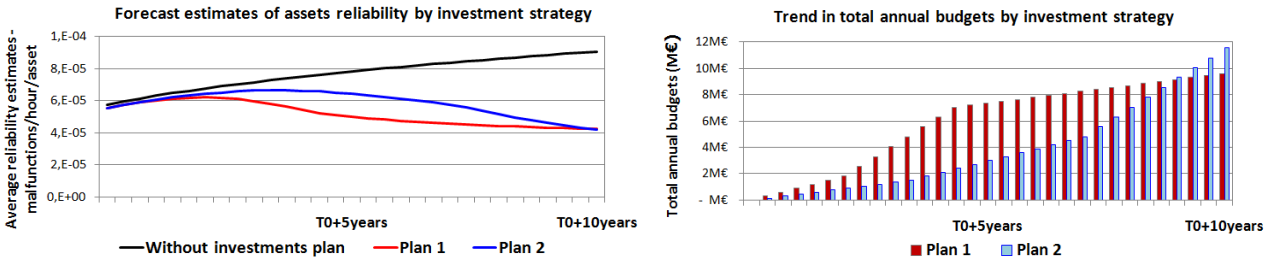


Figure 9 : Comparative analysis of medium-term-investments programmes

Both of these figures illustrate the case of specific facilities for which a voluntary renewal strategy helps to increase significantly its global reliability (blue and red curves in the left-hand figure). Each investments strategy simulated generates reliability levels equivalent to 10 years. These assessments also demonstrate that distribution of the budget amount under Plan 1 is more efficient than the one under Plan 2 since the forecast total investments over 10 years is less important (right-hand figure).

**Enhancing reliability modelling and operational gains**

Developing these approaches and tools will help to model two key considerations in greater detail:

- reliability of assets, via a statistical analysis of GrDF feedback data. Innovative techniques are currently being developed to:
    - identify the technical characteristics and operational factors which influence the reliability of facilities operated by GrDF;
    - model more effectively the influence of age on assets reliability.

  Major work is currently under way to develop the modelling process for use in relation to the whole GrDF distribution network (see section 1.c).

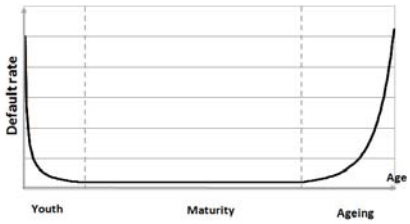


Figure 10 : Bathtubs curve hazard function

  These developments will help considerably in shoring up GrDF asset management strategy since they will make it possible to incorporate trends in the reliability of assets (existing or new) into investment and maintenance decision-making processes.

- operational gains as a result of a voluntary renewal policy.

## 6. Conclusion

The approach presented above seeks first and foremost to provide a set of standardised tools to all operators involved in managing GrDF assets with a view to optimising the efficiency of the latter's investment and maintenance policies at all levels.

The wide range of operational facilities, regional contexts and immediate environments mean that the GrDF Asset management Department needs to allocate the required resources in an objective manner to ensure agreements and enforceability. Widespread use of the GSI tool, simplified by its pragmatic and practical characteristics, has given GrDF a broader view of its multiannual investment programmes and enables it to allocate budget resources appropriately.

Finally, the quality of GrDF asset management practices has been recognised as Best Practices by the WOC4 Distribution working group of IGU at the 2009 World Congress.

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