A better understanding of uncertainties

A software environment for statistical and probabilistic analysis of electrical networks
A better understanding of uncertainties

You wish to:
- Optimise your investment decisions?
- Know the impact of the wind turbine generation on your network?
- Make better use of available resources and reduce system operational costs without compromising the security of supply and the integrity of equipment?
- Increase the international exchanges on your network?

And you know that your decisions should take into account an increasing number of uncertainties:
- The location and level of generation are more and more difficult to plan,
- The consumption and the power exchanges are also difficult to plan in a context of establishment of the European market.

You must operate your system closer and closer to its limits?

The ASSESS software environment allows:
- The execution of a large number of simulations on different network situations,
- The easy analysis of a very huge number of results in order to extract the crucial information on the system behaviour and its limits.

ASSESS has been developed by RTE and National Grid Transco.

ASSESS allows to generate new systematic or random situations modelling the uncertainties. It is possible to model uncertainties on any variable defining the studied network (for example: generation of a wind turbine site, consumption in a zone, maintenance of devices...).

To do so, the user has access to a great variety of probability laws. In a typical ASSESS study, the user generates between 1000 and 3000 new situations. Then each situation can be analysed with a full range of tools.
A full range of tools for the static and dynamic security analysis...

- **METRIX (RTE):** Optimal Power Flow in DC approximation
- **TROPIC (RTE):** AC Optimal Power Flow
- **ASTRE (UNIVERSITY OF LIEGE):** long-term dynamics simulator dedicated to the study of voltage phenomena. ASTRE integrates a load-flow, a long-term dynamic simulation module and a security margin computation module.
- **EUROSTAG (EDF, TRACTEBEL, RTE):** dynamics simulator allowing a detailed study of transient, mid and long-term stability. EUROSTAG uses a variable simulation step and integrates a large automata library.

... and for statistical and data-mining analysis

All the results produced by ASSESS are stored in a database. The exploration and analysis functions of the database are offered by the SAS (SAS INSTITUTE) and ANSWER TREE (SPSS) tools. The user can explore its data using easy extraction queries to define. The user has access to simple statistical analysis (histogram, mean, variance, correlation) or more sophisticated ones using detailed statistical models as the decision trees.
Minimization of operating costs in interconnected systems
METRIX: minimization of operating costs in interconnected systems

METRIX enables the transmission system operator to study a number of different problems: economic and technical analysis of a network reinforcement, determining the minimal redispatch linked to a congestion and associated cost, evaluation of the exchange capacities, assessment of the risk of not satisfying a transaction. METRIX computes, for one or several interconnected transmission systems, power injections hypotheses that are realistic from an economic point of view under thermal capacity limits (economic dispatch). Only active power flows are taken into account using the so-called DC approximation. METRIX therefore uses a linear programming algorithm which ensures a fast execution even on big networks.

METRIX has been developed at RTE and has benefited from years of experience in the domains of power system design and mathematical methods.

A realistic economic dispatch
At first, METRIX determines realistic power injections from an economic point of view without taking into account the network constraints. The computed injections can be interpreted as the generation schedule submitted to the TSO by the producers in a market with perfect competition. Then, METRIX modifies this schedule in order to make sure that all thermal capacity limits are respected, in normal state as well as, preventively, in case of a network contingency (N-1 line, N-k lines and generation units). In this step, METRIX can simulate an adjustment mechanism by taking into account inc/dec production costs. The redispatch obtained therewith avoids any congestion on active flows. It represents the least cost adjustment sequence that should be used by the TSO to maintain system security.

A software tool for ASSESS
METRIX is one of the modules of the ASSESS platform. The user can submit to METRIX a large number of situations based on multiple scenarios: availability of thermal units, of transmission lines, of AC/DC conversion stations, consumption level, wind farm production, fuel costs, etc.
Optimal working point
determination
TROPIC: optimization of the transmission system operation

TROPIC allows to compute a network steady state so that physical and operating constraints are satisfied and an economic criterion optimized. This model uses a full active-reactive representation of power flows and new high-performance solving methods based on a non linear programming algorithm: the « Primal-Dual Interior Point Method ».

TROPIC solves a large range of problems such as the economic dispatch (OPF), the voltage profile optimization or the planning of the necessary reactive power compensation means.

TROPIC has been developed at RTE and has benefited from years of experience in the domains of power system design and mathematical methods.

The economic dispatch
The economic dispatch computes power injections hypotheses that are realistic from an economic point of view (or the minimal deviation for these injections) so that the power flows or voltage constraints are satisfied. It can be used as a decision support by a Transmission System Operator to solve numerous problems: congestion management, assessment of the exchange capacities with foreign countries, appreciation of the stakes involving FACTS, evaluation/costing of the operation safety.

The voltage profile optimization
This function is aimed at obtaining an optimal voltage profile and thus determining the voltage setpoints of the generators participating in the primary voltage control, the voltage setpoints of the controlled buses when a secondary voltage control is used, the on load tap changer transformers position and the state of compensation means (capacitors, reactors, shunt FACTS) in order to obtain an optimal situation satisfying the user’s criterion (for instance, the active power losses minimisation).

The planning of compensation means
TROPIC allows to determine the investments in reactive means (VAR planning). The model set the optimal static and dynamic compensation means to add towards the base case and different network contingencies (a systematic « N-1 » analysis or a « N-k » one specifying a list of contingencies). Tropic uses a decomposition-coordination technique of the generalized Benders type especially well adapted to the problem at end.

A software tool for ASSESS
TROPIC is one module of the ASSESS platform.
A dynamic voltage security analysis
ASTRE: a dynamic voltage security analysis of transmission networks

ASTRE comprises several software tools dedicated to voltage security analysis and then offers a multi-level analysis:
- Base case load flow computation and steady-state contingency analysis,
- Time-domain simulation of power systems slow dynamics and voltage instability diagnosis,
- Evaluation of overall security indices in MW or MVAR produced by mixed computations associating steady-state calculations and dynamic simulations (for instance computation of the maximum load increase withstandimg the N-1 rule).

ASTRE has been developed by the University of Liège (Belgium).

Three modules:
- ARTERE is a load flow computation module featuring:
  - On load tap changers ratio adjustment for voltage control,
  - Phase shifters angle adjustment for power flow control,
  - Secondary Voltage Control maintaining the voltage profile while system condition are modified,
  - Contingency analysis checking voltage and current criteria.

QSSS (Quasi Steady-State Simulation) is the core of ASTRE. This time domain simulation module models the power systems slow dynamics using the quasi steady-state approximation. This technique offers a high computation efficiency allowing the analysis of numerous scenarios while maintaining a detailed level of modeling, notably on the grid automata and slow regulations. QSSS features a voltage stability analysis function that localizes the voltage collapse (modal analysis) and provides information on the appropriate corrective actions.

SOLD (Secure Operation Limit Determination) uses the ARTERE steady-state calculations and the QSSS dynamic simulations and interprets their results to compute overall security indices with respect to load or generation variations and a contingency list. For instance, SOLD offers the following index computations:
- Secure operation limits (for example, maximum load or generation level withstanding the N-1 rule),
- Post-contingency margins,
- Minimum preventive or corrective load shedding,
- Minimal reactive power reserve by generating unit.

A software tool for ASSESS
ASTRE modules are included in the ASSESS platform.
Software for the simulation of power system dynamics

A continuous display of both fast and slow phenomena
EUROSTAG: power system dynamic simulation for transient, mid and long term stability

**A reliable simulation**
EUROSTAG integrates all power system components and actions necessary to produce an accurate and faithful dynamic simulation: Generators – Motors – Controllers – Protection devices – Control equipment – Operator manoeuvres – ...

**A powerful algorithm**
EUROSTAG is based upon a unique algorithm using a continuously and automatically varying integration step size, featuring:
- A unique program using unique modelling of processes for a whole range of applications,
- A continuous display for both fast and slow phenomena.
EUROSTAG covers the full range of transient, mid and long term stability, from electromechanical oscillations up to daily load evolution.

**A flexible power system modelling**
EUROSTAG includes an extensive library of models (including wind turbine generation and any other dispersed generation facilities), as well as an advanced graphic modelling language for the representation of any type of device, machine or controller specific to a given power system.

**Faster and easier studies**
EUROSTAG offers an user-friendliness that makes all the studies easier and faster: modelling – network edition – simulation – results analysis

**A team of experts**
EUROSTAG is developed and managed by RTE, TRACTEBEL and EDF. A team of experts offers a large variety of services: support – upgrades – maintenance – modelling – training – consulting – users’ club – ...

**An open software**
EUROSTAG can read the data in international formats and can recover models and parameters used in older programs, allowing knowledge acquired with other tools to be saved. It goes further in result exploitation through export to specialized programs (Matlab®, Microsoft® Office®...)

**A code for ASSESS**
EUROSTAG can be used autonomously or as a module of the ASSESS platform.

- Planning
- Design
- Operation
- Operator training
- Transmission networks
- Distribution networks
- Industrial systems
- Post incident studies
- Defence plan studies
- Computation of available transfer capacities
- Restoration studies
- Reactive power management policy
- Compliance with safety standards

Study the impact of insertion of wind farms on your network!