Artelys | OPTIMIZATION SOLUTIONS

Artelys Crystal Super Grid

Cost-benefit analysis for power transmission projects

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FERC - 2015

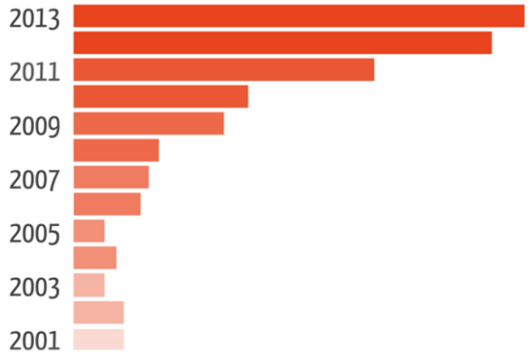
COMPANY OVERVIEW

Artelys

- We specialize in optimization, decision-support, modeling and deliver efficient solutions to complex business problems.

Key figures

- Independent company created in 2000
- 15 years of positive net profit
- 50 consultants (PhD/Engineers)



Net profit

Offices

- Paris, France
- Chicago, USA
- Montréal, Canada

COMPANY OVERVIEW

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- We specialize in optimization, decision-support, modeling and deliver efficient solutions to complex business problems.

Domains of expertise

- Energy
- Transport & Logistic
- Telecommunication
- Finance
- Defense

Services

- Auditing & Consulting
- On demand software
- Distribution and support of numerical optimization tools
- Training

ArtelysTools

NUMERICAL OPTIMIZATION TOOLS

- FICO Xpress Optimization Suite
  - High performance linear, quadratic and mixed integer programming solver (LP,MIP,QP)

- KNITRO
  - Industry leading solver for very large, difficult nonlinear optimization problems (NLP, MINLP)

- Artelys Kalis
  - Object-oriented environment to model and solve problems with constraints programming techniques

- AMPL
  - Comprehensive modeling language for Mathematical Programming

SCHEDULE

Artelys Crystal Super Grid

1. Overview of the software
2. Demonstration

WHAT IS ARTELYS CRYSTAL SUPER GRID ?

- **Decision-support software for the power domain**
  - Synthetic answers based on accurate computations
  - User-friendly interface.
- **Objective:**
  - Evaluate large generation and transmission projects (Optimal size, Cost-benefit analysis, Benchmark of concurrent investment projects, Congestion analysis)
- **Users:**
  - TSO/ISO, governments, regulators, utilities…
- **Leaning on:**
  - The computation of supply-demand equilibrium on multiple zones, taking into account commercial transmission capacities between zones.
- **Warning:**
  - Not meant to be used for short-term analysis of network security, where physical models for flows are used.

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WHAT IS THE DEMO ABOUT ?

- **Topic:**
  - Study of a transmission project: increase of interconnection capacity between France and Italy.
- **User:**
  - French energy regulatory commission wishes to evaluate independently the project.
- **What did Artelys:**
  - Software delivery + consulting (help to set-up the model and the methodology).

COMMISSION
DE RÉGULATION
DE L'ÉLECTRICITÉ

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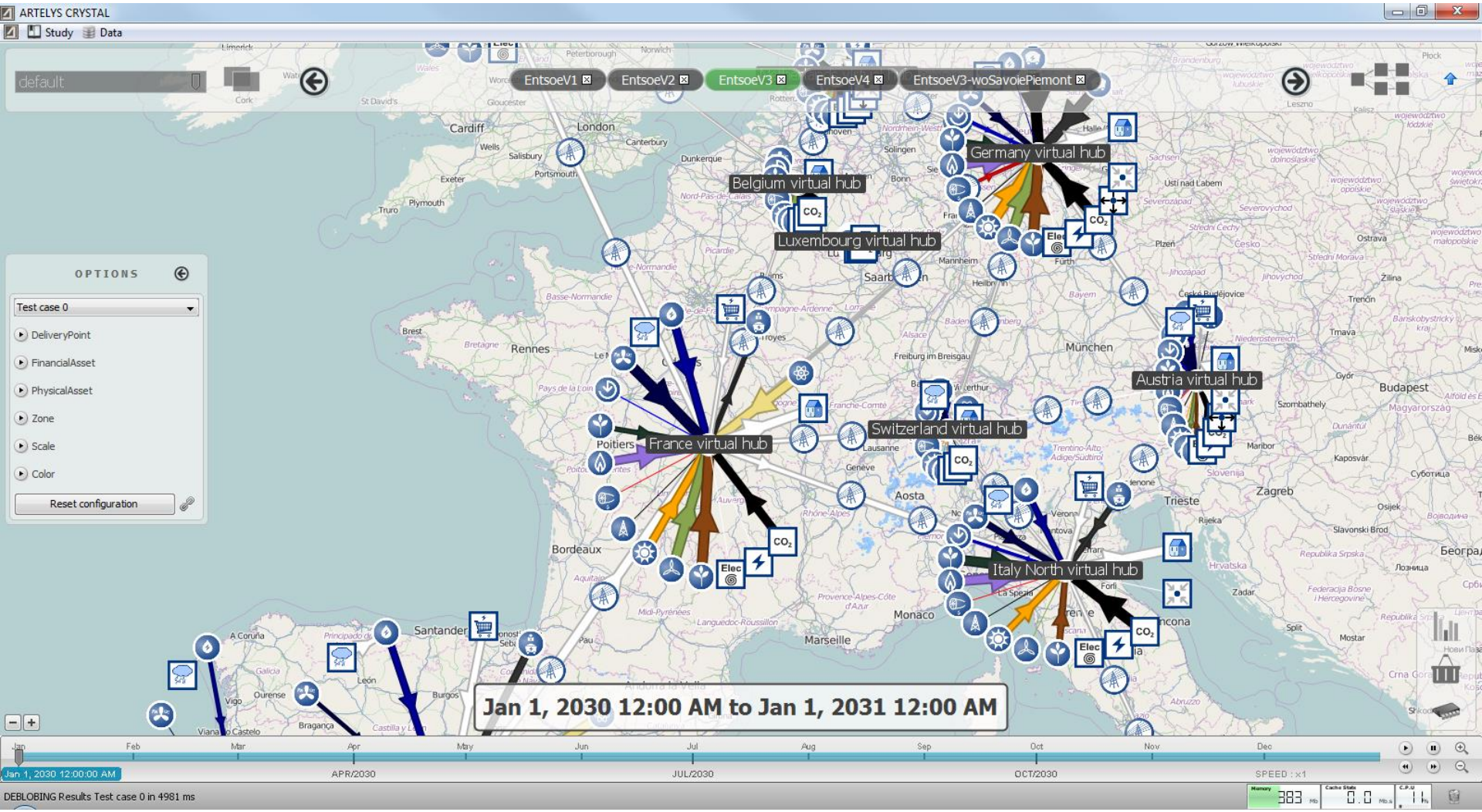
MAIN VIEW



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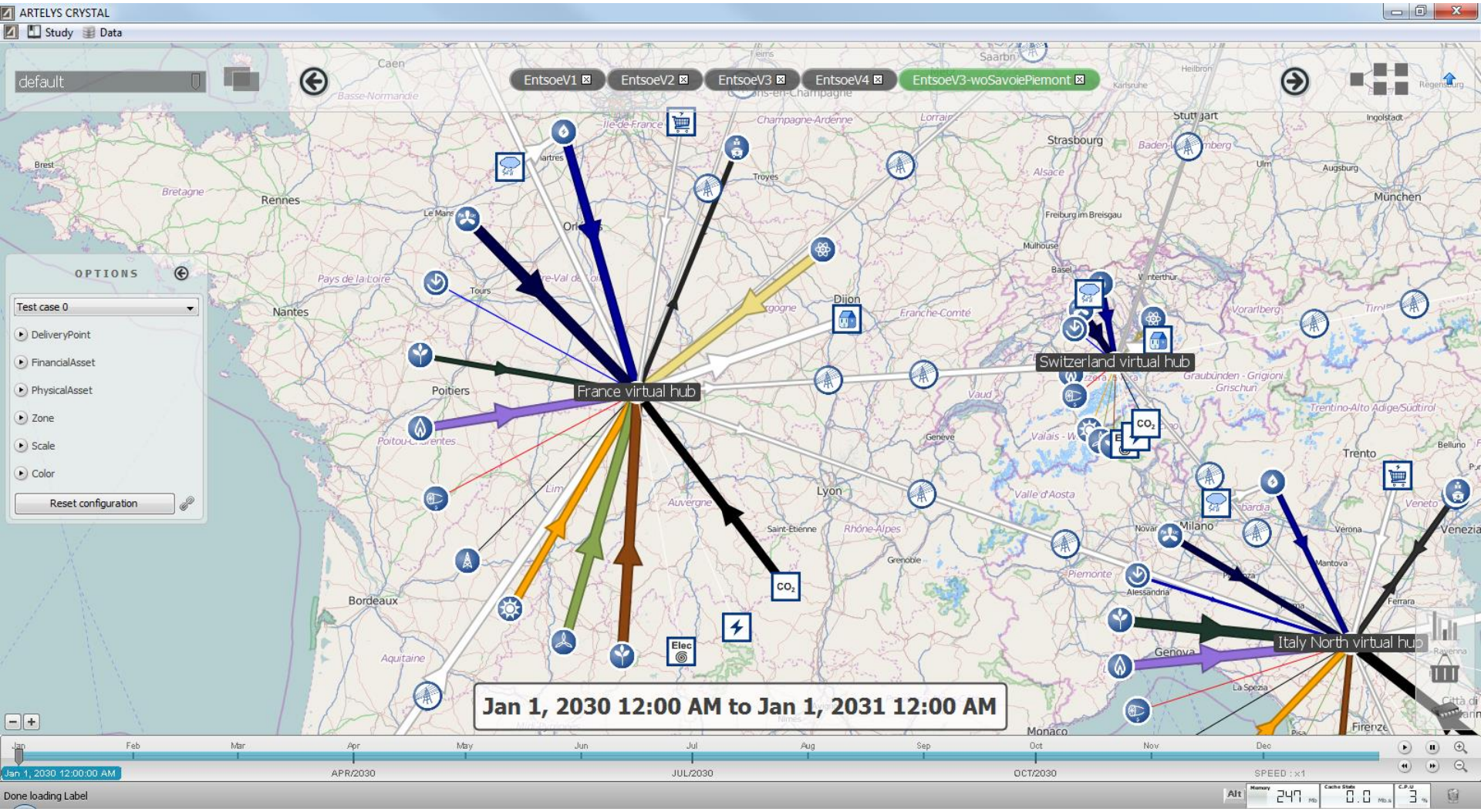
HOW IS THE ENERGY SYSTEM OF A COUNTRY REPRESENTED ?



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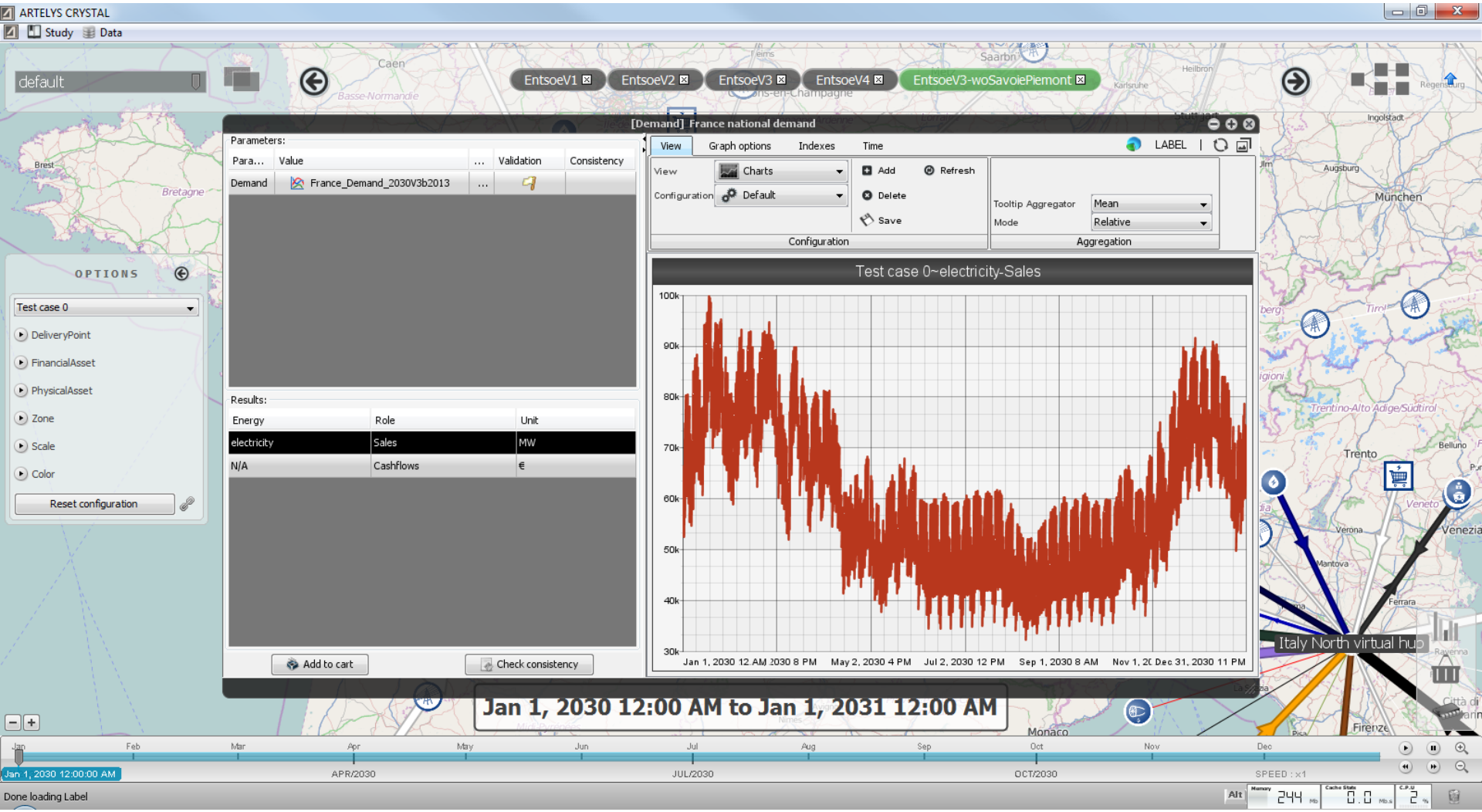
ELECTRICITY DEMAND



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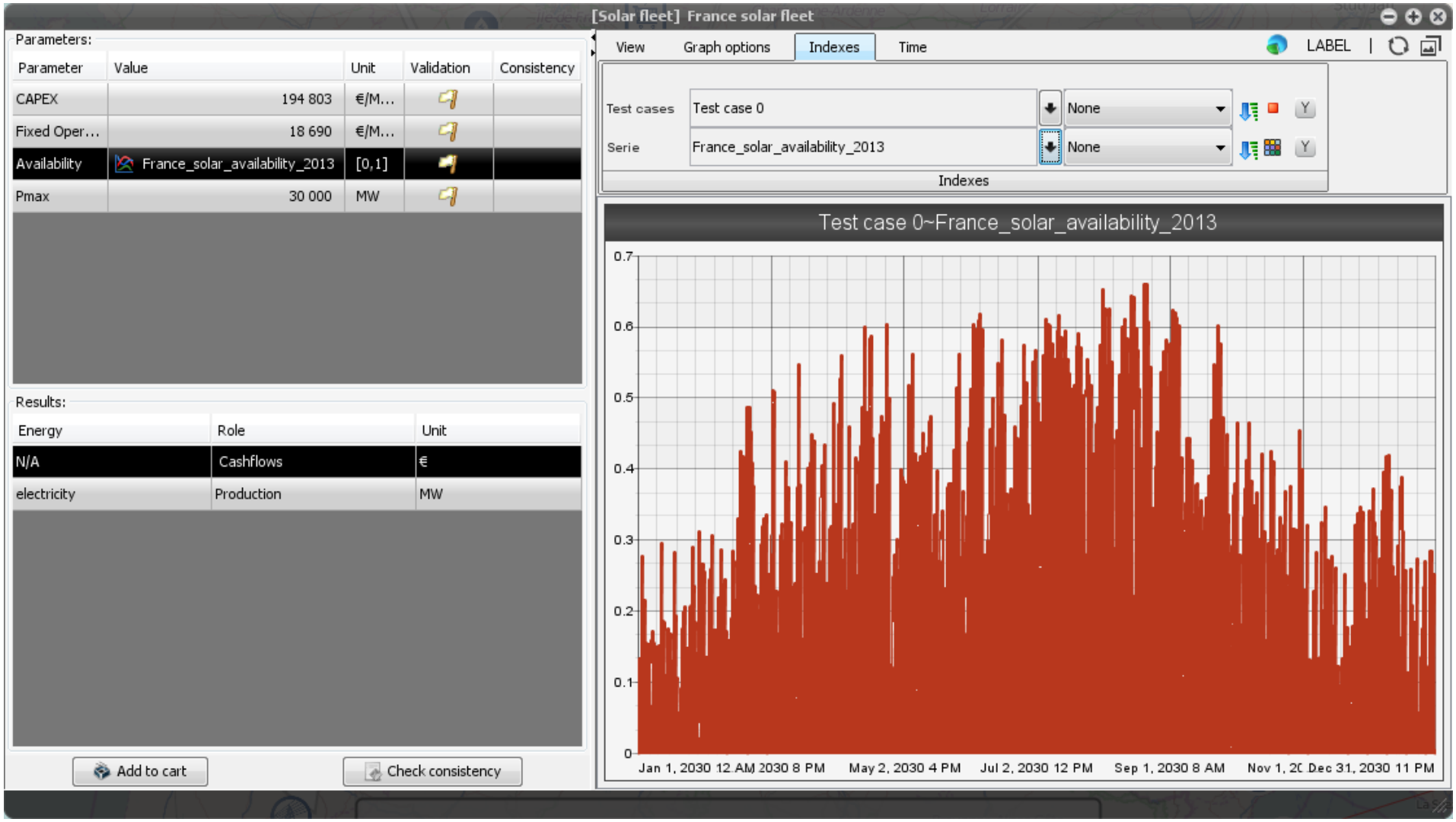
PRODUCTION UNIT



COMPUTATION

- The software computes the hourly supply-demand equilibrium on one year…

Business problem description

Transform the business problem into a mathematical program

Optimization Engine

Solve the mathematical problem

FICO™

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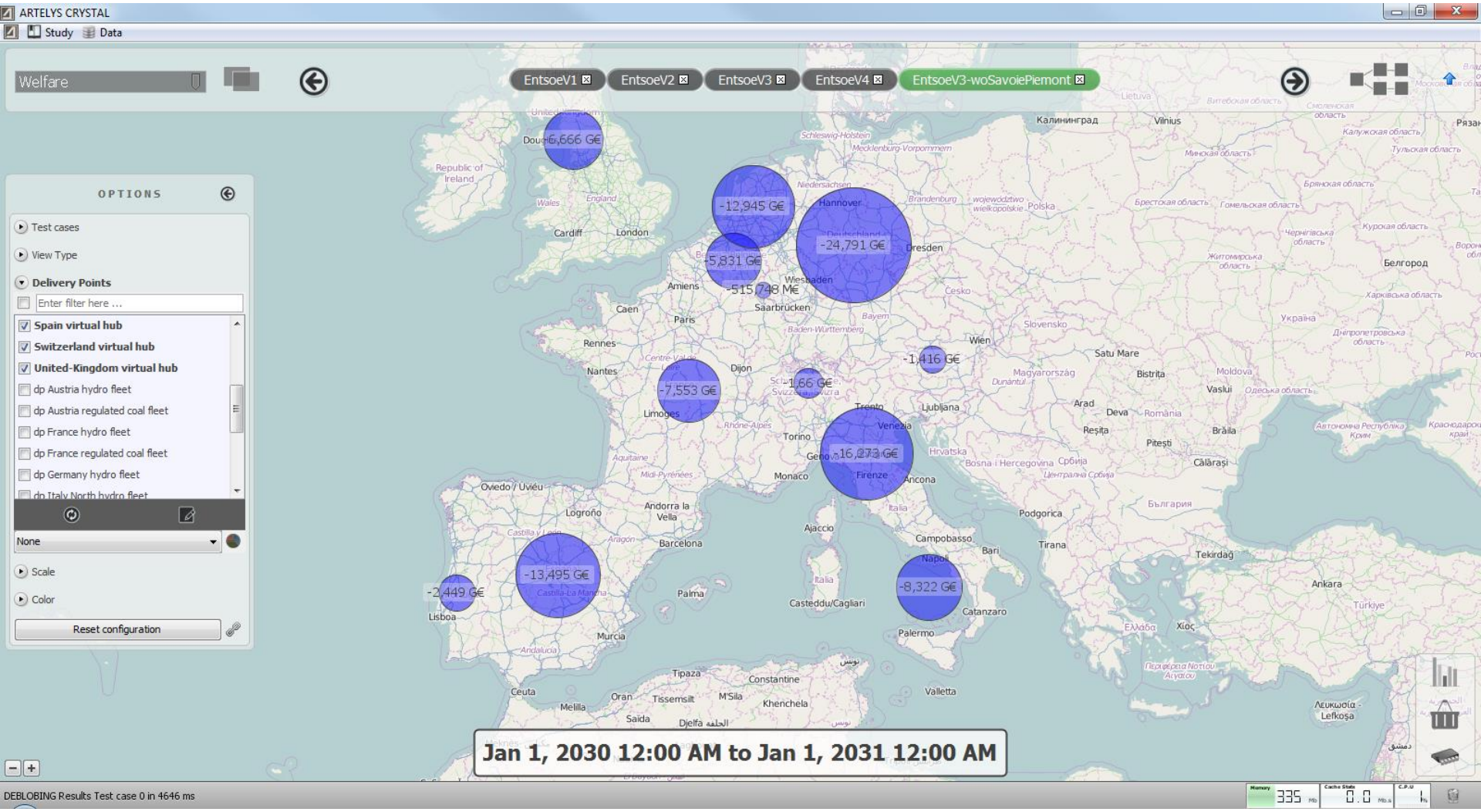
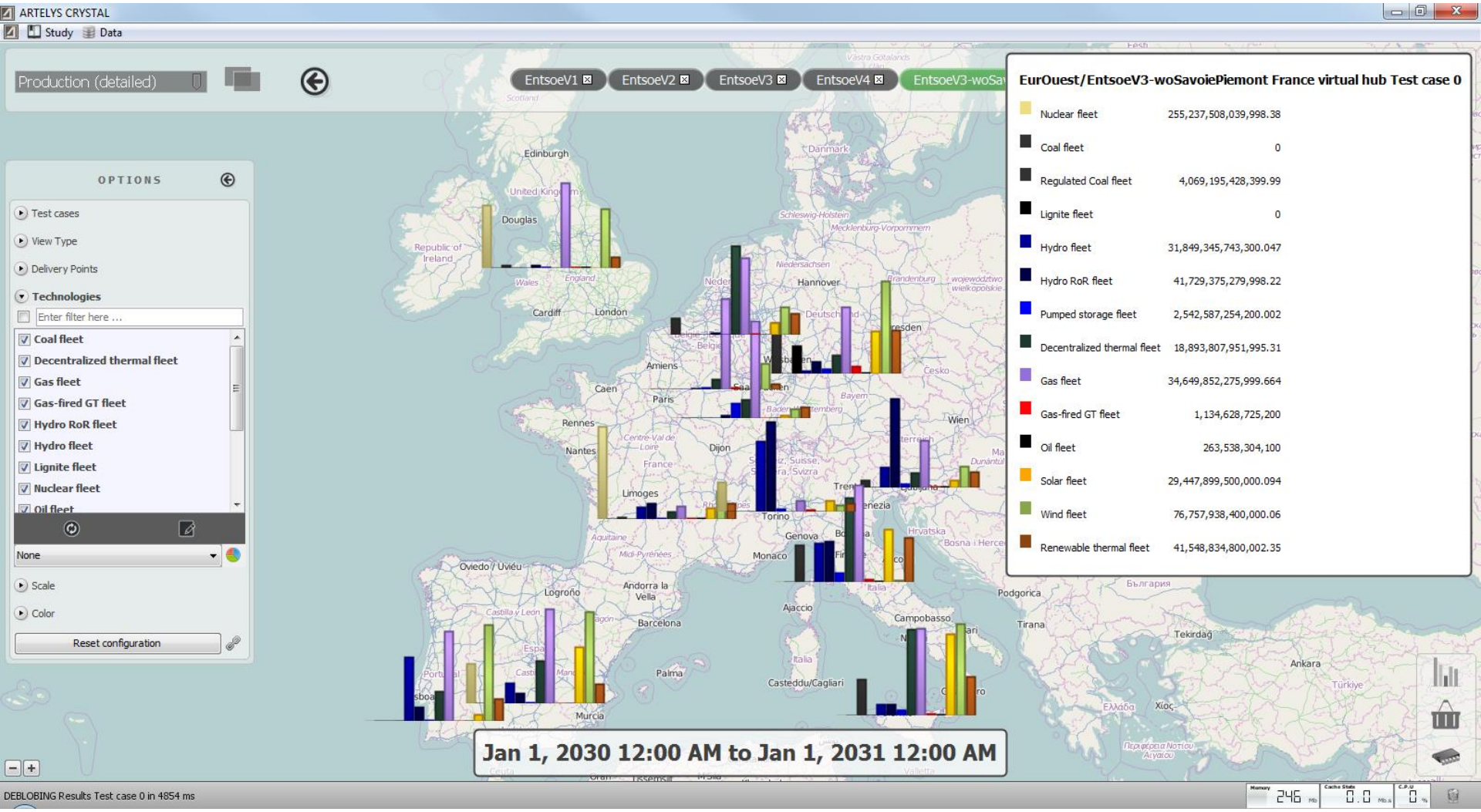
SINGLE SCENARIO: YEARLY WELFARE BY COUNTRY



SINGLE SCENARIO: PRODUCTION DISPATCH



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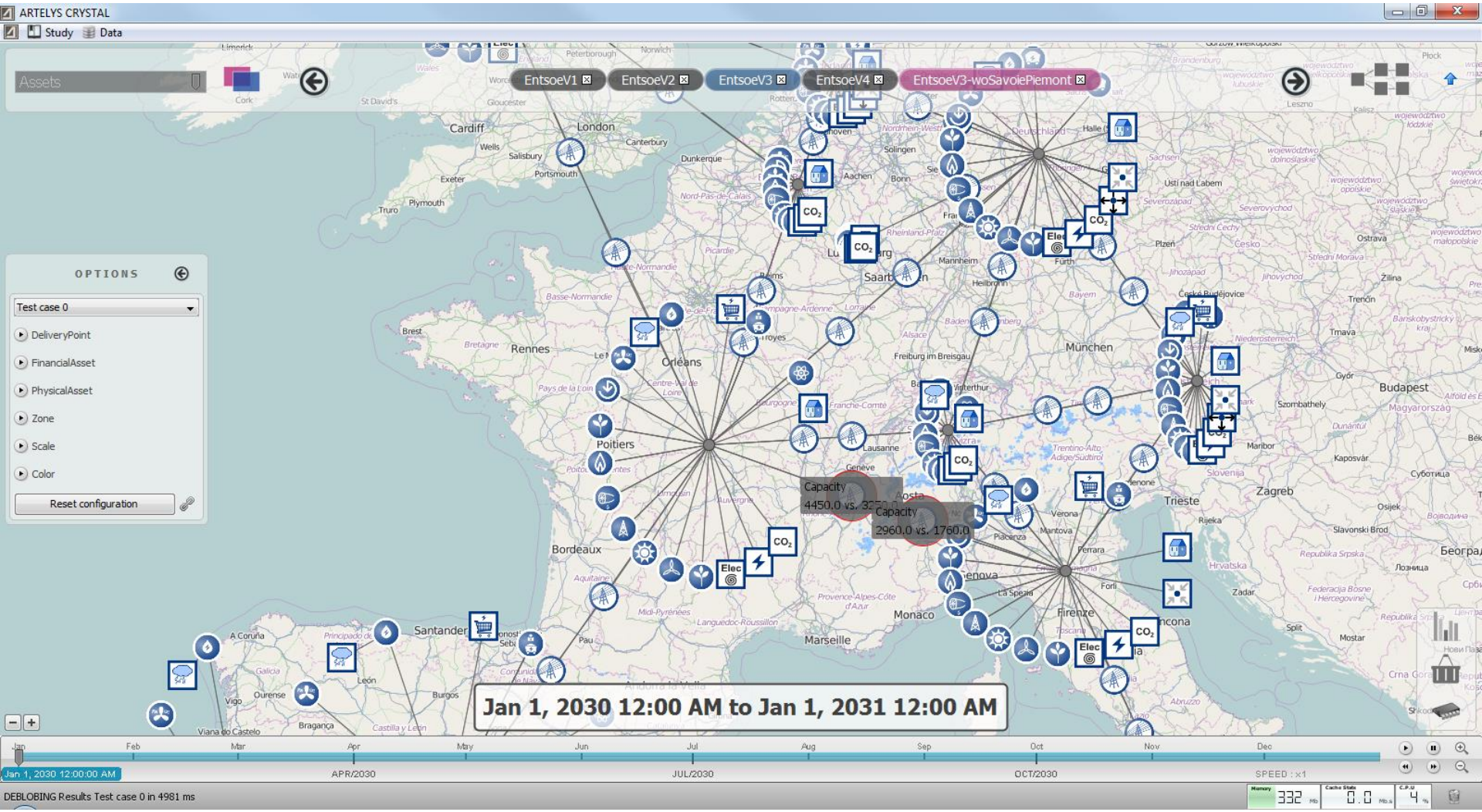
COMPARISON VIEW



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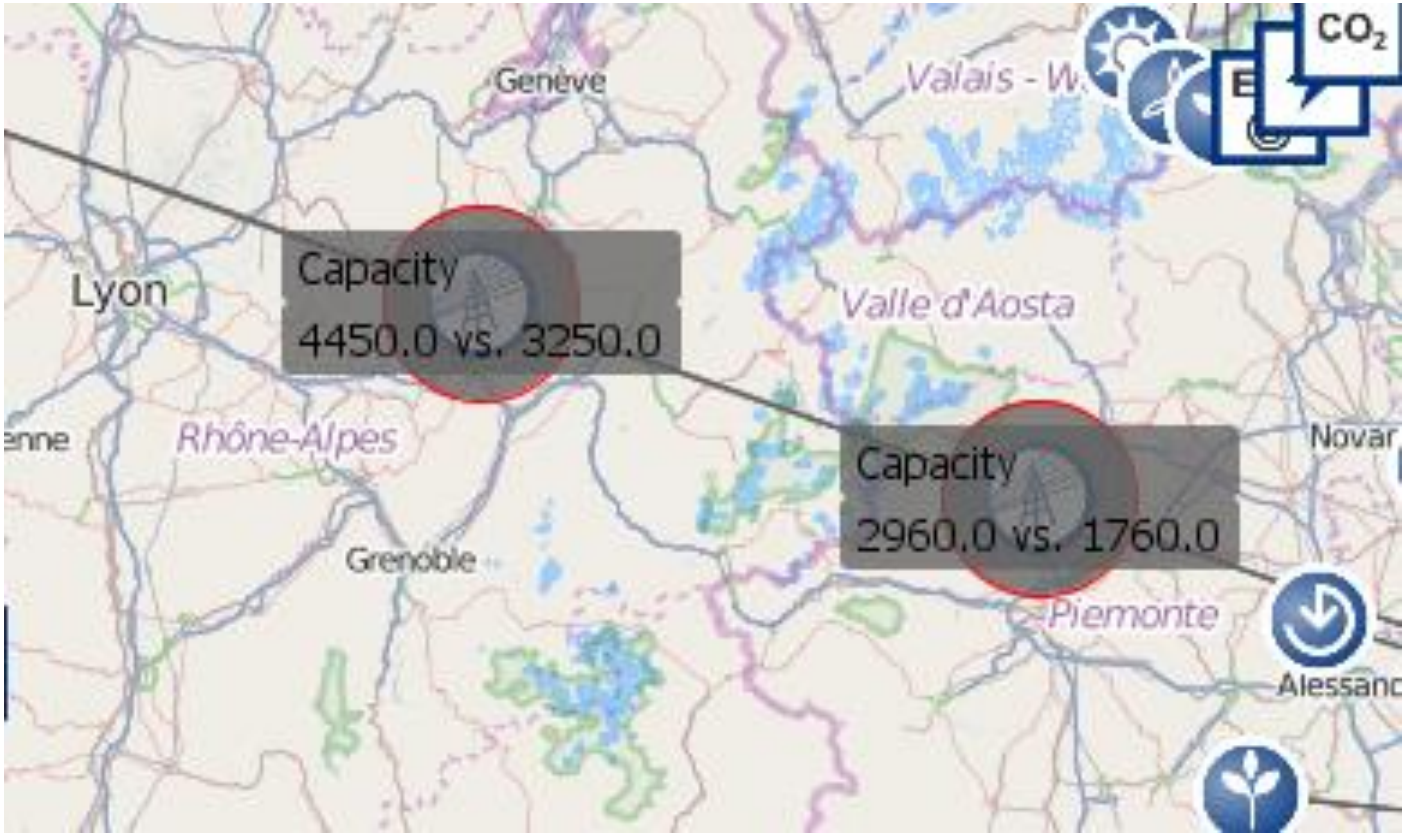

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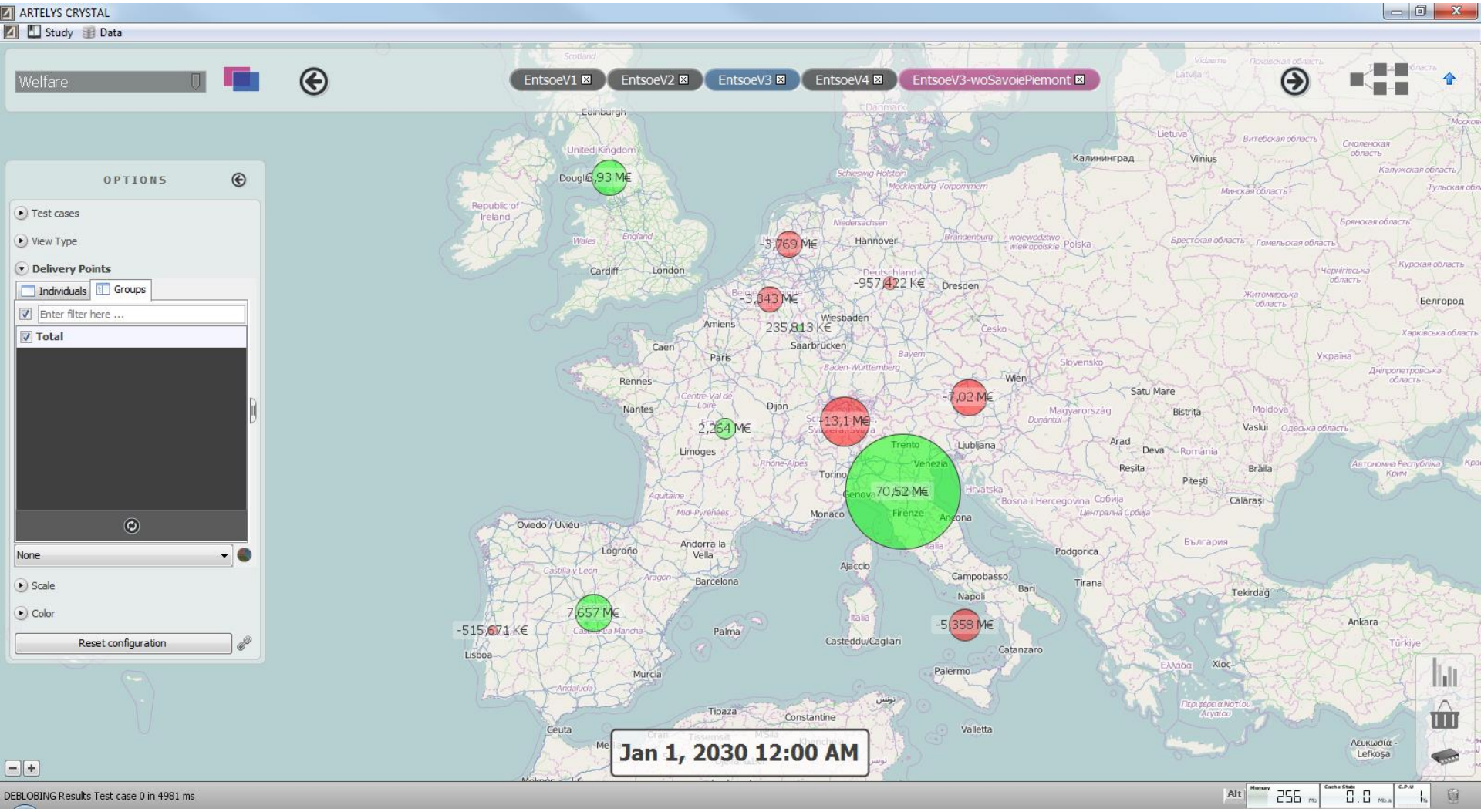
COMPARISON VIEW: YEARLY WELFARE BY COUNTRY



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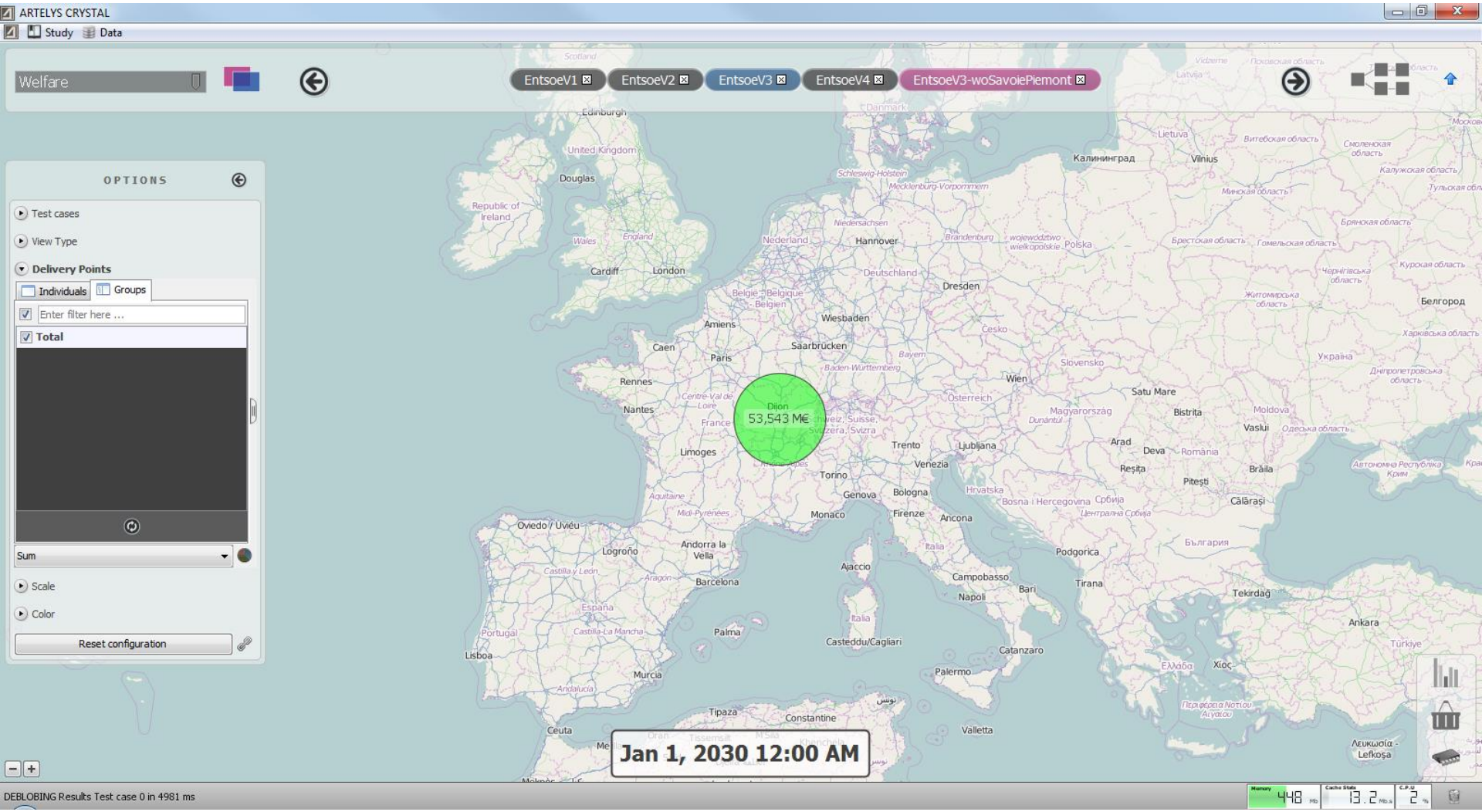
COMPARISON VIEW: YEARLY WELFARE FOR THE ZONE



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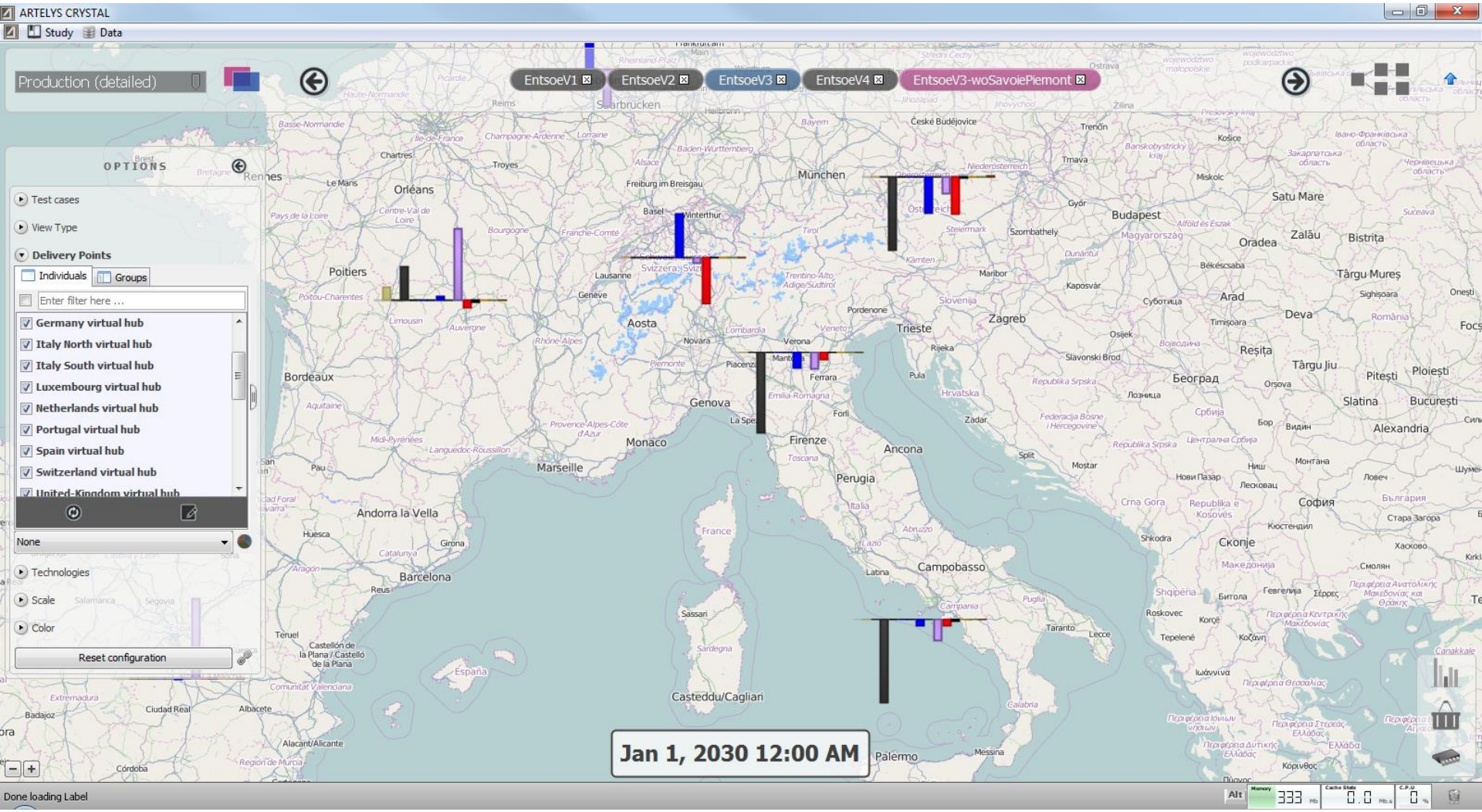
COMPARISON VIEW: PRODUCTION DISPATCH



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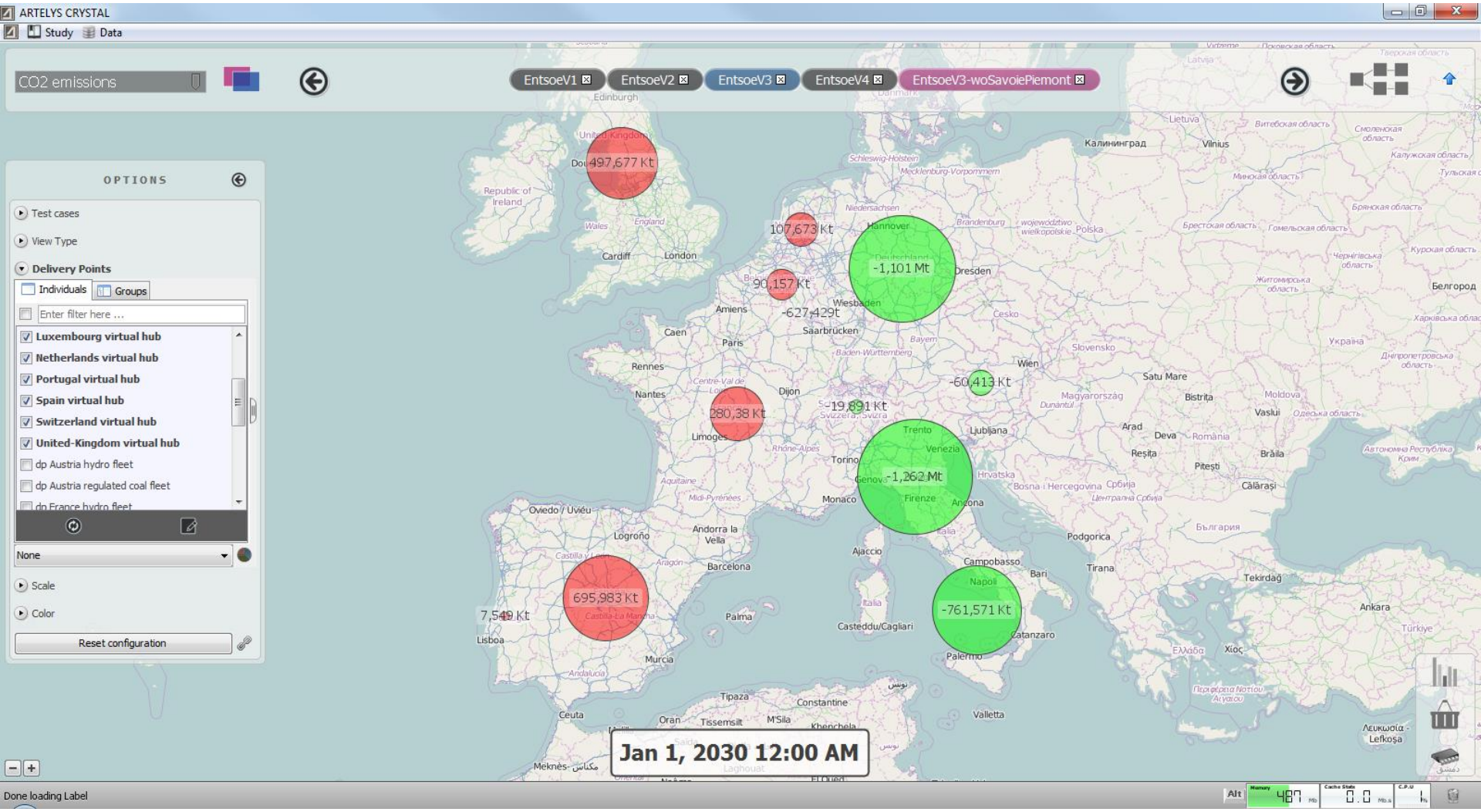
COMPARISON VIEW: CO2 EMISSIONS PER COUNTRY



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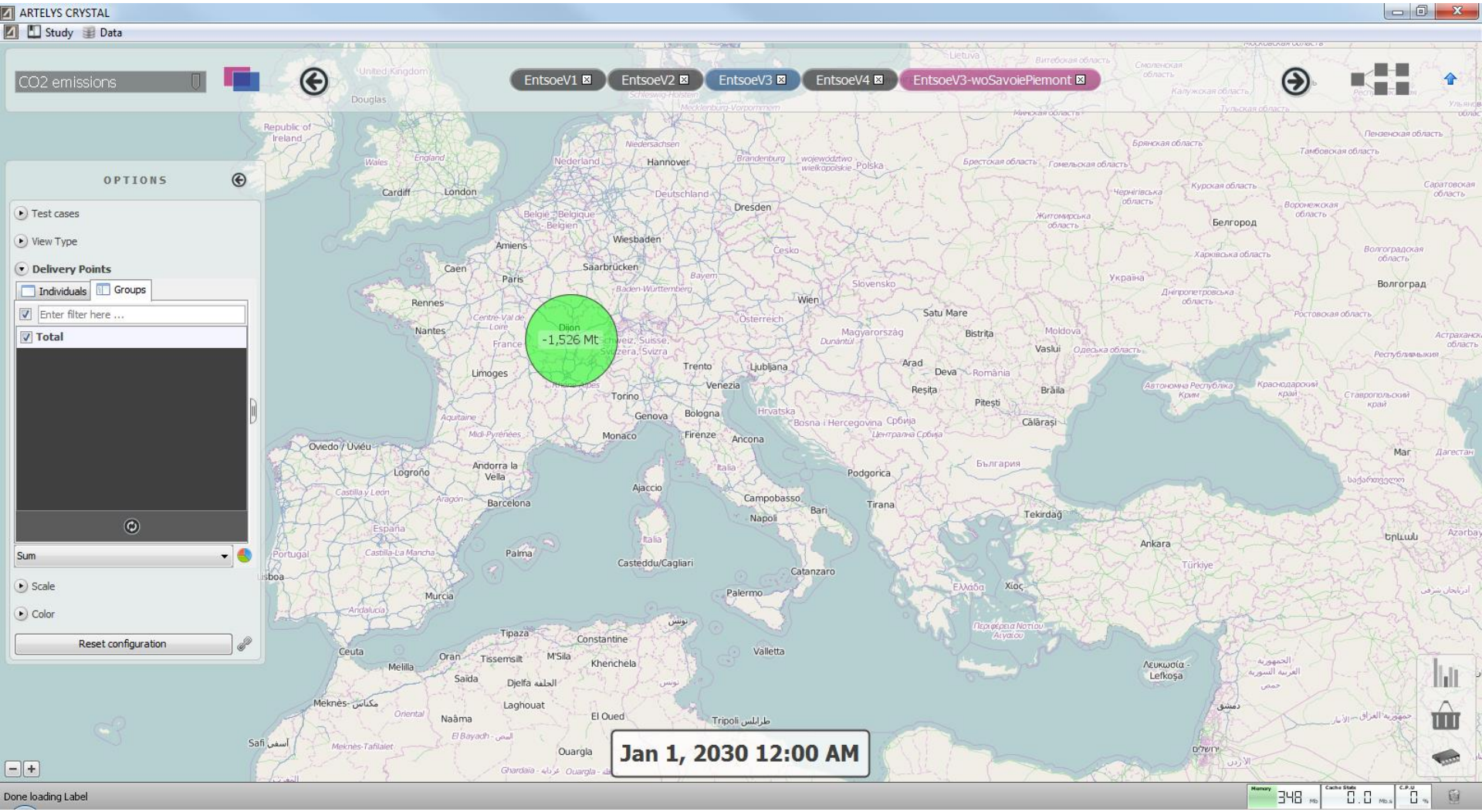
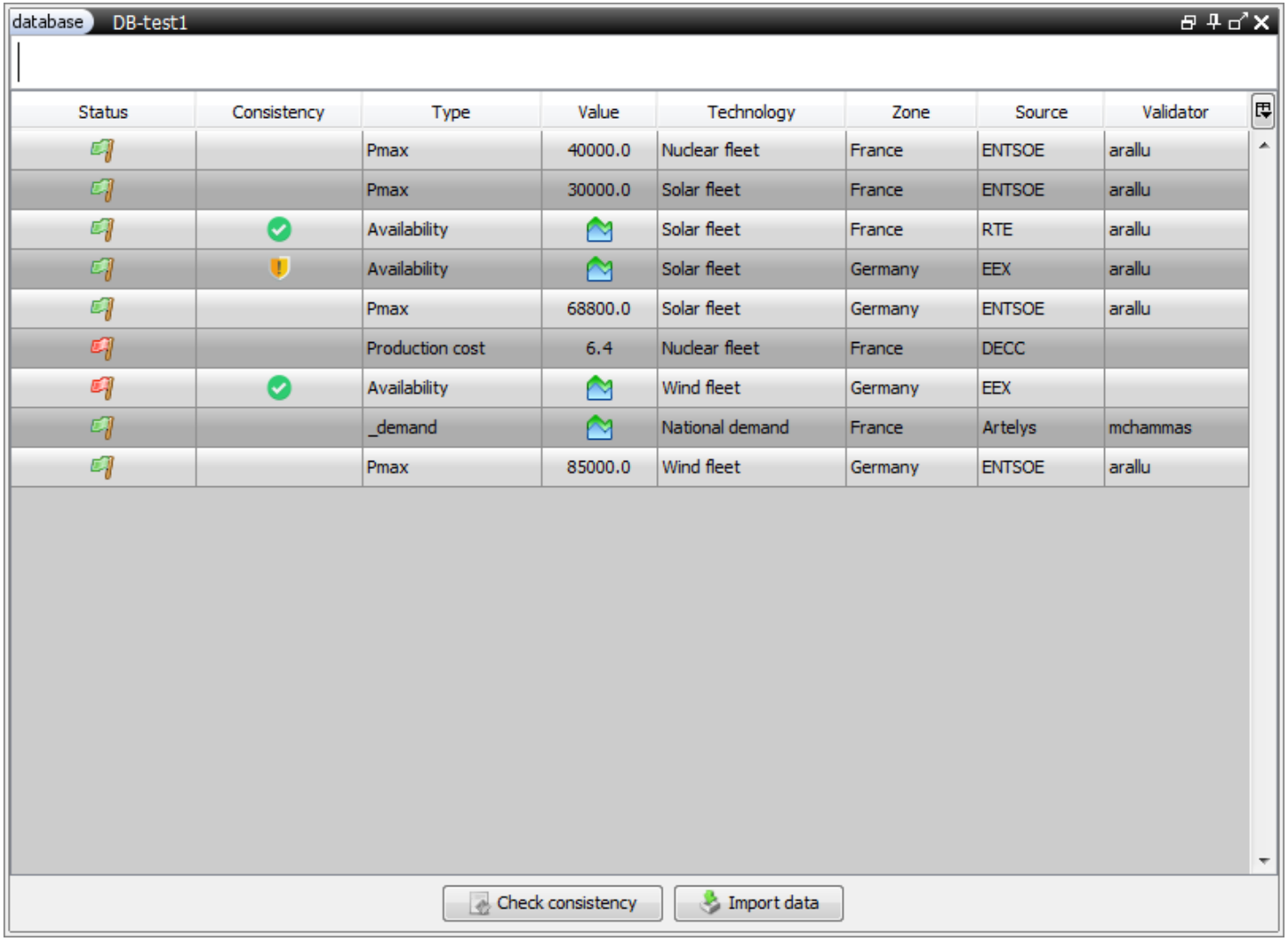
COMPARISON VIEW: CO2 EMISSIONS FOR THE ZONE



HOW TO ADDRESS DATA CONSISTENCY ?



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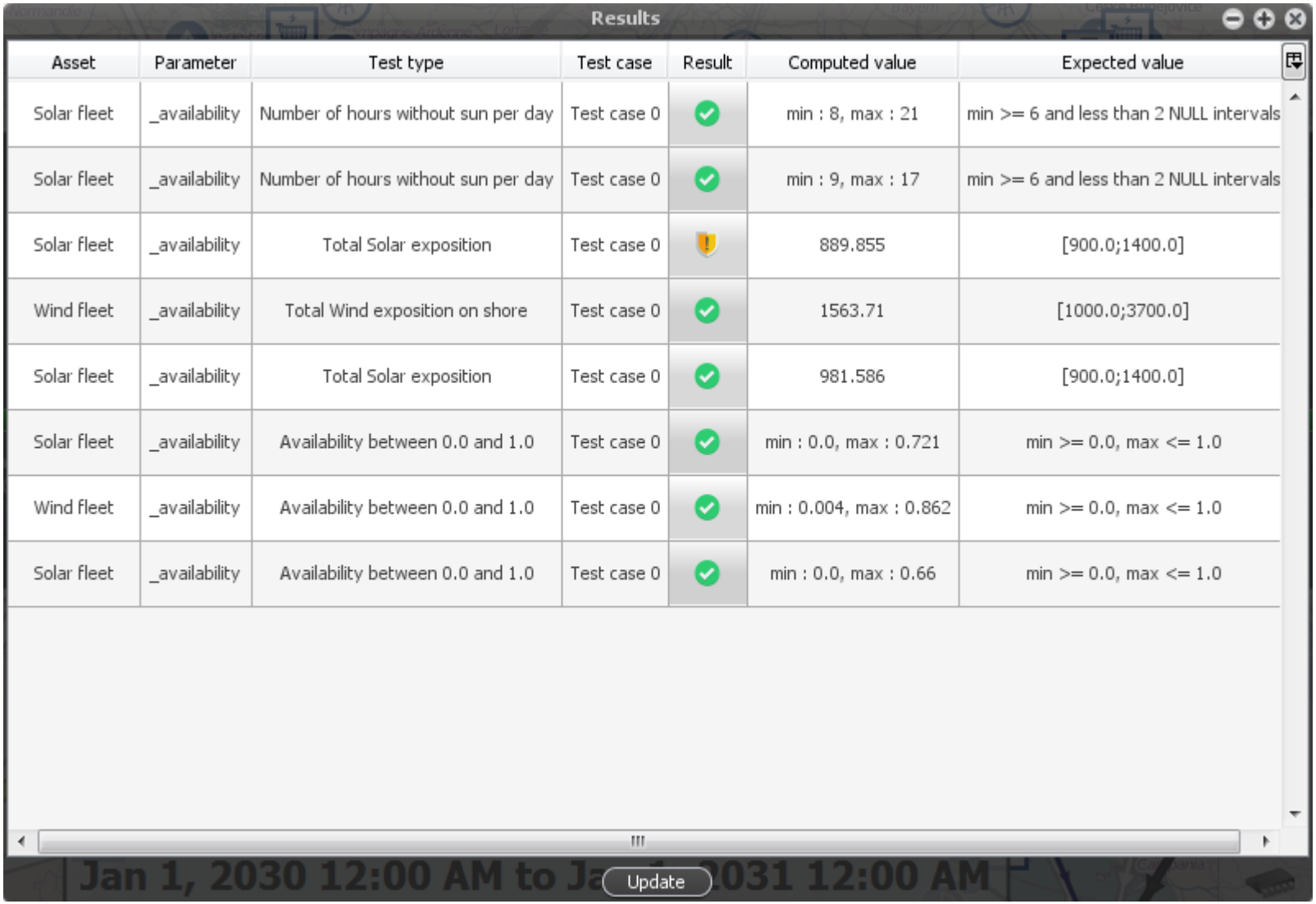

Asset	Parameter	Test type	Test case	Result	Computed value	Expected value
Solar fleet	_availability	Number of hours without sun per day	Test case 0		min : 8, max : 21	min >= 6 and less than 2 NULL intervals
Solar fleet	_availability	Number of hours without sun per day	Test case 0		min : 9, max : 17	min >= 6 and less than 2 NULL intervals
Solar fleet	_availability	Total Solar exposition	Test case 0		889.855	[900.0;1400.0]
Wind fleet	_availability	Total Wind exposition on shore	Test case 0		1563.71	[1000.0;3700.0]
Solar fleet	_availability	Total Solar exposition	Test case 0		981.586	[900.0;1400.0]
Solar fleet	_availability	Availability between 0.0 and 1.0	Test case 0		min : 0.0, max : 0.721	min >= 0.0, max <= 1.0
Wind fleet	_availability	Availability between 0.0 and 1.0	Test case 0		min : 0.004, max : 0.862	min >= 0.0, max <= 1.0
Solar fleet	_availability	Availability between 0.0 and 1.0	Test case 0		min : 0.0, max : 0.66	min >= 0.0, max <= 1.0

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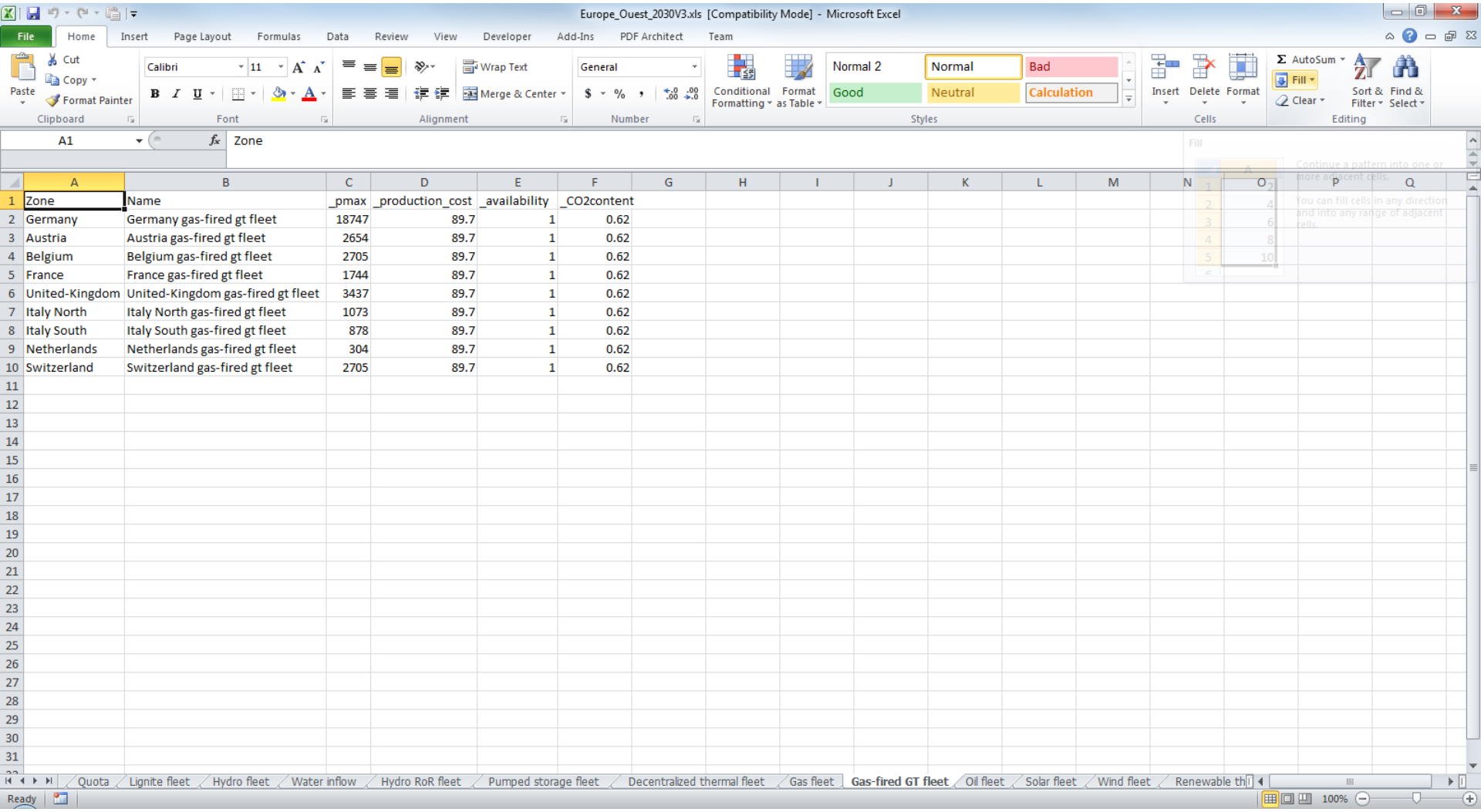
CREATION OF THE MODEL : MANUALLY

CREATION OF THE MODEL : THROUGH EXCEL TEMPLATES



Zone	Name	_pmax	_production_cost	_availability	_CO2content
Germany	Germany gas-fired gt fleet	18747	89.7	1	0.62
Austria	Austria gas-fired gt fleet	2654	89.7	1	0.62
Belgium	Belgium gas-fired gt fleet	2705	89.7	1	0.62
France	France gas-fired gt fleet	1744	89.7	1	0.62
United-Kingdom	United-Kingdom gas-fired gt fleet	3437	89.7	1	0.62
Italy North	Italy North gas-fired gt fleet	1073	89.7	1	0.62
Italy South	Italy South gas-fired gt fleet	878	89.7	1	0.62
Netherlands	Netherlands gas-fired gt fleet	304	89.7	1	0.62
Switzerland	Switzerland gas-fired gt fleet	2705	89.7	1	0.62

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