

Digitalization in the water industry

Alin Ene, Guest speaker of Grundfos Hellas

Water conference 02/12/2019, Marousi Plaza - Athens

Agenda

1. Introduction
2. Benefits of digitalization
3. Digital Products

Grundfos is ...

#1

Pump manufacturer
in the world

4

Turnover
(billion USD)



83

Companies across
the world

18,000

Employees
worldwide

16

Million units produced
every year

74

Years old
(founded in 1945)

(1)

Owner



“Digitalization is the transformational force in humanity that supports value creation by connecting people, companies, products or literally anyone and everything”

*Mads Nipper
CEO & Group President
Grundfos*

A dark blue Tesla Model S is shown driving on a winding asphalt road through a scenic, hilly landscape. The car is in motion, with a slight blur to the background, suggesting speed. The landscape features rolling green hills, scattered trees, and a clear sky. The car's headlights are on, and the overall scene is captured in a cinematic style.

**Digitalization redefines business systems
and models as well as value chains**

Digitalization is about the way companies interact and connect directly to customers and end-users in more relevant, simple, seamless and effective ways





PARTNERSHIP



KPIS IMPROVEMENTS



FINANCIAL BENEFITS

BENEFITS



Connect your data
on one platform



Reduce your water &
energy losses



Maximize your returns
in data acquisition



Optimize your
strategy on pipes
replacement



Reduce your operational
costs and boost your
service levels



Different apps for
different users



All upgrades
included

WASTEWATER CHALLENGES



GRUNDFOS iSOLUTIONS CLOUD FOR WASTEWATER NETWORKS

GRUNDFOS iSOLUTIONS



PUMP



CLOUD



SERVICES



be think innovate

GRUNDFOS 



**Strategic
Collaboration**

Co-creation solutions for a water utility to find new ways to deal with energy savings, infiltration, overflow and asset management

The first five solutions launched are based on shared insights and real time data from a part of the Provas wastewater network

Feedback from Provas



“Using the system to find infiltration flow makes sense. Today, we use EUR 4-7,000 for a single test, and because we are not certain of the exact location, we can end up doing multiple tests.”

Stafan,
Project Engineer



“What’s new is getting data of this quality. We get a good overview, which we can use as input when calibrating our models.”

Claus,
Planning Engineer



“This offers a faster way of finding infiltration flow. It’s fixed in position, so we can follow developments over time. We will be able to see the effect when we are renovating or separating.”

Tommy,
Project Engineer



“Previously, we could only see whether the pumps ran a little or a lot and use this as an indication of infiltration flow. Now we have something that identifies the most critical areas.”

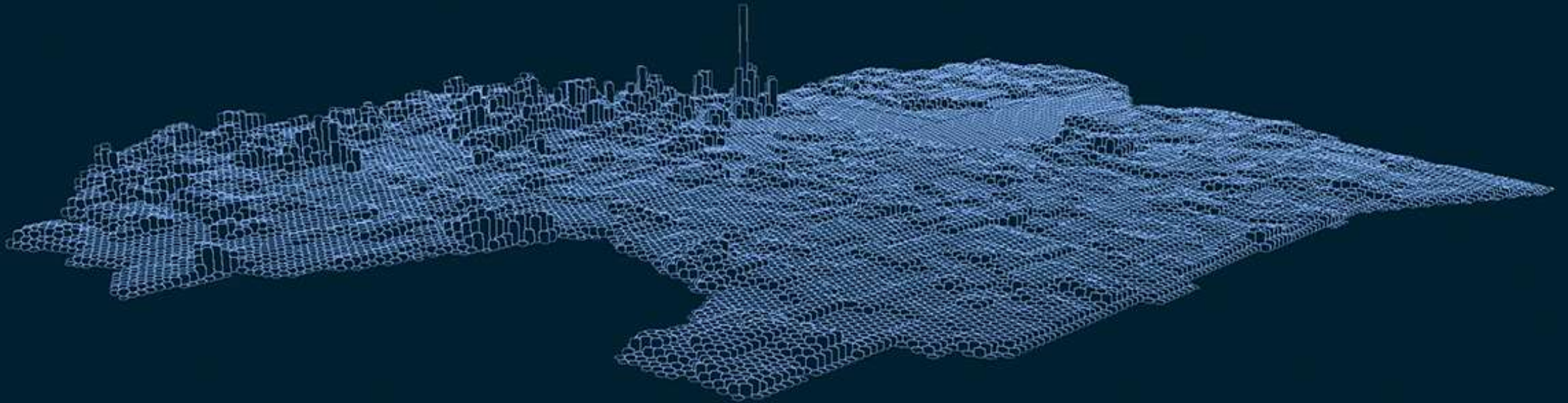
Casper,
Wastewater Operations Manager

WATER DISTRIBUTION CHALLENGES



Grundfos Intelligent Water Distribution

Powered by Baseform®



IWD home page

Apps

city

- People
- Network
- Zones 3D

Monitor

- Maps
- Meters
- Events
- Spectrum

Diagnose

- Network model
- Indices
- Minimum Energy
- Energy Balance
- Water Balance

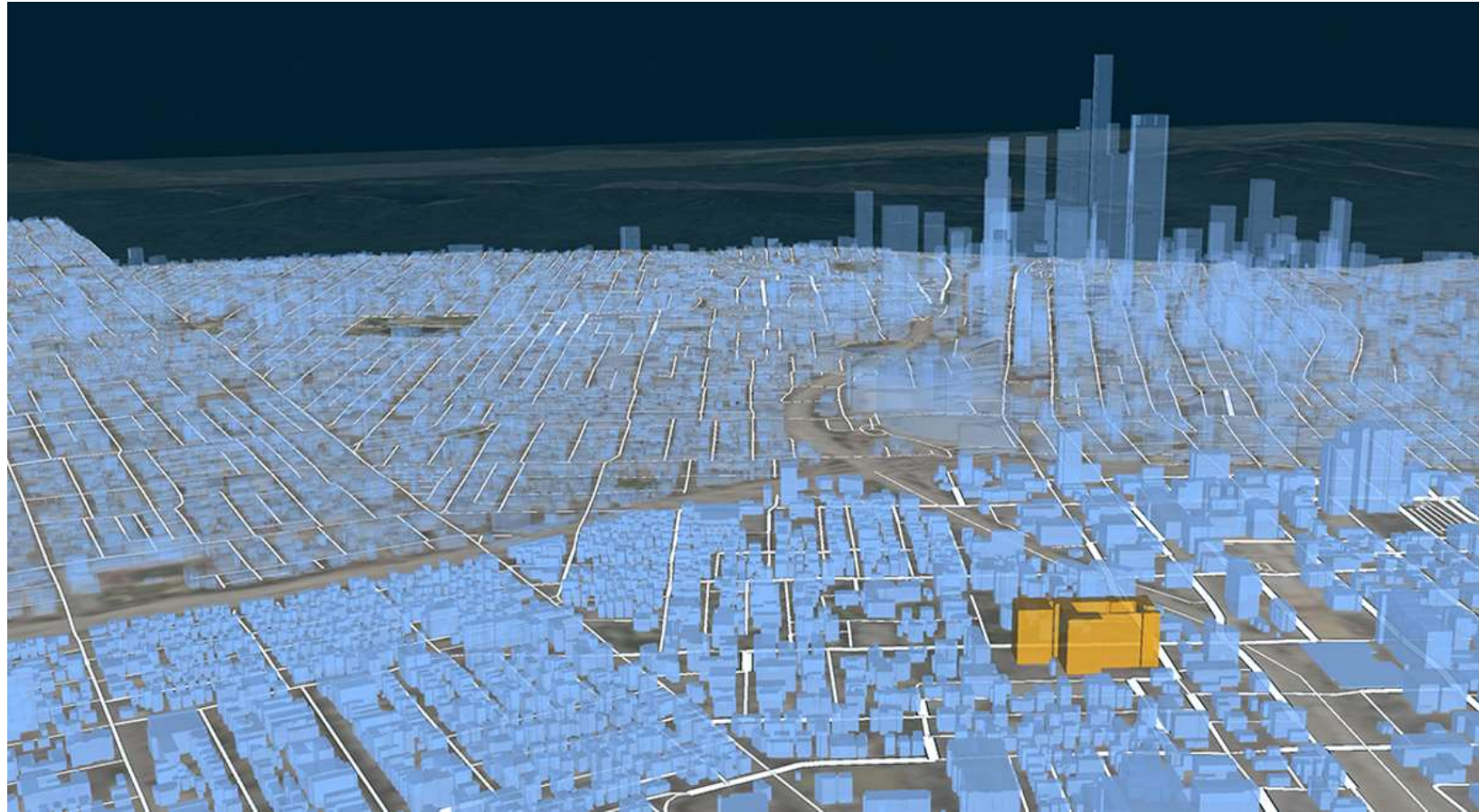
Predict

- Failure Prediction
- Inspection Analysis
- Component Importance
- Risk of no service

Plan

- Compare & prioritize
- Indicators
- Financial Analysis
- Infrastructure value Index

Sensorization

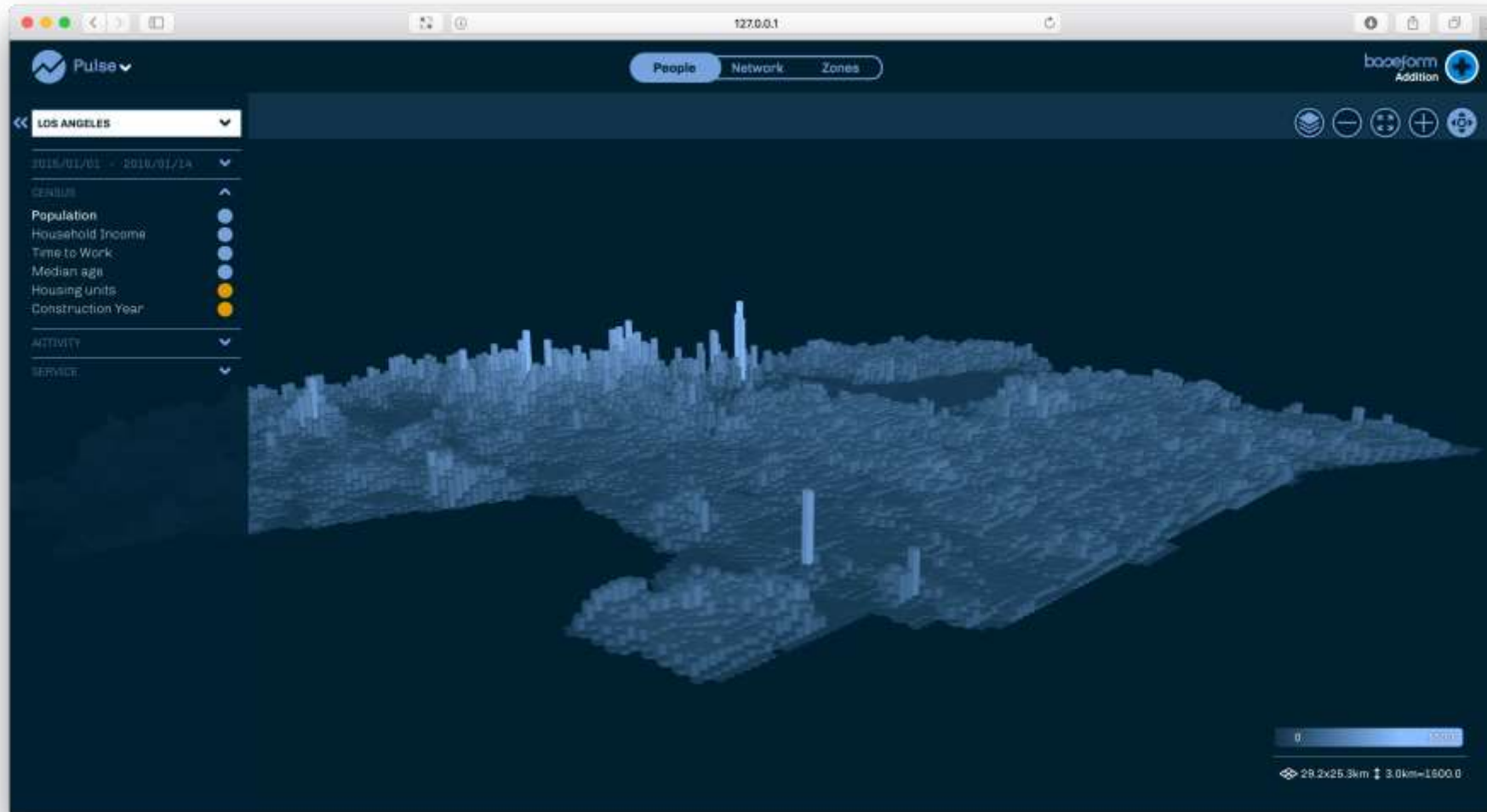


Z-So-19	
Network zone	Z-So-19
Building year	1964
Households	16
Avg. income	40.7k
Performance	
Pressure	34-38m
Cl ² residual	0.35-0.40mg/l
Energy to supply/yr	1871kWh
Risk	
Supply	●
Flooding from sewers	●
Cost	
Revenue/yr	3235
CapEX	970
OpEX	2215
IVI	0.3 ●
Real-time	
Consumption/24h	8.1 m ³
Flow	0.78 m ³ /h
Pressure	43.5m

CITY: Dynamic 3D spatial + time analytics

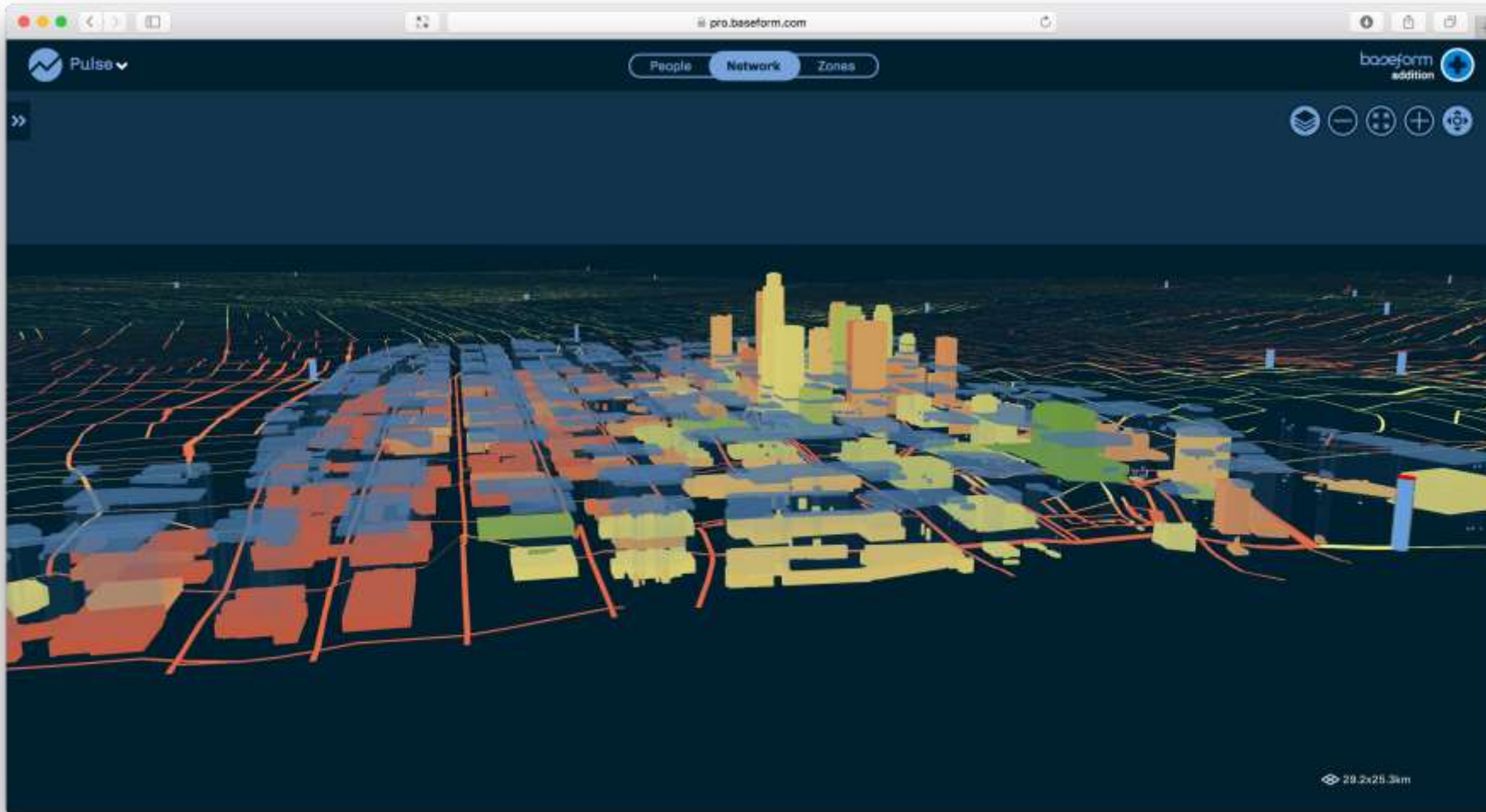


• PEOPLE



- The combination of consumption & service analytics, demographics, urban occupation, social data and other sources reveals new dimensions in understanding the city.
- ✓ city-centric, dynamic 3d space + time analytics
- ✓ cities are people: see them move and change throughout the day & the year, and across town
- ✓ combine data sources to reach a better understanding of human behavior
- ✓ observe reality in detail and continuously evolve plans & designs

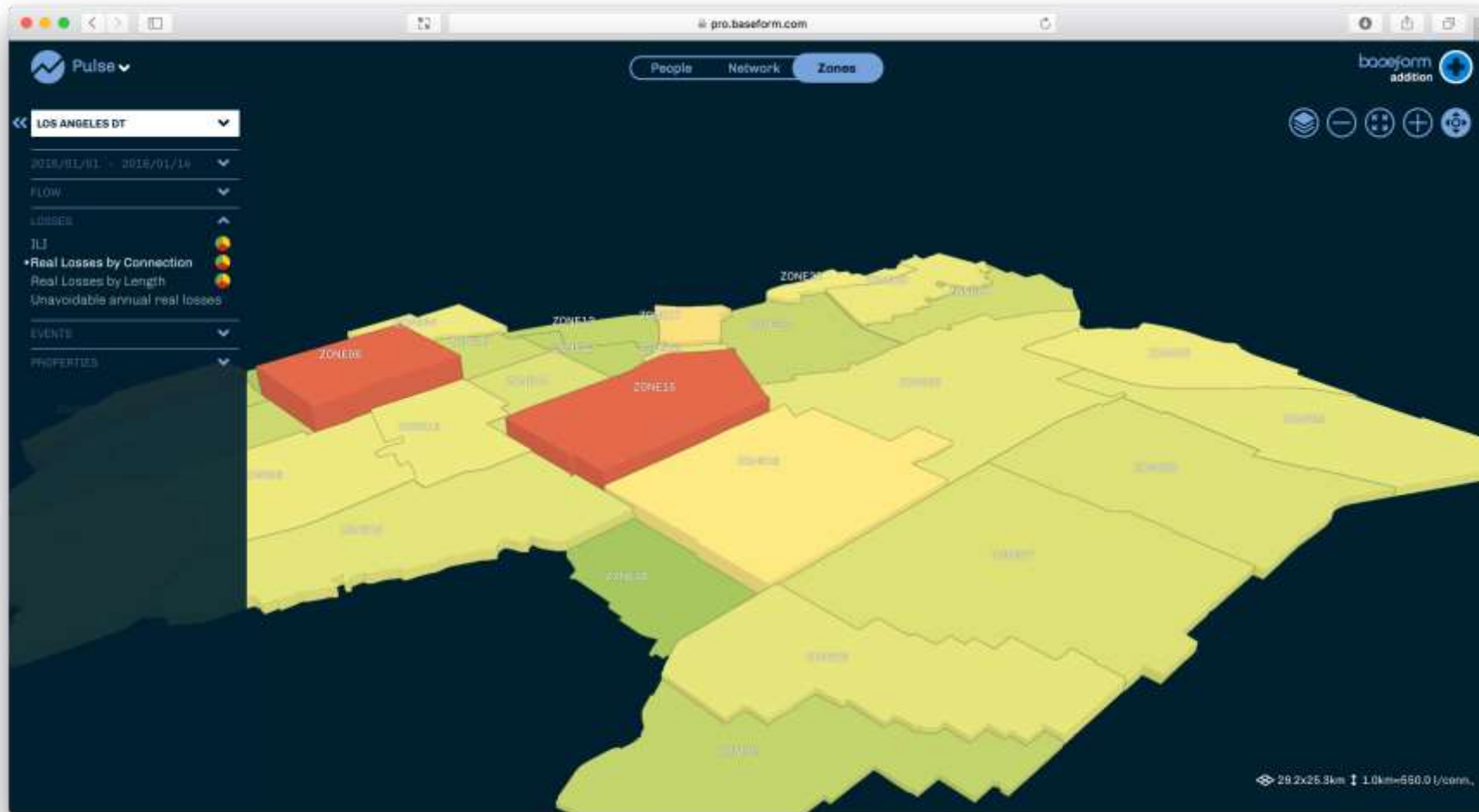
CITY: Dynamic 3D spatial + time analytics



• NETWORK

- A full 3D environment for the network, combined with a powerful, next-gen cityscape, affords even non-experts deeper insight into its behavior and analytics.
- ✓ service-centric, dynamic 3d space + time analytics
- ✓ available hi-quality buildings literally add new dimensions in service analytics display
- ✓ wide range of hydraulic, water quality, asset management, leakage/flow, risk, cost and other metrics

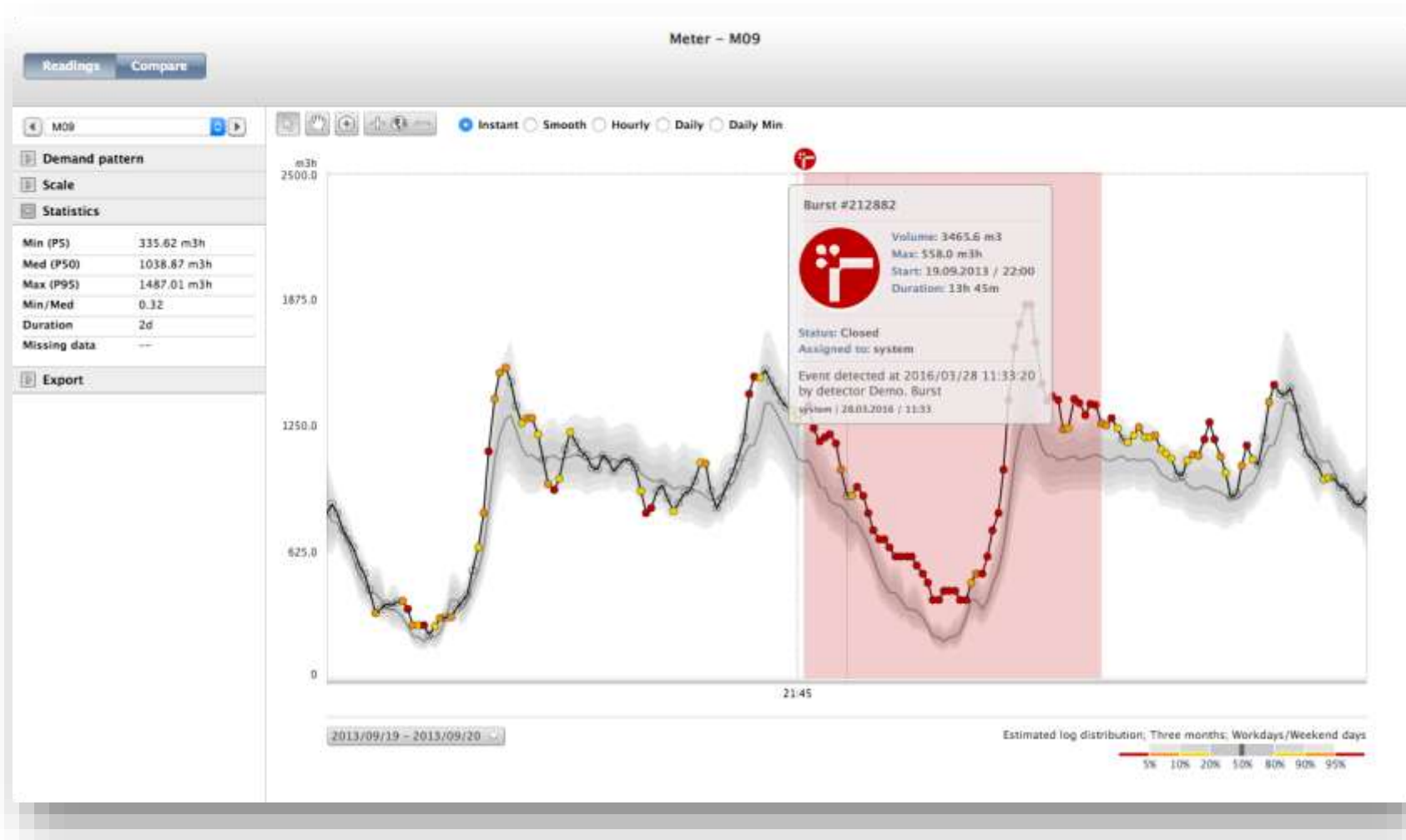
CITY: Dynamic 3D spatial + time analytics



• ZONES 3D

- The 3D counterpart to the Zones app provides a fully immersive cityscape where urban zoning becomes easier to analyze and prioritize in time and space, simplifying decision-making.
- ✓ planning-centric, dynamic 3d space + time analytics
- ✓ wide range of zone-based kPI.
- ✓ time tracking of zone and system diagnostics.
- ✓ repeatable, direct support to system prioritization

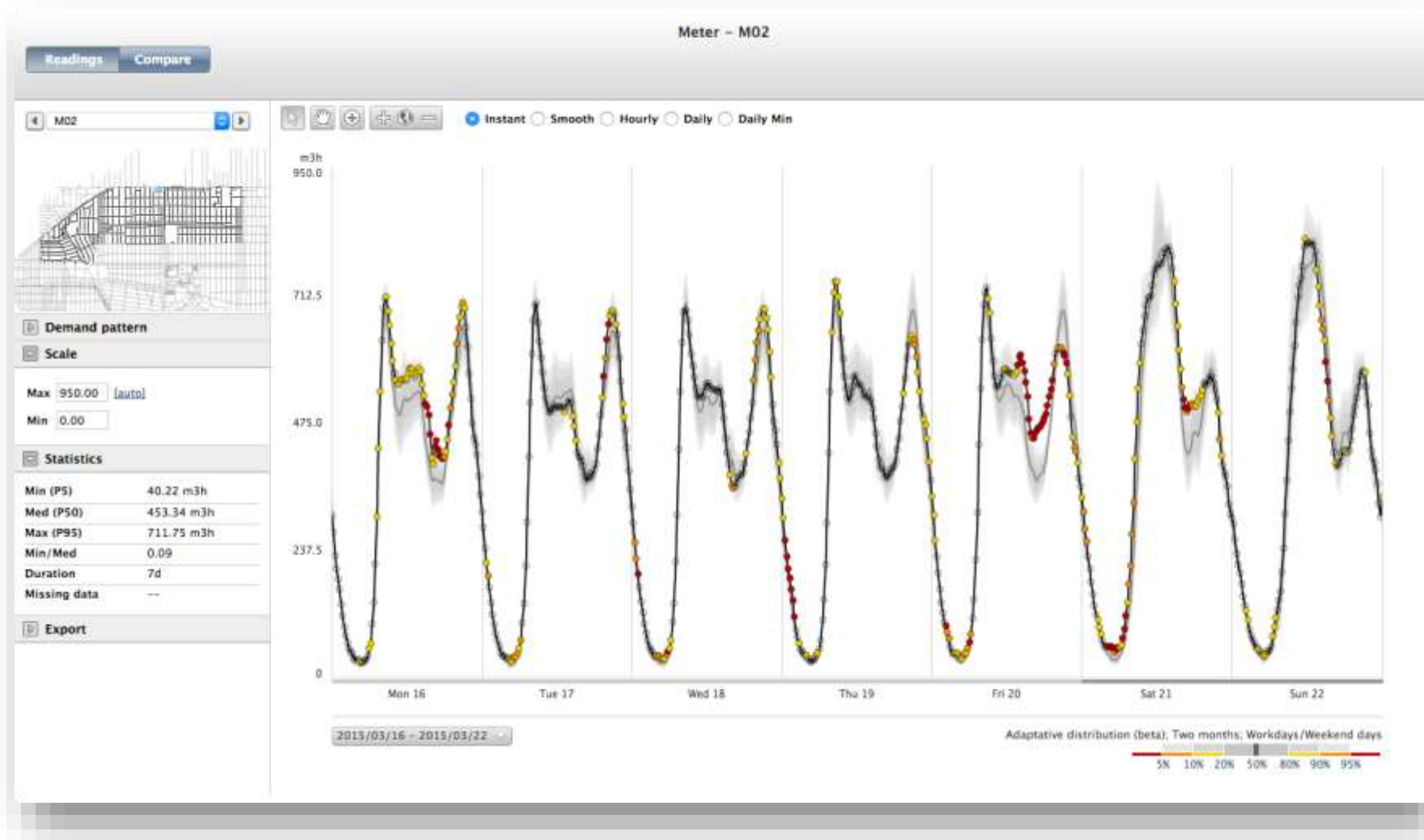
MONITOR: Real Time operational efficiency



• EVENTS

- Detects deviations to normal network behavior that may translate leaks, pipe breaks, unusual demand or a variety of network issues.
- ✓ Active, fast detection of leaks, bursts and other network events, as well as metering and communications malfunctions.
- ✓ Reduced response times to field events.
- ✓ Reliable, automated estimation of volumes lost.
- ✓ Streamlined workflow for operational events.
- ✓ Operational feedback validates flow data, work orders.

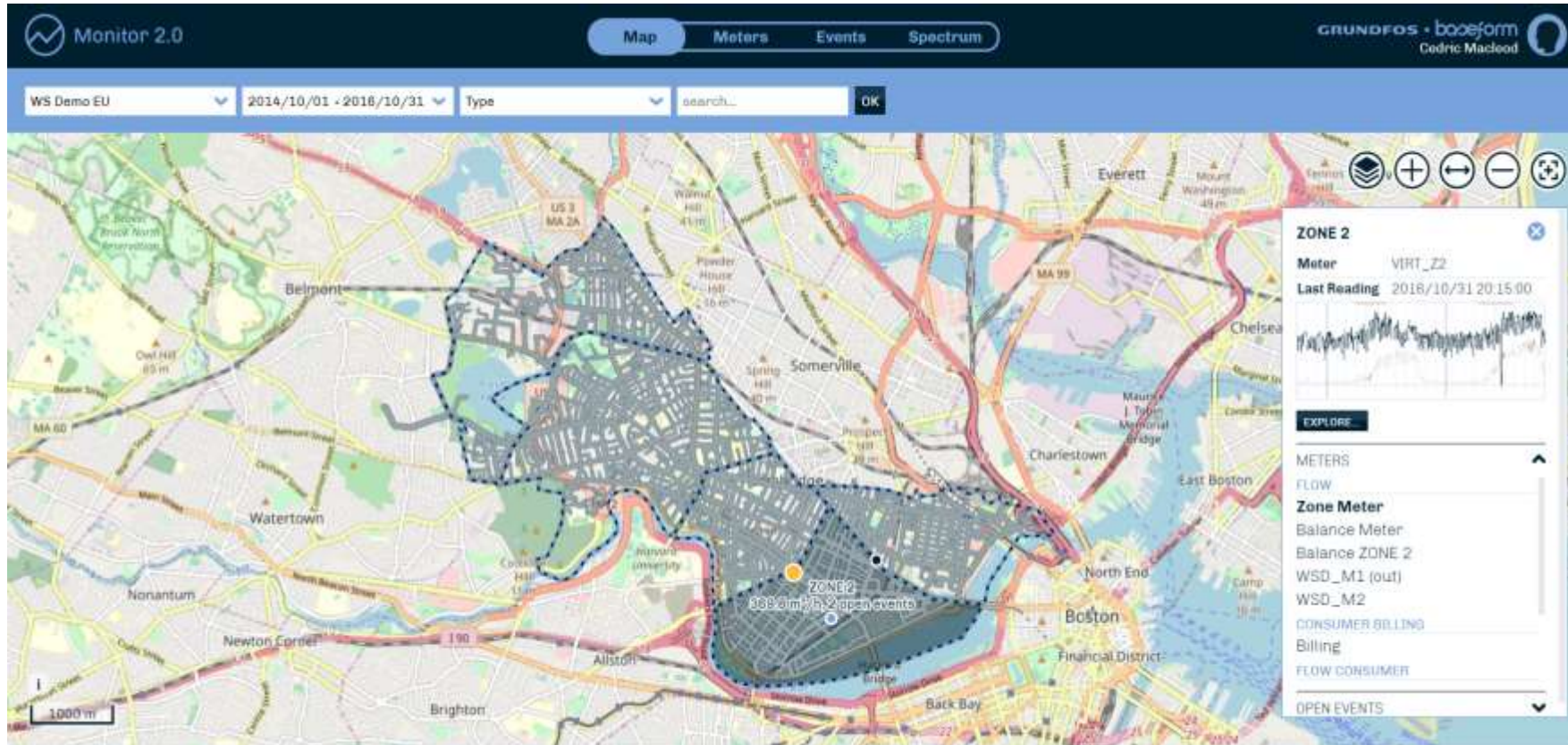
MONITOR: Real Time operational efficiency



• METERS

- Sensor-based monitoring drives system usage analytics, learning and predicting demand patterns & trends, and consumer behavior.
- ✓ Dynamic, predictive demand patterns.
- ✓ Advanced flow analysis of trends, behaviors, consumers, network.
- ✓ Individual meter validation and reliability analysis.
- ✓ A monitoring-based, direct depiction of network behavior.
- ✓ Integrated feed of demand patterns and data to simulation models.

MONITOR: Real Time operational efficiency



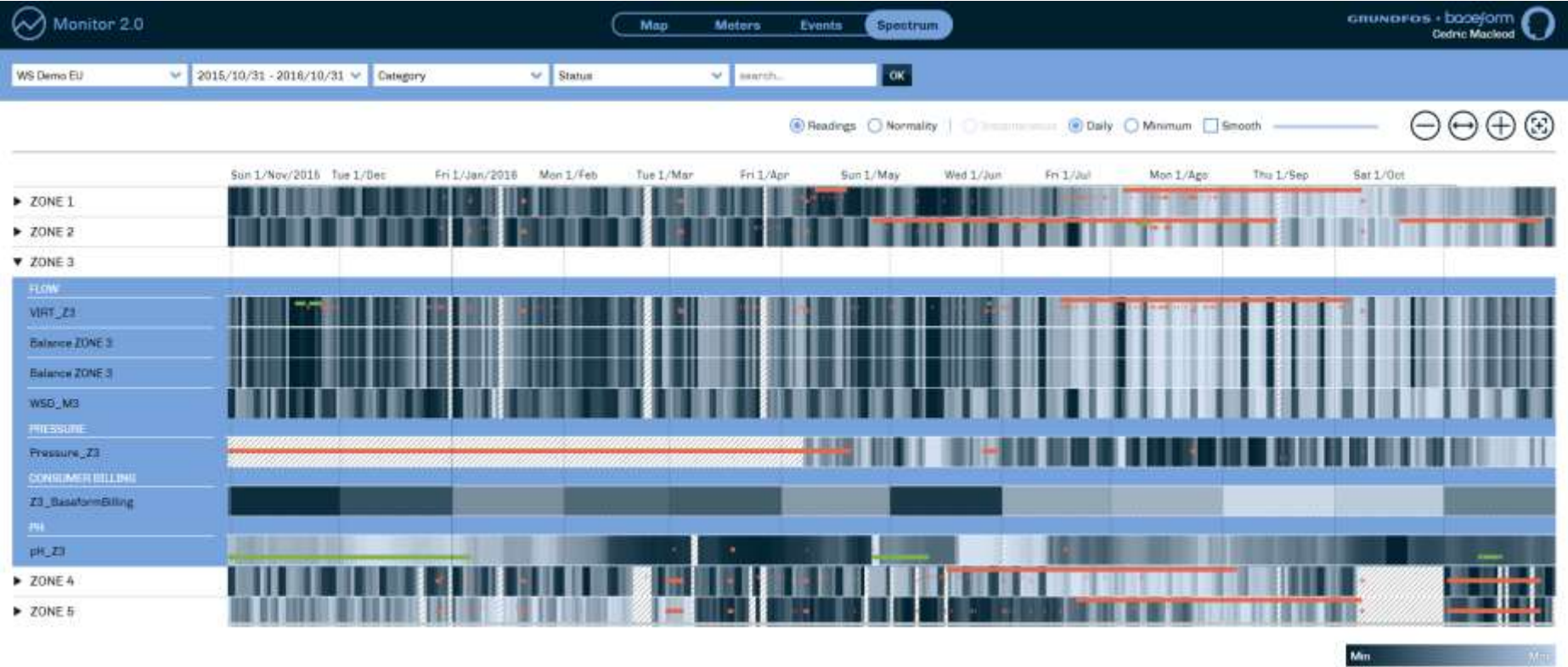
• MAPS

- Interactive map-for quick overview of meters and associated events in the selected zone, with direct access to a specific meter or event.

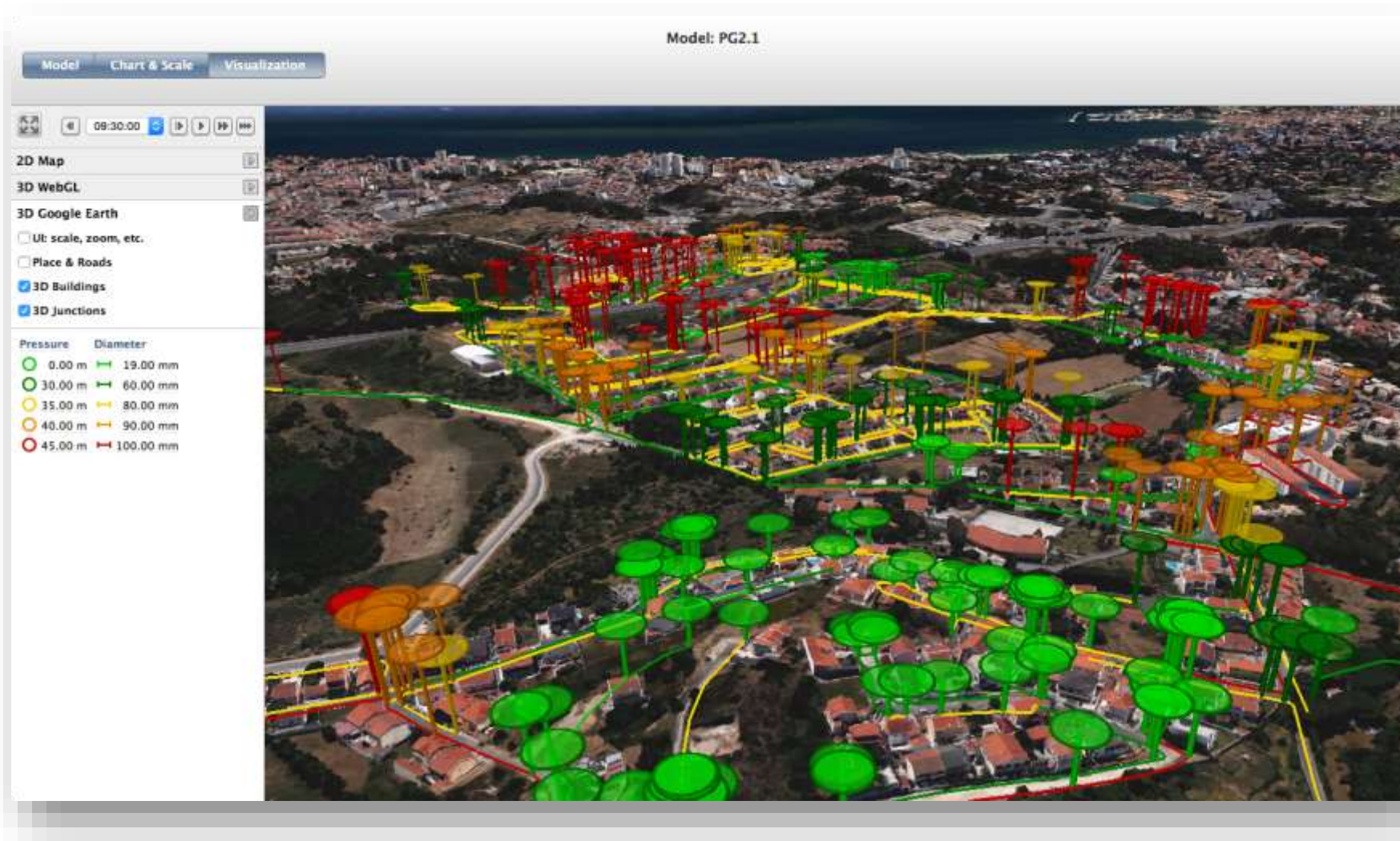
MONITOR: Real Time operational efficiency



- SPECTRUM
- Meters activity and health overview



DIAGNOSE: Spatial & system behaviour analytics



• NETWORK • MODELLING

- Efficient, Java-implemented Epanet simulation engine for full-range hydraulic and water quality simulation, with 3D visualization and Google Earth integration.
- ✓ Full-range hydraulic simulation available in an internet browser, using Epanet .inp files
- ✓ Native inclusion of the MSX advanced water quality simulation library
- ✓ Powerful result visualization helps bridge gap to non-expert users
- ✓ Full Excel® export/import of model data and results
- ✓ Integrates results from all other network-related apps [eg., failure analysis, geo analysis)

DIAGNOSE: Real Time operational efficiency

Water Balance

Data Indicators Table

System profile
Library
File info
Import/Export

Water Balance data can be exported to and imported from Excel spreadsheets. Imported data will replace existing values; please try exporting first, editing data on Excel and then importing.

EXPORT IMPORT

Reference year 2015 [change](#) System input volume (corrected for known errors) 2,325,252 m³ Remaining to justify 119,498 m³ (5%)

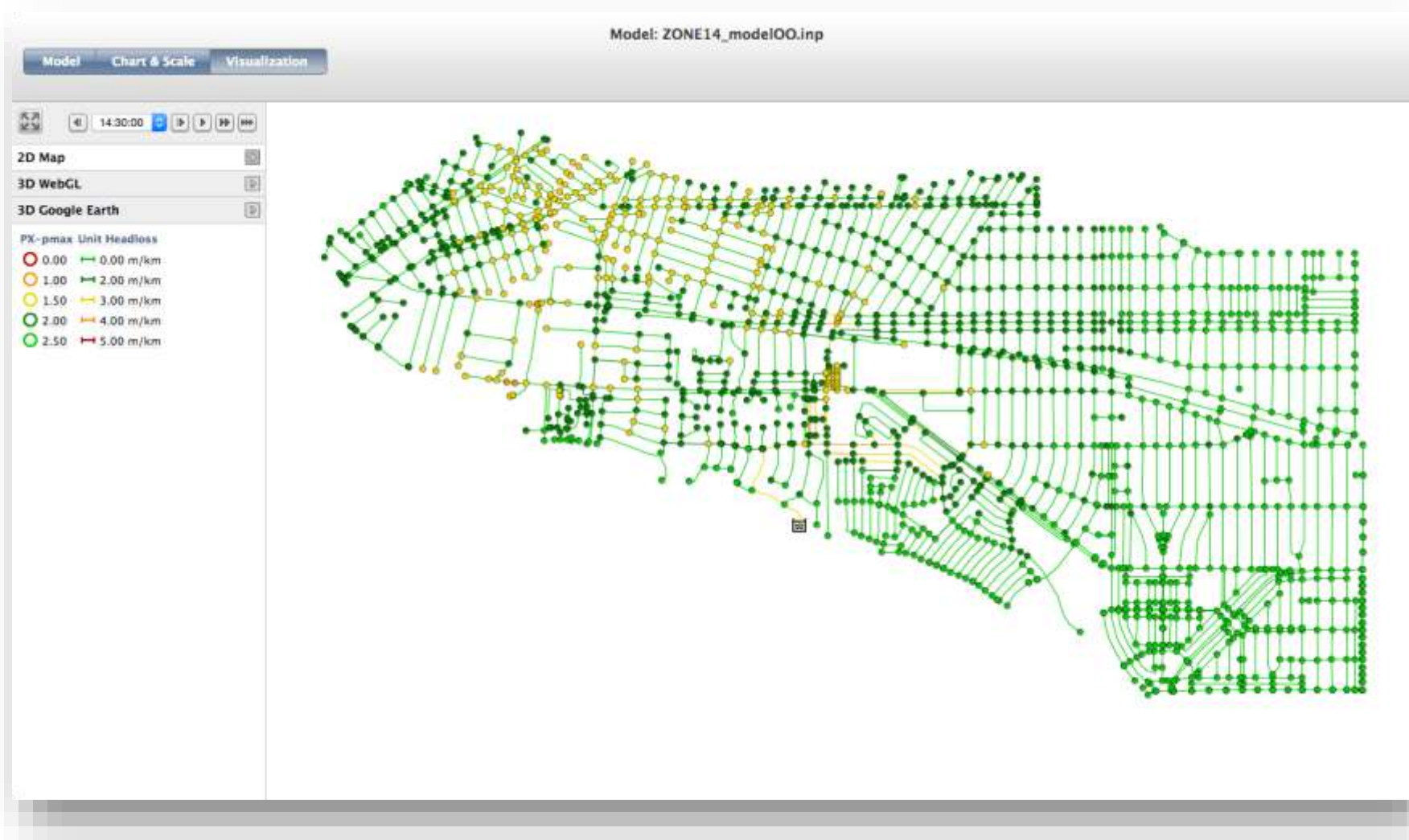
System input volume (corrected for known errors) (4/6)	2,325,252 m ³
System input volume	2,325,252 m ³
Water abstracted	0 m ³
Billed water imported (raw or treated) (billed by others)	2,325,252 m ³
Unbilled water imported (raw or treated) (billed by others)	0 m ³
System input volume errors	0 m ³
Water abstracted	0 m ³
Billed water imported (raw or treated) (billed by others)	0 m ³
Unbilled water imported (raw or treated) (billed by others)	0 m ³
Billed authorised consumption (6/12)	1,916,178 m ³
Billed unauthorised consumption (6/13)	6,126 m ³
Apparent losses (4/4)	130,740 m ³
Unauthorised consumption	2,366 m ³
Consumption due to illegal use of hydrants and irrigation taps	66 m ³
Consumption due to illegal connections	2,300 m ³
Authorised consumption errors	128,374 m ³
Authorized metered consumption errors	128,168 m ³
Authorized unmetered consumption errors	206 m ³
Real losses (3/4)	152,710 m ³
Leakage and overflows at transmission and/or distribution storage tanks	1,250 m ³
Leakage on service connections up to the measurement point	76,501 m ³
Real losses on raw water mains and at the treatment works	
Leakage on transmission and/or distribution mains	74,959 m ³



• WATER BALANCE

- Library-based, IWA / AWWA-compliant water audit standard framework for rigorous, automated diagnosis, NRW reduction and asset management.
- ✓ Systematic calculation of water balance for system and zones.
- ✓ Automated, consistent estimates for supplied and lost volumes and for NRW and water losses kPI.
- ✓ Fully configurable libraries for any combination of audit items.
- ✓ May be automatically fed from billing/CRM, network monitoring & other sources

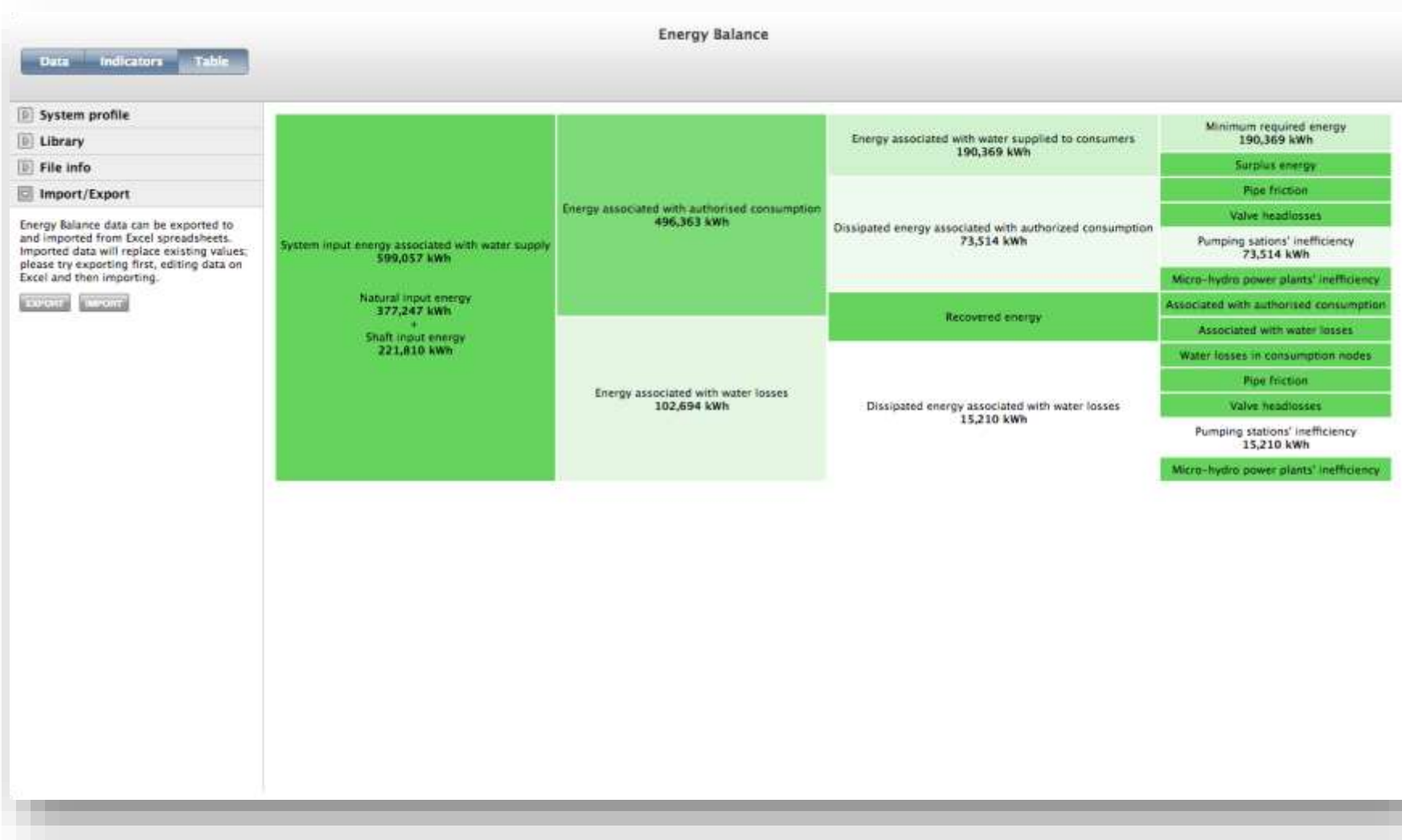
DIAGNOSE: Spatial & system behaviour analytics



• PERFORMANCE INDICES

- Simulation-based, technical performance assessment of system capacity, water quality, energy use and any other system behavior.
- ✓ Calculates performance indices – detailed technical performance metrics based on the values of certain features or state variables of urban water networks.
- ✓ Indices include hydraulics [e.g., service pressure, contingency pressure, pressure variation, velocity), water quality (travel time, concentration)
- ✓ Performance indices selected from editable libraries updated with latest R&D

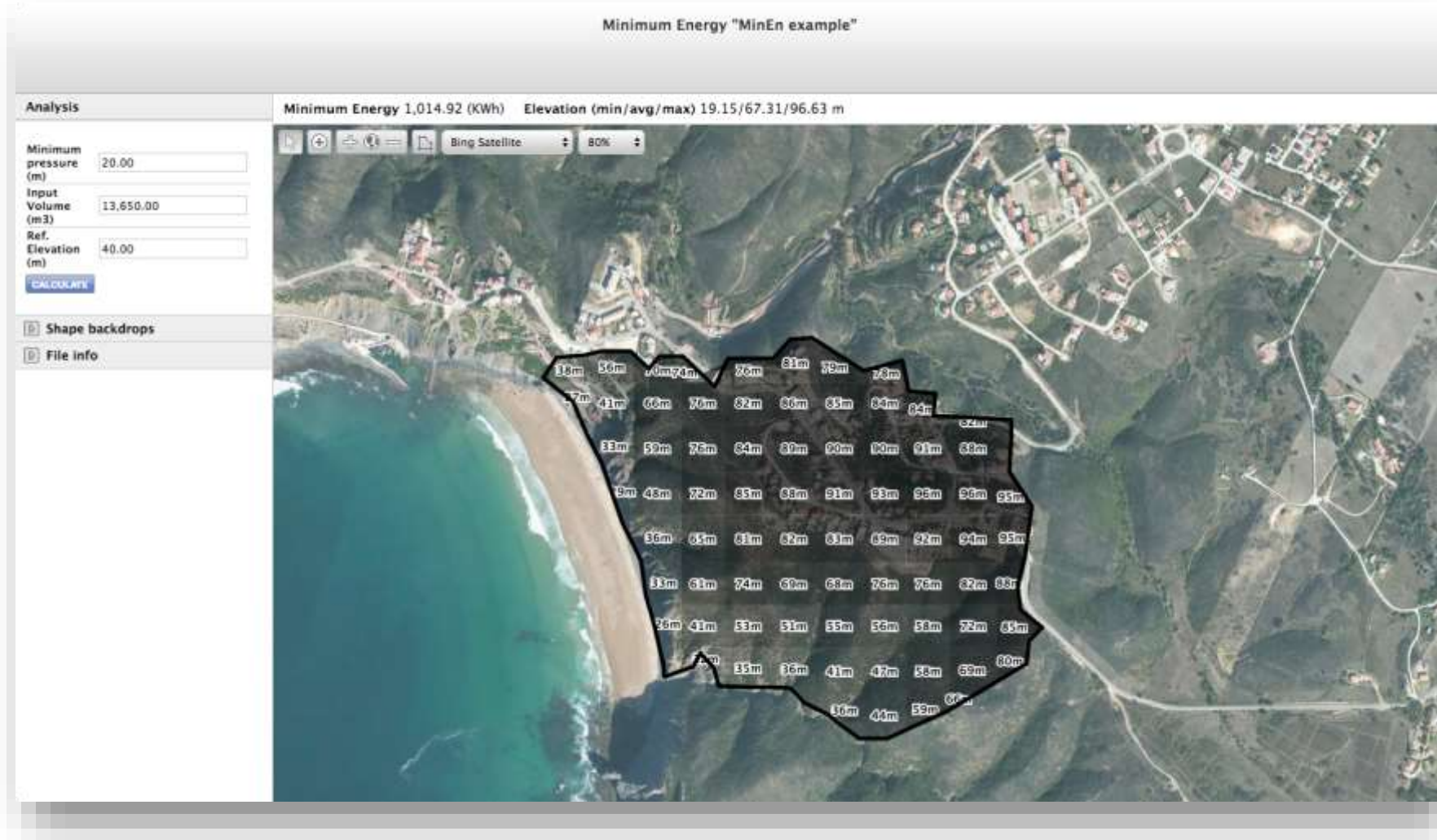
DIAGNOSE: Spatial & system behaviour analytics



ENERGY BALANCE

- Library-based energy balance framework for automated diagnosis and prioritization of system sectors from an energy assessment viewpoint.
- ✓ Systematic calculation of energy balance for system and zones.
- ✓ Automated, consistent estimates for delivered, dissipated, recovered and lost energy, as well as energy efficiency KPI.
- ✓ Fully configurable libraries for any combination of audit items.

DIAGNOSE: Spatial & system behaviour analytics



• MINIMUM ENERGY

- Automatically calculates the minimum energy needed to supply distributed demand in a water network using web-available detail geodata.
- ✓ Calculates the minimum energy needed to supply a given demand volume uniformly distributed across a specified geographical area.
- ✓ On-map direct freehand drawing of target area.
- ✓ Automatically retrieves detail elevations for the target area from web-available geodata.
- ✓ Shape files may be imported as guidance backdrops.

PREDICT: System & Asset Analytics

Failure analysis: Alternative 0 Failure analysis

Summary Results by pipe Pipe data Failure data

Simulation

View simulation log

Poisson LEYP


RUN SIMULATION

File info

Network info

Model	Alternative 0
Pipes	458
Junctions	568
Simulation	24:00:00 hours
Hydraulic Step	00:15:00
Units	SI
Headloss Formula	HW

CHANGE



Export

Descriptive statistics

Material	Pipes	Failures	Length (mi)	Observation (years)	Failure rate (fails./year)	Failure rate (fails./mi./year)
FF	6	1	0.01	9.17	0.11	16.40
FG	82	9	0.47	10.23	0.88	1.87
FD	334	14	1.99	9.58	1.46	0.73
PEA	3990	246	23.88	6.92	35.53	1.49
PVC	3984	464	21.70	10.08	46.03	2.12
FC	3085	1225	21.67	10.23	119.73	5.52
	11481	1959	69.72	8.95	218.99	3.14

Poisson aggregated results

Material	Prob. Fail. 1 year, 1 mi
FF	100.00%
FG	84.64%
FD	51.94%
PEA	77.42%
PVC	88.01%
FC	99.60%

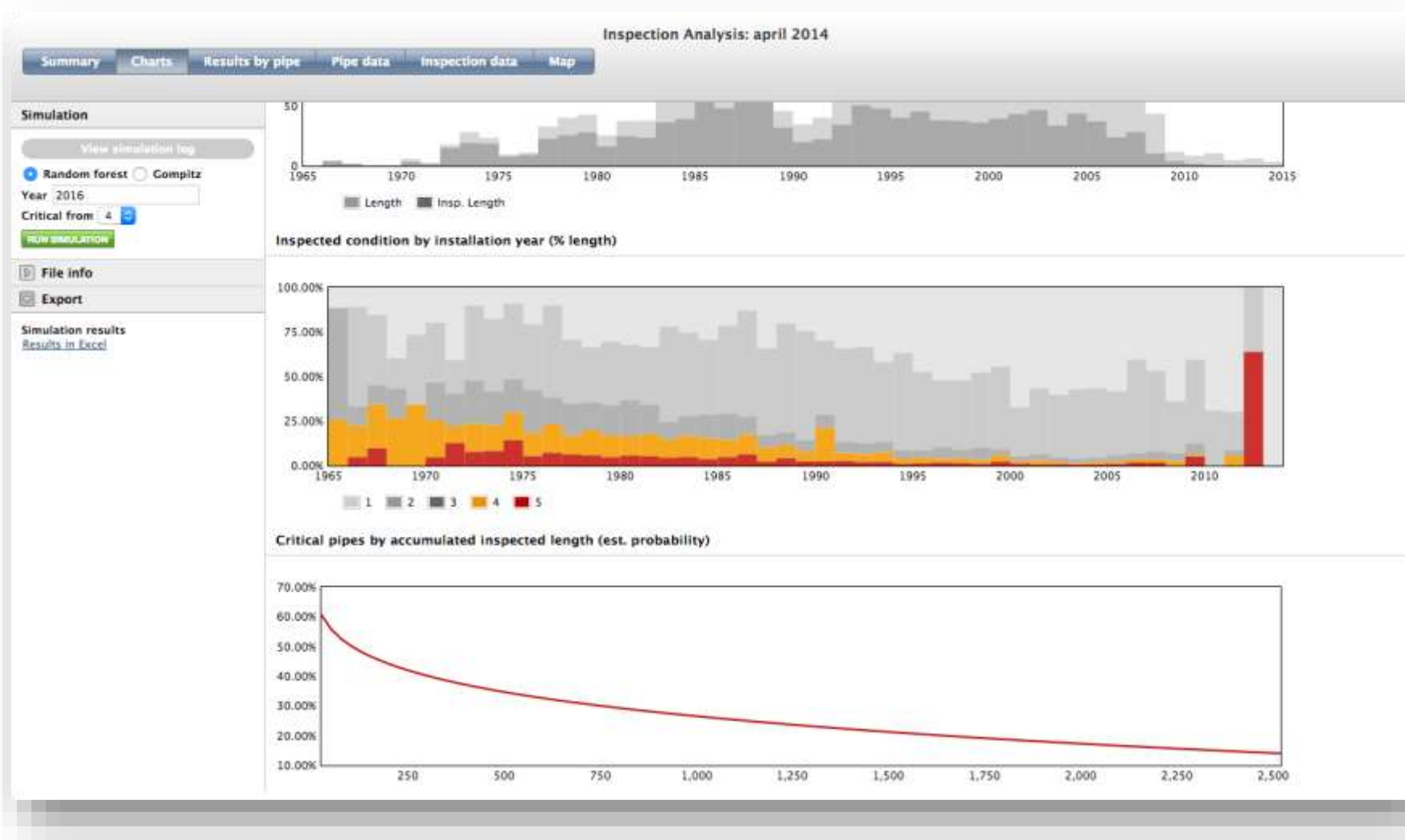
Poisson analysis results are summarized below. The Poisson model uses a counting process in which the events occur independently at a constant rate and where the number of events follows a Poisson distribution. It is assumed that the rate of the counting process is proportional to the length of each pipe. The failure rate is estimated by the maximum likelihood method.



• FAILURE ANALYSIS

- Using system component failure records, such as work orders, predicts present and future probability of failure of pipes or sewers.
- ✓ Predicts individual pipe/sewer probability of failure and failure rate at any point in time.
- ✓ Uses pipe/sewer inventory data and asset failure records [e.g. from work orders).
- ✓ Includes two alternative predictive models: Poisson and LEYP [Linear Extended Yule Process).

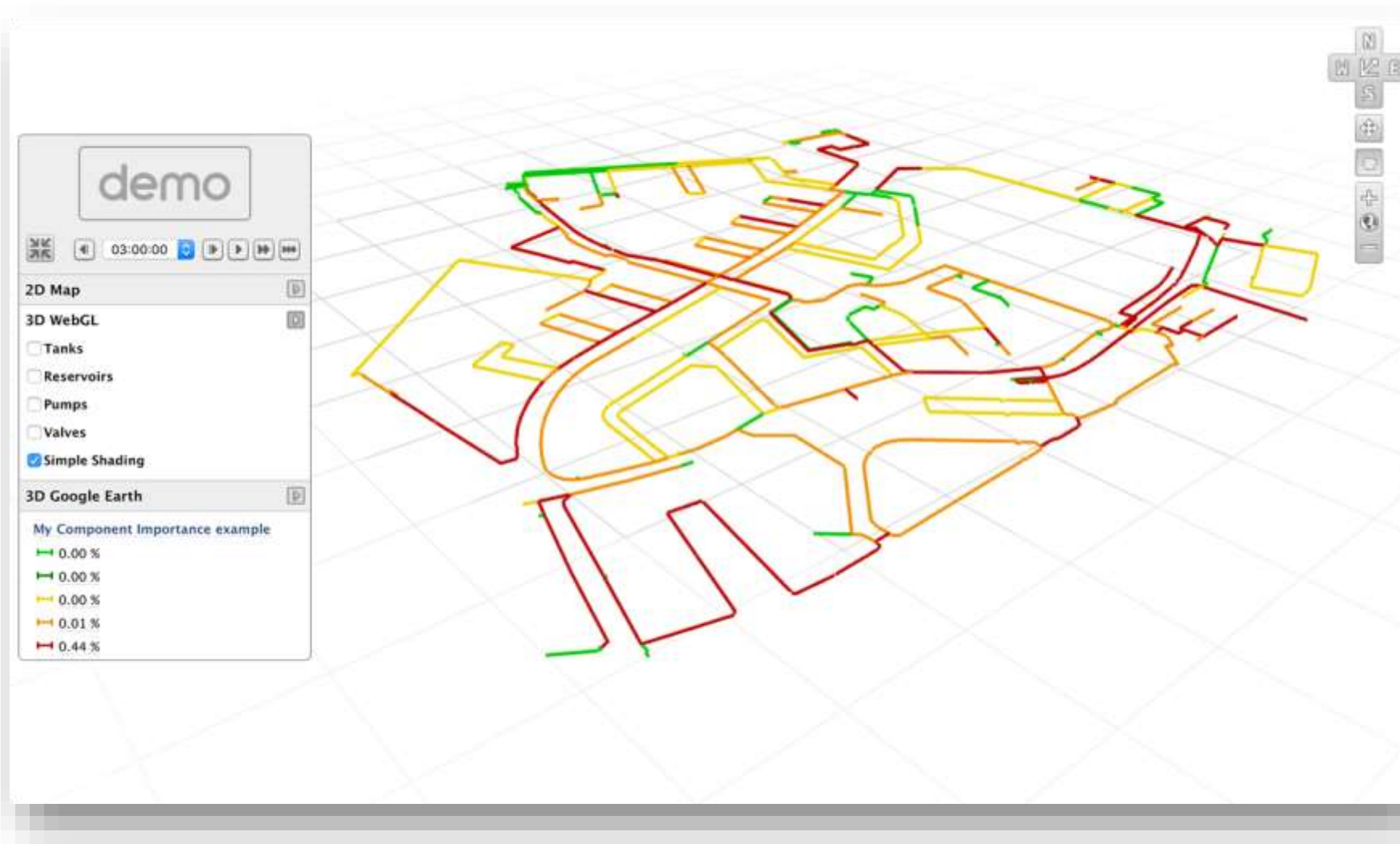
PREDICT: System & Asset Analytics



• INSPECTION • ANALYSIS

- Using pipeline/sewer inspection and condition assessment records, predicts future condition, residual life, and guide the inspection effort.
- ✓ Uses pipe/sewer inventory data and failure records [e.g. work orders].
- ✓ Other covariates may be supplied as geodata.
- ✓ Projects the effect of age on condition & estimates confidence levels for the predictions.
- ✓ Measures the value of explanatory variables.
- ✓ Two predictive models: Random Forest machine-learning model and Gompitz stochastic model

PREDICT: System & Asset Analytics



• COMPONENT • IMPORTANCE

- Assesses the consequence of failure of each pipe in a water supply network, by simulating the resulting reduced service.
- ✓ Calculates the individual importance of each pipe by comparing the total demand that the network is hydraulically capable of satisfying when that pipe is down, with the total demand supplied by the unimpaired network.
- ✓ Capable of computing the effect over extended periods (e.g., the 24h cycle).
- ✓ Results available in 2D or 3D mapping visualization, alongside all hydraulic results

PREDICT: System & Asset Analytics

Unmet Demand: Customer cubic meters lost

Summary Results by pipe Failure Rates Component Importance

457 rows (100 per page) 1 2 3 4 5

Simulation

Average downtime: 3.0 (hours)

File info

Model file

Model: My network model example.inp

Pipes: 458

Junctions: 568

Simulation: 24:00:00 hours

Hydraulic time step: 00:15:00 hours

Units: SI

DOWNLOAD FILES

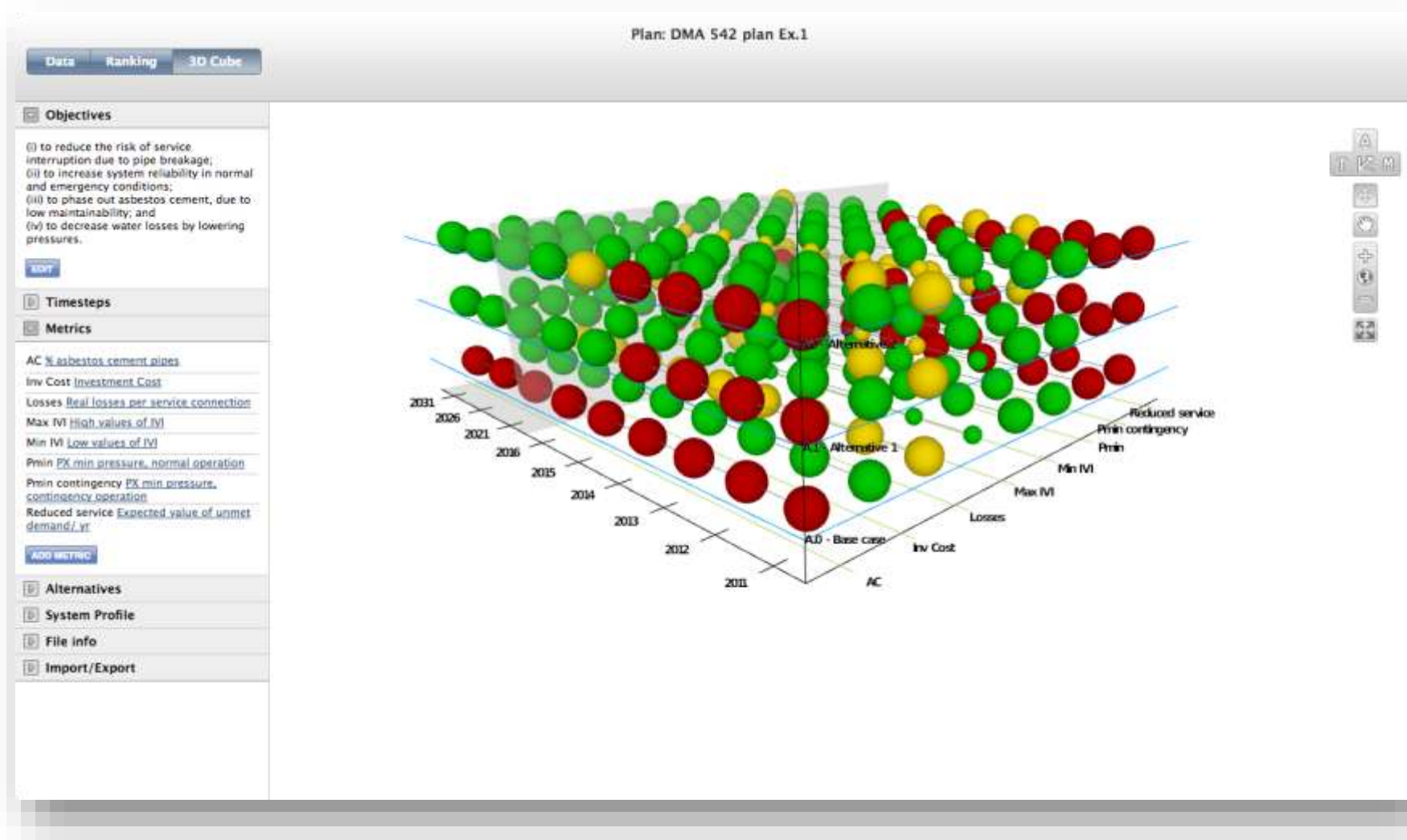
Sort by Risk Descending

Pipe ID	Unmet demand/year	Risk
14478	2.6072	1.1%
1111888	1.3952	0.7%
1055057	1.3317	0.6%
1055023	1.0622	0.4%
1055055	0.6786	0.3%
14408	0.6704	0.3%
14400	0.5605	0.3%
14522	0.4102	0.2%
1113742	0.3975	0.2%
1111895	0.3604	0.2%
14479	0.3561	0.2%
14477	0.3185	0.2%
1113120	0.3206	0.2%
1103894	0.3648	0.2%
14402	0.2805	0.1%
1113119	0.2854	0.1%
1113745	0.2610	0.1%
1113749	0.2298	0.1%
905055	0.2210	0.1%
14532	0.2318	0.1%
1055847	0.1956	0.1%
1113748	0.1850	0.1%
14335	0.1896	0.1%
14291	0.1894	0.1%
14092	0.2047	0.1%
14403	0.2029	0.1%
1055878	0.1813	0.1%
14383	0.1967	0.1%
14375	0.1847	0.1%
1055857	0.1662	0.1%
14405	0.1587	0.1%



- RISK OF
- NO-SERVICE
- Quantifies supply service interruption risk through expected reduced service, based on individual pipe failure probabilities and consequences.
- ✓ Calculates a service interruption risk metric, expressed as the expected volume of demand that the system will be unable to satisfy over one year, caused by the failure of each individual pipe.
- ✓ Combines results from Failure Analysis and Component Importance.

PLAN: Time & Space Prioritization



• COMPARE & • PRIORITIZE

- AWARE-P decision-support environment where competing/strategies projects are measured up and prioritized through objectives-guided metrics.
- ✓ Quantification of impacts over the long term
- ✓ Ability to include the most relevant viewpoints
- ✓ Ready to incorporate expert knowledge but engage non-technical decision-makers
- ✓ Defendable decisions are reached through a repeatable, audible and transparent process

PLAN: Time & Space Prioritization

Performance Indicator: Example PI

Summary PI calculation 70 PIs

File info

PI Cart

- Op31 Mains failures (No./100 km/year)
- F127 Investments for asset replacement and renovation (€)
- Ph7 Energy recovery (%)
- Q513 Water interruptions (%)

Input variables required

- C8 Mains length (km)
- D1 Pumping energy consumption (kWh)
- D28 Mains failures (No.)
- D35 Water interruptions (person x hour)
- D5 Energy recovery (Wh)
- F1 Population supplied (person)
- G32 Investment in tangible assets (€)
- G34 Investments for asset replacement and renovation (€)
- H1 Assessment period (day)

Library

Code Op16
Name Mains rehabilitation
Definition (Length of transmission and distribution mains rehabilitated during the assessment period x 365 / assessment period) / total mains length x 100
It is recommended that this indicator is not assessed for periods shorter than one year, since it may lead to misleading conclusions. Annual values should ideally be analysed over a number of years and not in isolation. If a shorter assessment period cannot be avoided, special care is required in result interpretation. External comparisons on such timebases must be avoided. Or
or $Op16 = Op17 + Op18$.
Comment
Rule $(D20 * 365 / H1) / C8 * 100$
Units (%/year)
Input Variables D20 Length of transmission and distribution mains rehabilitated during the assessment period.
H1 Period of time adopted for the assessment of the data and of the PI.
C8 Total transmission and distribution mains length (service connections not included), at the reference date

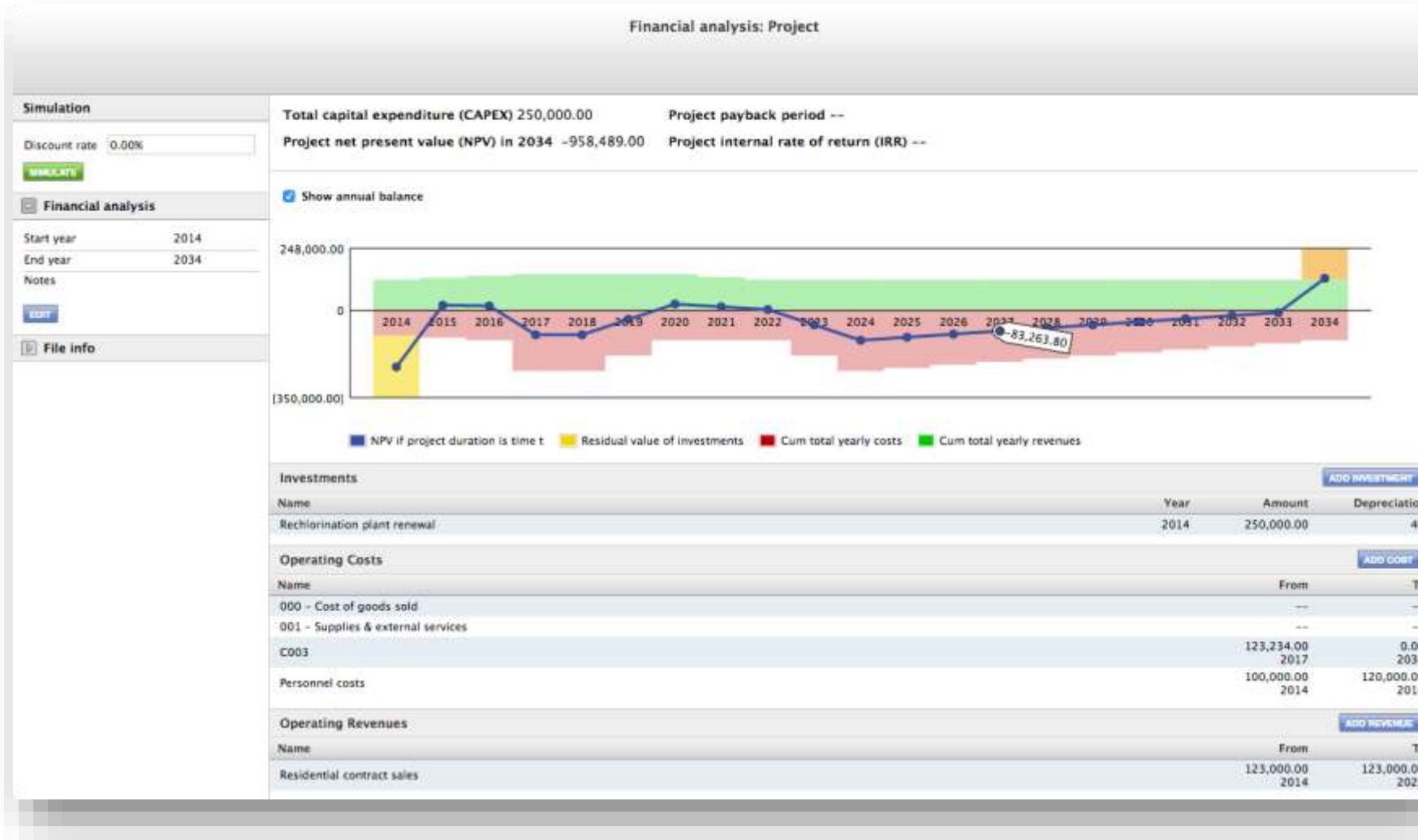
CANCEL ADD

Pi

• PERFORMANCE INDICATORS

- A framework for selection and calculation of kPI based on organized libraries, including industry standards [IWA) and user-developed libraries.
- ✓ Guided kPI selection process leads to informed, efficient selection.
- ✓ Rigorous PI definitions, base data and units.
- ✓ Required information clearly displayed.
- ✓ Includes reference kPI libraries such as IWA's for water supply and for wastewater.

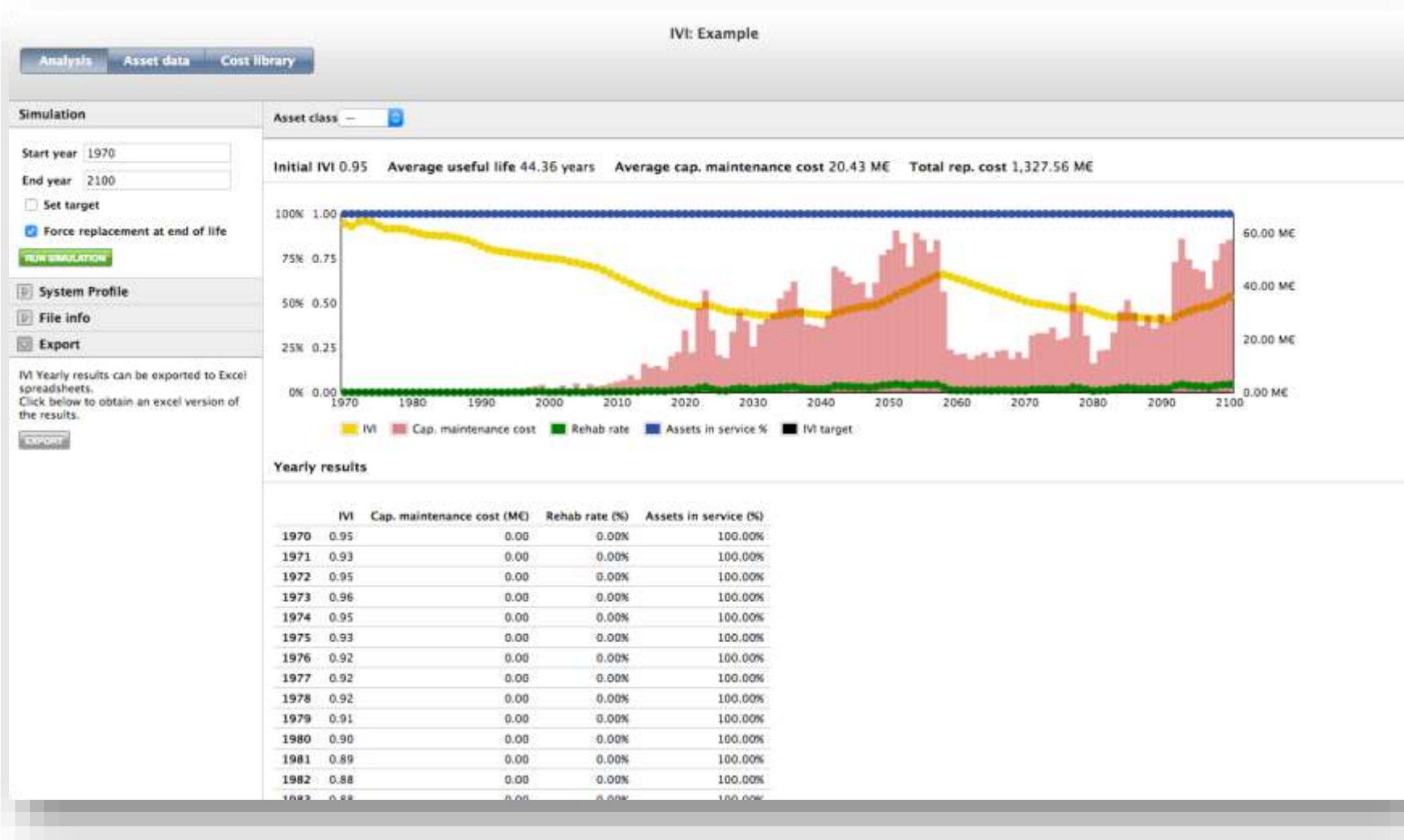
PLAN: Time & Space Prioritization



FINANCIAL PROJECT ANALYSIS

- Assesses net present value [NPV] and the internal rate of return [IRR] of any financial project from a long-term perspective.
- ✓ A planning tool with the capability to project user-defined investments, costs and revenues over any period of time.
- ✓ A simplified, rapid means to explore the relationship between the duration of a given plan's projected horizon and its NPV and IRR.

PLAN: Time & Space Prioritization



- INFRASTRUCTURE
- VALUE ANALYSIS

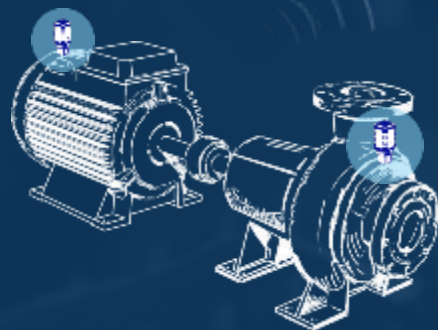
- Analyses the ageing degree of an infrastructure comprised of any number of assets, and forecasts short- and long-term investment and rehab needs.
- ✓ IVI translates the aging degree of an infrastructure, calculated as the asset-value weighted ratio between the current value and replacement value of its components.
- ✓ An effective tool for assessing the impact of investment policies on service availability and financial sustainability.
- ✓ Linear and vertical assets with any degree of granularity may be included in the analysis.



PUMPS AND OTHER HARDWARE

Condition Monitoring

THE NEW WAY



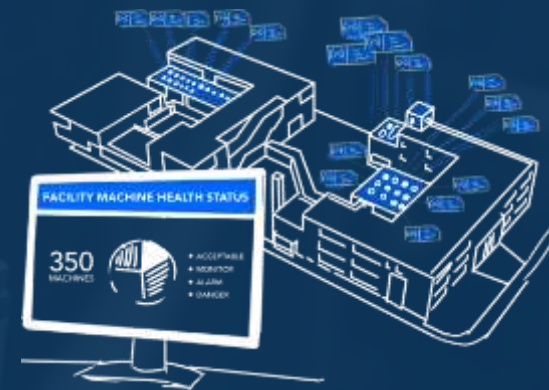
COLLECT

Smart sensors monitor your machines 24/7



ANALYZE

Algorithms predict malfunctions and provide alerts



VISUALIZE

Full visibility of machine health across your facility

GO THE LIMIT WITH CR PUMP MONITORING

One single solution that eliminates the risk of unexpected downtime and maintenance, improving your peace of mind at the same time. How good does that sound? With the Grundfos Condition Monitor, this is possible.

WHAT IS THE GRUNDFOS CONDITION MONITOR?

The Grundfos Condition Monitor is a smart sensor that monitors your pump and pump system for the most common failures. Compared to traditional pump monitoring solutions, it provides you with instant results instead of simply extracting data to a graph. Additionally, it can easily be connected to your internal SCADA/BMS/DCS system via ModBus, while Grundfos service technicians are available to remotely monitor and help you optimise your system.

WHAT DOES IT TELL ME?

The Grundfos Condition Monitor keeps track of a variety of parameters including motor bearings, dry-run, cavitation, unbalance and water hammer. Once it has defined where the issue lies, you will know exactly how to approach it.



BEARING



CAVITATION



WATER HAMMER



UNBALANCE



DRY-RUN



LIQUID TEMPERATURE

WHAT IS IN IT FOR ME?

The Grundfos Condition Monitor offers a wide range of benefits.

Increased system uptime

Unexpected downtime can be costly, but the Grundfos Condition Monitor allows you to fix common issues before it is too late – thus, increasing system uptime.

No more unplanned maintenance

The Grundfos Condition Monitor keeps track of what goes on in the pump. This allows you to plan ahead and carry out maintenance whenever it is convenient.

Easy connection possibilities

You can integrate the Grundfos Condition Monitor with your SCADA/BMS/DCS system keeping you updated on system activity at all times.

HOW DO I GET MY HANDS ON A GRUNDFOS CONDITION MONITOR?

You can get your hands on this unique solution right now! We offer subscription-based services with no up-front investments, meaning that you can get your Grundfos Condition Monitor whenever you want. Check out our individual leaflets to find out much more about our services.



TRACK YOUR PUMP INSTALLATIONS FROM ANYWHERE



Thank you!