Deltares

enabling delta life

RTC-Tools:

Real-Time-Control Tools

Jesús A. Rodríguez, Deltares

Jorn Baayen, PortfolioEnergy

PORTFOLIO energy

TAC Meeting LF Energy

September 2, 2025

The Need for Optimization in Energy Systems

Modern energy systems are becoming increasingly **dynamic and interdependent** as more renewables come online.

For instance, **hydropower plants**, **battery energy storage systems** and **district heating** systems must operate under:

- **Uncertainty** (e.g., market prices, weather forecasts, power generation)
- **Competing objectives** (e.g., economic efficiency vs. system reliability)
- **Complex system interactions** (e.g., system coupling, nonlinear behaviour, grid constraints)

RTC-Tools enables robust, real-time decision-making in the energy systems by incorporating **predictive uncertainty** into **prioritized optimization objectives** within a **flexible modelling framework**.

What is RTC-Tools?

RTC-Tools is a robust open-source Python framework designed for the control, simulation, and optimization of operational systems. Its core capability is multi-objective decision-making under uncertainty for complex systems models. RTC-Tools has been in use for real-time operations and system planning across infrastructure sectors globally for the past decade.

Challenge	RTC-Tools capability
Predictive uncertainty	Optimization under uncertainty Support for ensemble forecasts and multi-stage optimization
Multi-objective optimization	Optimization with prioritised objectives (goal programming)
Modelling complex systems	Flexible modelling of linear and nonlinear systems, numerically robust optimization
Runtime performance guarantees	Integration with state-of-the-art optimization solvers such as Highs, Ipopt, MadNLP, Gurobi, etc.

RTC-Tools overview (software perspective)

Development:

- Initiated and maintained by Deltares since 2015
- Active community (Deltares + external contributors)

Technical specifications:

- Language: Python 3 with modern package manager support (pip, uv)
- Modelling specification: Python, Modelica
- Mathematical core: CasADi automatic differentiation framework
- Support for a large family of solvers (Ipopt, HiGHS, Gurobi, etc.)

Licensing considerations:

- License: LGPL v3.0 (compatible with commercial use)

Extensions and applications

Energy systems:

- rtc-tools-heat-network: design optimization of district heat networks
- Mesido: design optimization of multi-commodity electricity systems
- BESS demo: BESS-backed energy trading

Water systems:

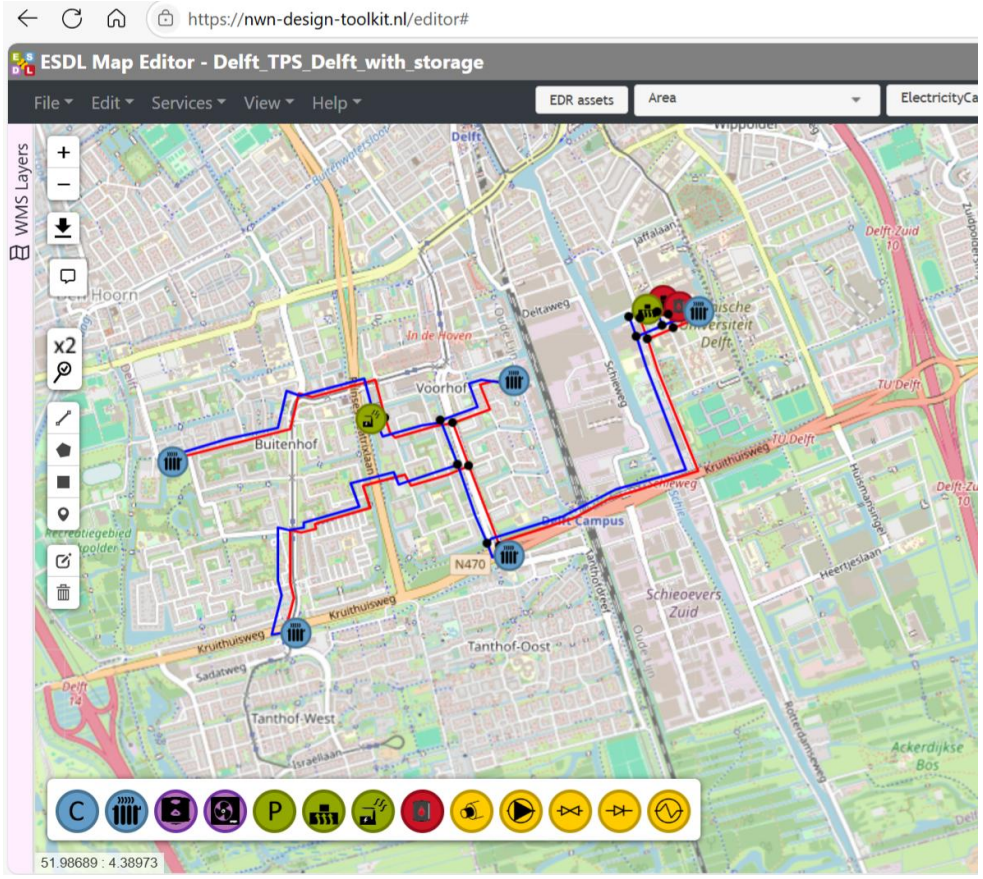
- rtc-tools-channel-flow, rtc-tools-hydraulic-structures: water system components (channels, pumps, valves, reservoirs)

Extensions:

- rtc-tools-interface: low-code specification of goals, closed-loop workflows and visualization of optimization results
- rtc-tools-diagnostics: analysis and debugging the results of RTC-Tools optimization runs

Selected **energy** users and use cases:

- **Ontario Power Generation** (Canada): Hydropower optimization
- **Shell Energy** (USA, EU, Australia): Asset-backed energy trading - optimization of thermal storage and chiller plants, and gas turbine power flexibility.
- **Verbund** (Austria): Hydro-backed energy trading
- **PortfolioEnergy** (EU, USA, Australia): BESS-backed & portfolio energy trading
- **Nieuwe Warmte Nu** Consortium (Netherlands): Software package for the design of district heating networks (Design Toolkit).
- **TNO** (Netherlands): Software package for multi-commodity energy system design and optimization (Mesido)



Selected **water** users and use cases

Energy-optimized water systems management:

- **Rijnland Water Authority**, **Delfland Water Authority, Rijkswaterstaat** (the Netherlands): Water system optimization
- **Royal Haskoning DHV** (the Netherlands): Sewer systems optimization

Water resource management:

- **Bundesanstalt für Gewässerkunde** (Germany): Water resources management
- **HydroTasmania** (Australia): Reservoir and lake modelling
- **National Weather Service** (USA): Reservoir modelling

Alignment with LF Energy

RTC-Tools advances LF Energy's mission to *accelerate the energy sector's transition to open-source technologies* by contributing a **widely adopted optimization framework that has been delivering value across the world for the past decade**.

RTC-Tools is currently governed by **Deltares**, a non-profit specialized in water resources management with a mandate exclusively limited to water. **Shell Energy** and **PortfolioEnergy**, however, and possibly other organisations, use RTC-Tools for applications beyond water systems.

There is a need for an independent 3rd party with a broad mandate to adopt the project.

In our view Linux Foundation is the natural home for RTC-Tools. We have aligned project governance with LF Energy standards.

Strategic value for LF Energy Ecosystem

- **Flexibility**: Adaptable to diverse resource optimization challenges across the energy domain.
- **Reliability**: Proven in operational deployments for critical infrastructure around the world.
- **Ecosystem Growth**: Attracts cross-sector participation to LF Energy; aligns with other LF Energy projects on the technical level through a common use of Python and Modelica.
- **Intelligence Enablement**: Serves as the computational backbone for smart systems and decision support in energy trading organizations.

Active contributors

Engagement of contributors

- Weekly stand-up
- Bi-weekly Technical Coordination meeting with external contributors
- Regular contributions: pull requests, code reviews, issues, project discussions

Deltares:

- Jesus A. Rodríguez S.
- Ailbhe Mitchell
- Farid Alavi
- Bernhard Becker
- Klaudia Horvath

Other organizations:

- Joris Gillis (Yacoda)
- Tjerk Vreeken (PortfolioEnergy)
- Jorn Baayen (PortfolioEnergy)
- Sjoerd Geevers (Vortech)

Growth strategy

Context:

- Growing demand for optimization in energy
- BESS deployments are growing exponentially across the world

Planned activities:

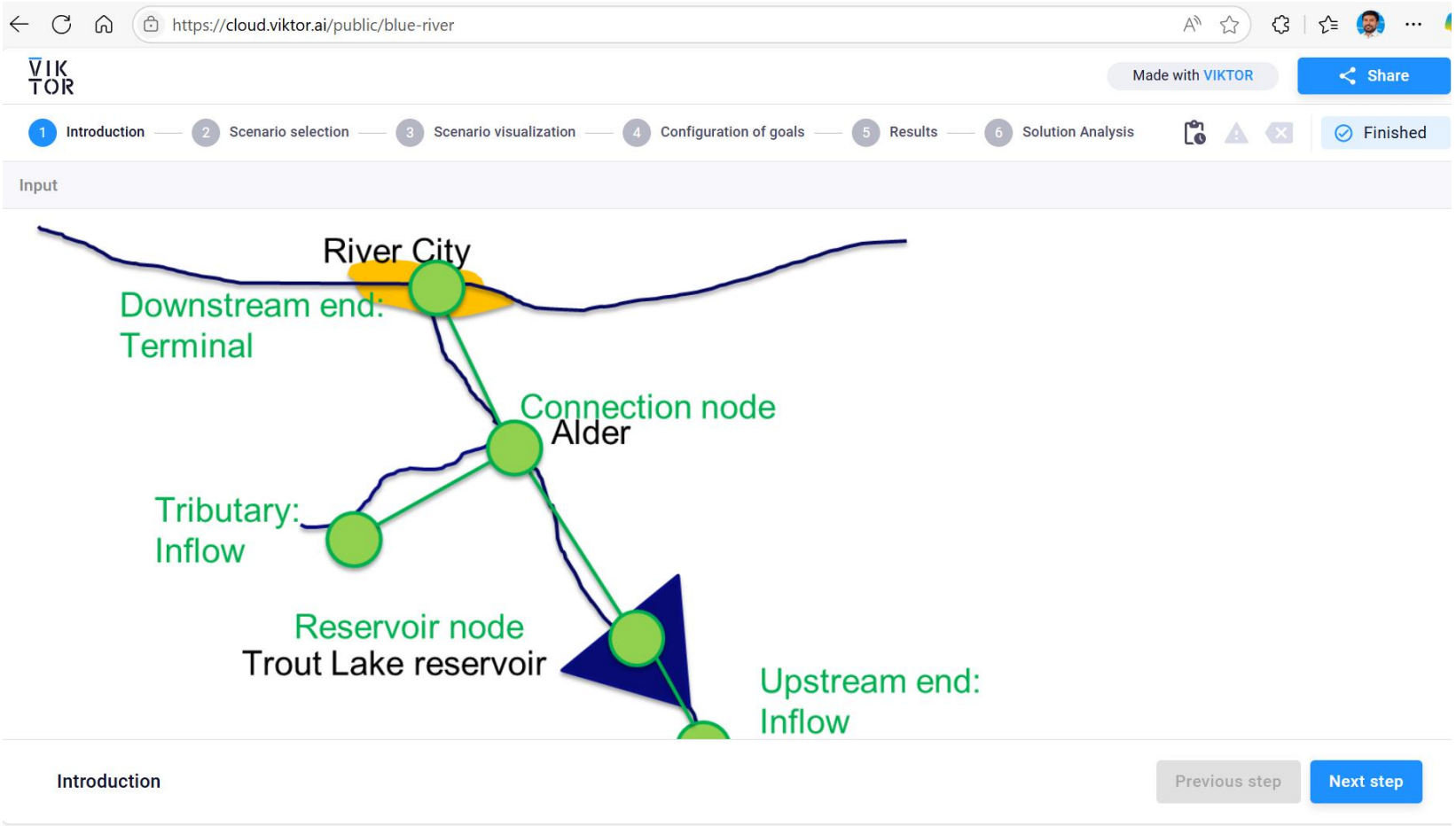
- Live RTC-Tools demo at the LF Energy Summit Europe 2025
- RTC-Tools User Day at Deltares (November 4, 2025)

Community Growth Strategy:

- Connect with LF Energy Ecosystem
- Build bridges between water management and energy communities
- Expand collaboration with partners in the energy and optimization sectors
- Increase visibility of completed and ongoing projects and developments
- Dissemination in academic education (universities)

Demo I

- Blue-river model - Viktor Web App



Demo II

Battery Energy Storage System demo (BESS)

BESS-backed trading in the National Electricity Market, Australia.

Jorn to demonstrate.

How to get started with RTC-Tools

Github repository

- Contributing
- Governance

Read the Docs Documentation

Published package on Pypi

Thank you!