



CMET

Center for Microbial Ecology and Technology



CAPTURE

Centre for Advanced Process Technology
for Urban REsource recovery



**FACULTY OF
BIOSCIENCE ENGINEERING**

Linking on site water recovery options to key resilience drivers using the OSiRIS tool

A C++ modelling approach available as standalone application

Seppe Ongena 21/10/24



De Watergroep

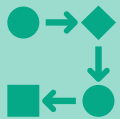
Contents (click for link)



Introduction: what is the model (not) for?



App layout: screenshots, description of app



Example workflow: from data to results

OSiRIS: what is it?

OSiRIS Model and current OSiRIS App



High flexibility with building blocks, configurable in .json file:



Water tanks: volume, pre-filled or not, is tracked over time with pollutant concentration



Treatments and pumps: simplified, based on “specs sheet”



Applications (e.g. toilet):

- Water use: any tank or external source
- Wastewater production: any tank or external sink, adds pollutant to source water
- Different IE per application → multiple applications = household and/or community
- Actor (pump, treatment, gravity, tap pressure) provides flow

- Sources: 2 types



Catchment: catchment area with pollutant concentration and collection efficiency



Tap: tap water source with pollutant concentration



Sinks: e.g., sewer system, infiltration, collection trucks



PV system: installed panel capacity (kWp), battery, efficiencies

OSiRIS: what is it?

OSiRIS Model and current OSiRIS App

 High flexibility with building blocks (contd.):

 Controls:

- Hysteresis or full control, for filling/emptying tank, increasing/decreasing tank concentrations
- Separate limits for locally produced and grid energy, e.g. grid as back-up
- Any number of steps (e.g. first treatment, then pumping to other tank, then infiltration)

 Highly efficient C++ model

- Rapid simulation
- 12 seconds for 10 years @ 15 min resolution (350 000 time points, 114 000 000 datapoints on Intel i5-1145G7)
- Water and pollutant balances for error checks
- Streaming in & out of data: low RAM memory use, potential for online data streaming

OSiRIS: what is it?

OSiRIS Model and **current OSiRIS App**



Standalone app (.exe, Windows)

- User interface for scenario management and comparison based on KPI
- Scheme automatically adapts to user input
- Simulation results displayed in graphs
- Results, settings, and graphs saved to file



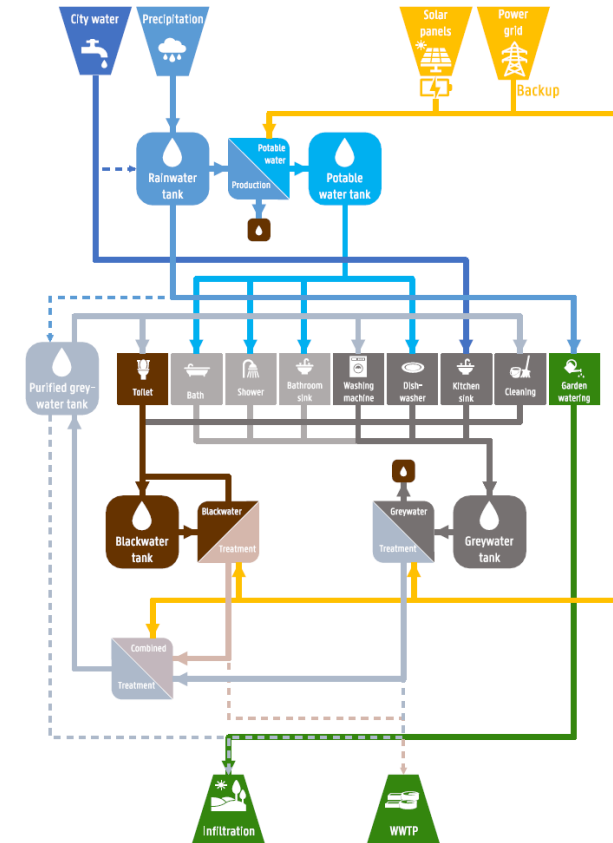
Pre-configured household from building blocks

- Most model parameters configurable
- Default pollutant = chloride
- Modifiable from centralized to extremely decentralized



Sub-models built-in:

- Diurnal water usage patterns: enables use of high-resolution precipitation data(15 min)
- Garden watering based on insolation (~plant transpiration)
- Insolation and cloud models if insolation data is unavailable



What is it *not* for?



Complex modeling of wastewater treatment

- e.g. distinction between recalcitrant and degradable organics not *currently* possible
- Degradation is implemented in model (can be used separately), but not released in app



Design tool for dimensioning volumes/treatments/photovoltaics

- Not straightforward *currently*
- Main focus = scenario comparison
- Possible through trial-and-error
- Future “design mode” potential



Smart control of rainwater tank refilling/emptying (e.g. RainPlus project)

- Full refill when empty
- Implementation of more dynamic control possible in future



OPEX/CAPEX estimation

App layout

OSiRIS

App Load/Save Simulation

Current scenario: **8 - Extreme dec. + BW reuse**

Datasets | Scenario settings | Scenario simulation and management | KPI info | Publications and partners

Load data Success!

Simulate current Simulations complete!

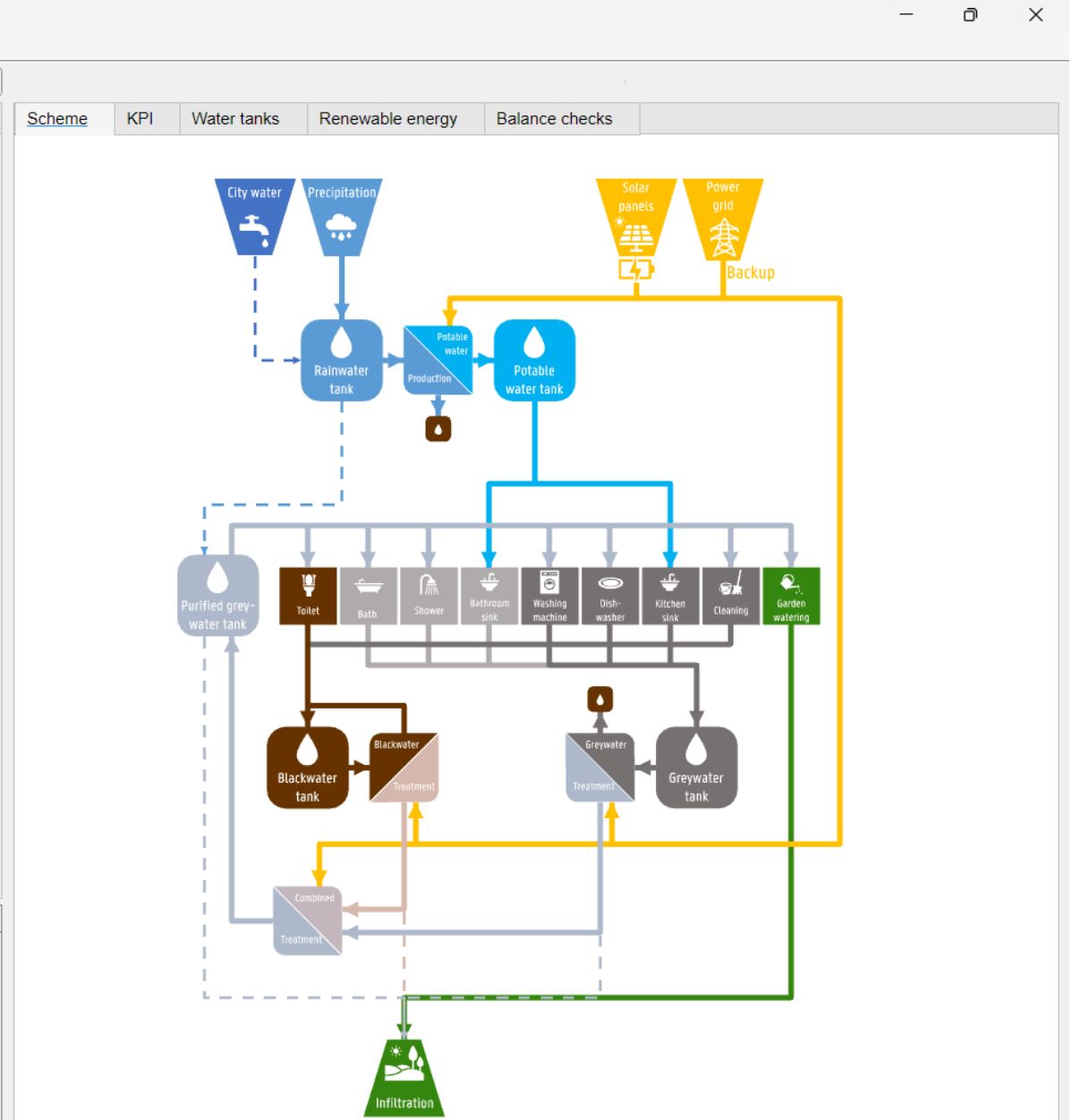
Add Load Simulate Delete Save

Select	Scenario	Name	Simulated
<input type="checkbox"/>	1	0 - Centralized	<input checked="" type="checkbox"/>
<input type="checkbox"/>	2	1 - Rainwater use	<input checked="" type="checkbox"/>
<input type="checkbox"/>	3	2 - GW treatment for reuse	<input checked="" type="checkbox"/>
<input type="checkbox"/>	4	3 - Dec. treatment and infil.	<input checked="" type="checkbox"/>
<input type="checkbox"/>	5	4 - PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	6	5 - GW reuse and PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	7	6 - Dec. treatment + PW	<input checked="" type="checkbox"/>
<input type="checkbox"/>	8	7 - Extreme dec.	<input checked="" type="checkbox"/>
<input type="checkbox"/>	9	8 - Extreme dec. + BW reuse	<input checked="" type="checkbox"/>

Log

[2025-07-10 10:34:24] Scenario 4/9 completed in 25.1659 seconds
[2025-07-10 10:34:45] Scenario 5/9 completed in 20.6135 seconds
[2025-07-10 10:35:17] Scenario 6/9 completed in 32.3333 seconds
[2025-07-10 10:35:41] Scenario 7/9 completed in 23.7611 seconds
[2025-07-10 10:36:07] Scenario 8/9 completed in 25.7667 seconds
[2025-07-10 10:36:33] Scenario 9/9 completed in 25.9487 seconds
[2025-07-10 10:36:33] All scenarios were successfully simulated.

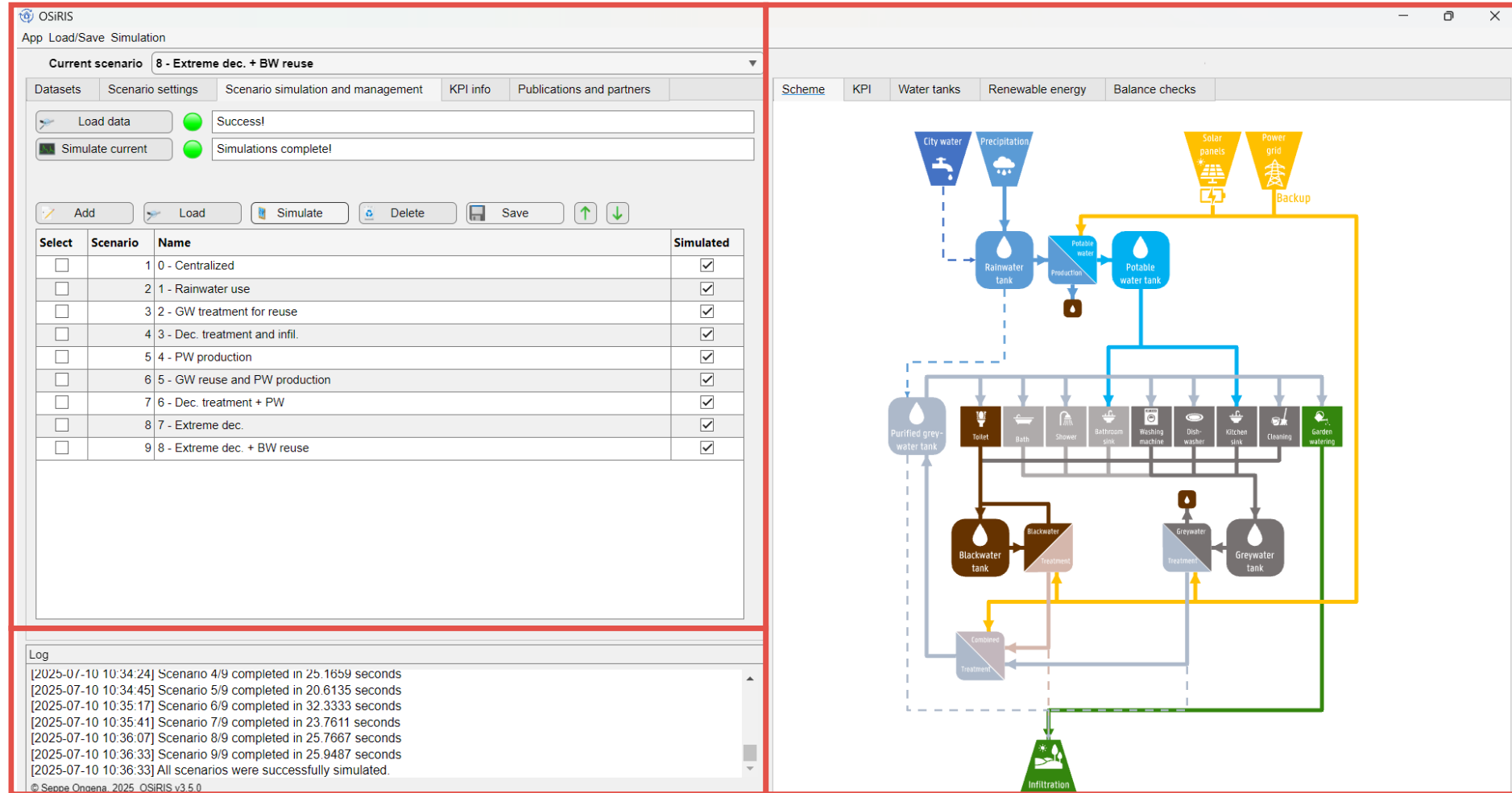
© Seppe Ongena, 2025 OSiRIS v3.5.0



Main Interface

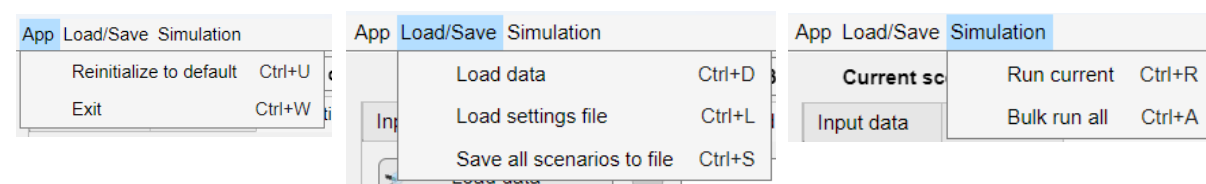
1.0 User input side (changing settings, scenario's,...)

2.0 Graph side (display results, current scheme,...)



Log (simulation progress, errors, info,...)

1.0 User input side



Main menus (quickly select actions, shortcut keys possible)

Tab selector

Scenario selector

select scenario for editing, copying settings to new scenario, displaying plots,...

1.1 Datasets

1.2 Scenario settings

1.3 Scenario simulation and management

1.4 KPI info

1.5 Publications and partners

App Load/Save Simulation

Current scenario **8 - Extreme dec. + BW reuse**

Datasets Scenario settings Scenario simulation and management KPI info Publications and partners

Load data Success!

Simulate current Simulations complete!

Add Load Simulate Delete Save ↑ ↓

Select	Scenario	Name	Simulated
<input type="checkbox"/>	1	0 - Centralized	<input checked="" type="checkbox"/>
<input type="checkbox"/>	2	1 - Rainwater use	<input checked="" type="checkbox"/>
<input type="checkbox"/>	3	2 - GW treatment for reuse	<input checked="" type="checkbox"/>
<input type="checkbox"/>	4	3 - Dec. treatment and infil.	<input checked="" type="checkbox"/>
<input type="checkbox"/>	5	4 - PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	6	5 - GW reuse and PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	7	6 - Dec. treatment + PW	<input checked="" type="checkbox"/>
<input type="checkbox"/>	8	7 - Extreme dec.	<input checked="" type="checkbox"/>
<input type="checkbox"/>	9	8 - Extreme dec. + BW reuse	<input checked="" type="checkbox"/>

Tab contents

1.1 Datasets

Timezone for data reading

Datasets

Scenario settings

Scenario simulation and management

KPI info

Publications and partners

Time zone

Europe

Europe/Brussels

Precipitation data

C:/Users/songena/OneDrive - UGent/PhD/Content/1. Decentralized household

Browse file

Delimiter ;

Decimal sep. ,

Time format yyyy-MM-dd'T'HH:mm:ss.SSSZZZZ

Data should be a .csv file obtained from [WaterInfo.be](#) or in a similar format.

Renewable energy data

Insolation threshold for irrigation 5 kWh/m²/d

☒ Use photovoltaic panel model

Model settings

Data settings

Panel slope (degrees) 40

Panel tilt angle (degrees) 0

☐ Advanced settings

File format:

- Metadata header rows
- Followed by (at least) two columns for the data:
 - #Timestamp: first column, in time format
 - Value: precipitation in mm
- Followed by optional footer rows

Cloud data table (days or %)

	Clear	Cloudy	Overcast
J	3.2000	9.2000	18.5000
F	3.3000	10.9000	14.1000
M	4.4000	13.3000	13.5000
A	4.8000	15.2000	10.0000
M	5.1000	16.5000	9.4000
J	4.7000	16.8000	8.5000
J	5.8000	18.9000	6.3000
A	5.6000	19.0000	6.4000
S	5.9000	15.4000	8.7000

Precipitation file selection

including browse button, file options, required format tooltip

Renewable energy data

option between [PV model \(1.1.1\)](#) and [datafile \(1.1.2\)](#)

1.1.1 Datasets: PV model

The screenshot shows the 'Datasets' tab of a software interface. It includes sections for 'Precipitation data' and 'Renewable energy data'. The 'Renewable energy data' section has sub-tabs for 'Model settings' and 'Data settings'. Red boxes and arrows highlight specific areas: one box around 'Panel slope' and 'Panel tilt angle' with an arrow pointing to the 'Solar panel orientation' text; another box around 'Advanced settings' with an arrow pointing to the '(Advanced) Atmospheric model parameters' text; and a third box around the 'Cloud data table' with an arrow pointing to the 'Cloud model parameters' text.

Precipitation data

Time zone: Europe | Europe/Brussels

File path: C:/Users/songena/OneDrive - UGent/PhD/Content/1. Decentralized household

Delimiter: ; | Decimal sep.: , | Time format: yyyy-MM-dd'T'HH:mm:ss.SSSZZZZ

Data should be a .csv file obtained from [WaterInfo.be](#) or in a similar format.

Renewable energy data

Insolation threshold for irrigation: 5 kWh/m²/d

☒ Use photovoltaic panel model

Model settings

Panel slope (degrees): 40

Panel tilt angle (degrees): 0

☒ Advanced settings

Advanced settings

T_{LK} , Linke turbidity factor: 3

ρ , ground reflectivity: 0.2

Data settings

Cloud data table (days or %)

	Clear	Cloudy	Overcast
J	3.2000	9.2000	18.5000
F	3.3000	10.9000	14.1000
M	4.4000	13.3000	13.5000
A	4.8000	15.2000	10.0000
M	5.1000	16.5000	9.4000
J	4.7000	16.8000	8.5000
J	5.8000	18.9000	6.3000
A	5.6000	19.0000	6.4000
S	5.9000	15.4000	8.7000

Solar panel orientation

(Solar panel technological settings in [House characteristics \(1.2.1\)](#))

Cloud model parameters

= number or % of clear, cloudy, and overcast days

- Probabilistic model
- Random number to determine type of day
- Cloud probability:
 - 0-20% on a clear day
 - 20-80% on a cloudy day
 - 80-100% on overcast day
- "Spawn" in cloud: value 0 or 1
- Clouds eliminate beam insolation, slightly increase diffuse insolation, drastically reduce reflections

(Advanced) Atmospheric model parameters

- For calculation of total panel irradiation
= beam, diffuse and reflected irradiance
- Based on trigonometric model

1.1.2 Datasets: renewable energy

Datasets Scenario settings Scenario simulation and management KPI info Publications and partners

Time zone Europe Europe/Brussels

Precipitation data

C:/Users/songena/OneDrive - UGent/PhD/Content/1. Decentralized household Browse file

Delimiter ; Decimal sep. , Time format yyyy-MM-dd'T'HH:mm:ss.SSSZZZ;

Data should be a .csv file obtained from [WaterInfo.be](#) or in a similar format.

Renewable energy data

Insolation threshold for irrigation 5 kWh/m²/d

☐ Use photovoltaic panel model

Model settings Data settings

Browse file

Delimiter , Decimal sep. . Time format yyyyMMdd:HHmm

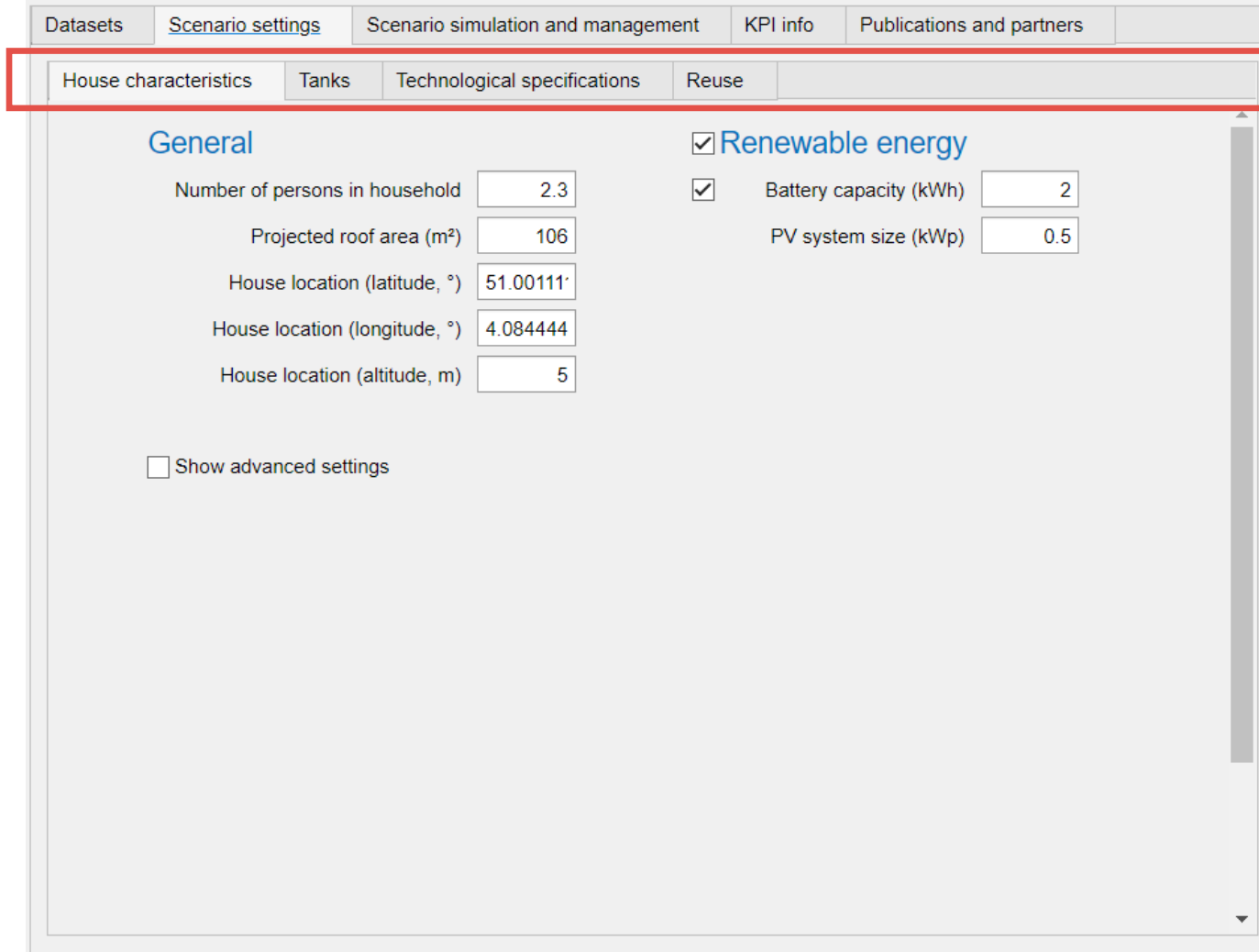
Data should be a .csv file obtained from [PVGIS](#) or in a similar format.

File format:

- Metadata header rows
- Followed by (at least) two columns for the data;
- time: first column, in time format
- G(i): Global irradiance on the inclined plane in W/m²
- Followed by optional footer rows

Similar to precipitation data

1.2 Scenario settings



The screenshot shows a web application interface for 'Scenario settings'. At the top, there are five tabs: 'Datasets', 'Scenario settings' (which is underlined in blue), 'Scenario simulation and management', 'KPI info', and 'Publications and partners'. Below these, there is a subtab bar with four options: 'House characteristics', 'Tanks', 'Technological specifications', and 'Reuse'. A red rectangular box highlights this subtab bar. The 'House characteristics' subtab is currently selected, displaying a 'General' section with various input fields and checkboxes. The inputs include 'Number of persons in household' (2.3), 'Projected roof area (m²)' (106), 'House location (latitude, °)' (51.00111), 'House location (longitude, °)' (4.084444), and 'House location (altitude, m)' (5). There are also checkboxes for 'Renewable energy' (checked) and 'Show advanced settings' (unchecked). To the right of the 'Renewable energy' checkbox, there are two more inputs: 'Battery capacity (kWh)' (2) and 'PV system size (kWp)' (0.5). A vertical scrollbar is visible on the right side of the main content area.

Tab	Subtab	Field	Value
Scenario settings	House characteristics	Number of persons in household	2.3
		Projected roof area (m²)	106
		House location (latitude, °)	51.00111
		House location (longitude, °)	4.084444
	Tanks		
	Technological specifications		
	Reuse		

General

☒ Renewable energy

☐ Show advanced settings

Battery capacity (kWh): 2

PV system size (kWp): 0.5

Subtab selection

1.2.1 House characteristics

1.2.2 Tanks

1.2.3 Technological specifications

1.2.4 Reuse

1.2.1 Scenario settings: house characteristics

House characteristics Tanks Technological specifications Reuse

General

☒ Renewable energy

Number of persons in household ☒ Battery capacity (kWh)

Projected roof area (m²) PV system size (kWp)

House location (latitude, °)

House location (longitude, °)

House location (altitude, m)

☒ Show advanced settings

Advanced settings

Flows and concentrations Rain correction factor Photovoltaics

Pollutant name (only affects graph legends)

Pollutant concentrations in tap- and rainwater (mg/L)
 C_{tap}
 C_{rain}

Appliance daily flows (L/p/d)

Q_{TL}	<input type="text" value="21.3"/>
Q_{BT}	<input type="text" value="5.1"/>
Q_{SH}	<input type="text" value="23.8"/>
Q_{WM}	<input type="text" value="16.6"/>
Q_{BS}	<input type="text" value="9.4"/>
Q_{DW}	<input type="text" value="2.3"/>
Q_{KS}	<input type="text" value="17.1"/>
Q_{CL}	<input type="text" value="5.8"/>
Q_{GA}	<input type="text" value="7.4"/>

Wastewater pollutant concentrations for tap water (mg/L)

C_{TL}	<input type="text" value="100"/>
C_{BT}	<input type="text" value="166"/>
C_{SH}	<input type="text" value="284"/>
C_{WM}	<input type="text" value="450"/>
C_{BS}	<input type="text" value="237"/>
C_{DW}	<input type="text" value="716"/>
C_{KS}	<input type="text" value="223"/>
C_{CL}	<input type="text" value="600"/>
C_{GA}	<input type="text" value="0"/>

General settings and renewable energy settings

(i.a. checkbox whether to use renewable energy and whether to use a battery)

(Advanced) Total daily flows

(used to calculate diurnal flow values based on literature patterns)

(Advanced) Pollutant concentrations for tap water

(the model will subtract the tap water concentration from these values and add the background concentration from the used source water streams)

(Advanced) Rain correction factor tables

(for main wind/rain direction, evaporation, filter efficiencies,...)

Advanced settings

Flows and concentrations **Rain correction factor** Photovoltaics

Total rain correction factor η_{rain}

1. Correction for roof slope & tilt (in case SW = main wind direction)

Slope	NE	NW	SW	SE
30°	0.75	1	1.25	1
35°	0.7	1	1.3	1
40°	0.64	1	1.36	1
45°	0.57	1	1.43	1
50°	0.48	1	1.52	1
≥50°	0.45	1	1.55	1

2. Correction for roof type

Roof type	Factor
Flat with gravel	0.6
Flat with bitumen	0.7-0.8
Flat with slate or tile	0.75-0.9
Sloped with slate or tile	0.9-0.95
Sloped with glazed tiles	0.9-0.95
Sloped with bitumen	0.8-0.95

3. Correction for coarse filter

Filter type	Factor
Self-cleaning filter well	0.9
Filter in downcomer pipe	0.9
Cyclone filter	0.95

Flows and concentrations Rain correction factor **Photovoltaics**

Photovoltaic panel heat efficiency $\eta_{heat} = (1 - losses\ due\ to\ heat)$

Efficiency of the DC/AC inverter $\eta_{inverter}$

Efficiency of the battery $\eta_{battery}$

(Advanced) Values used to convert solar irradiance (data or PV model) to available energy

1.2.2 Scenario settings: tanks

Datasets

Scenario settings

Scenario simulation and management

KPI info

Publications and partners

House characteristics

Tanks

Technological specifications

Reuse

Tank settings

(is the tank installed?, maximum volume?, is tank initially filled with tap water?, what is the initial volume?)

		Nominal volumes (m ³)		Initial volume (m ³)
Potable water tank)	<input checked="" type="checkbox"/>	<input type="text" value="1"/>	<input checked="" type="checkbox"/>	<input type="text" value="1"/>
Rainwater tank	<input checked="" type="checkbox"/>	<input type="text" value="10"/>	<input checked="" type="checkbox"/>	<input type="text" value="10"/>
Purified greywater tank	<input checked="" type="checkbox"/>	<input type="text" value="1"/>	<input checked="" type="checkbox"/>	<input type="text" value="1"/>
Blackwater/septic tank	<input checked="" type="checkbox"/>	<input type="text" value="1"/>	<input type="checkbox"/>	<input type="text" value="0"/>
Greywater buffer tank	<input checked="" type="checkbox"/>	<input type="text" value="0.5"/>	<input type="checkbox"/>	<input type="text" value="0"/>

assumes tap water

☒ Show advanced settings

Advanced settings - control parameters

$\max(c_{PGW})$

$\min(V_{RW})$

(Advanced) maximum PGW concentration

Maximum allowed pollutant concentration in the purified greywater tank. When exceeding this concentration, the tank will be purged with rainwater (see reuse settings).

(Advanced) minimum RW tank level

Minimum volume of the rainwater tank. When below this, the refilling mechanism will come into action.

1.2.3 Scenario settings: technological specifications

Datasets | Scenario settings | Scenario simulation and management | KPI info | Publications and partners

House characteristics | Tanks | Technological specifications | Reuse

☒ **Greywater treatment**

Design flow (m³/d)

Energy use (kWh/m³)

Water recovery

Rejection

☒ **Blackwater treatment**

Design flow (m³/d)

Energy use (kWh/m³)

Water recovery

Rejection

☒ **Potable water treatment**

Design flow (m³/d)

Energy use (kWh/m³)

Water recovery

Rejection

☒ **Combined grey- and blackwater treatment**

Design flow (m³/d)

Energy use (kWh/m³)

Water recovery

Rejection

☒ **Water pumps**

Design flow (m³/d)

Energy use (kWh/m³)

Water recovery (r)
$$r = \frac{Q_{permeate}}{Q_{feed}} = 1 - \frac{Q_{retentate}}{Q_{feed}}$$

Rejection (R)
$$R = \frac{C_{feed} - C_{permeate}}{C_{feed}} = 1 - \frac{C_{permeate}}{C_{feed}}$$

☒ Show advanced settings

Advanced settings - salts removal in buffer tanks

Removal in blackwater tank

Removal in greywater tank

Technology selection

(select whether a technology is present and fill its primary specifications)

Water pumps

(whether to consider pump energy for i.a. rainwater pumping to applications or when a treatment is not installed)

Theoretical explanation and visualisation of the primary specifications recovery and removal

(Advanced) Salts removal due to sedimentation

1.2.4 Scenario settings: reuse

Datasets

Scenario settings

Scenario simulation and management

KPI info

Publications and partners

House characteristics

Tanks

Technological specifications

Reuse

☒ Reuse blackwater?

Blackwater excess

Send to sewer

Greywater excess

Empty by truck

Rainwater excess

Infiltrate

Purge water

Infiltrate

☐ Treat rainwater before purging/refilling purified greywater tank?

☒ Rainwater excess: pass through purified greywater tank (purge)?

This serves as a purge by diluting the PGW with rainwater. WARNING!
Can heavily impact energy use when the rainwater is also treated first!

Source water:

Toilet flushing

Purified greywater

Bathing

Purified greywater

Showering

Purified greywater

Bathroom sink

Potable water

Washing machine

Purified greywater

Dishwasher

Purified greywater

Kitchen sink

Potable water

Cleaning

Purified greywater

Garden watering

Purified greywater

City water

Potable water

Rainwater

Purified greywater

Wastewater to:

Blackwater tank

Blackwater tank

Greywater tank

Greywater tank

Greywater tank

Greywater tank

Greywater tank

Greywater tank

Greywater tank

Greywater tank

Greywater tank

Greywater tank

Blackwater tank

Blackwater tank

Infiltration

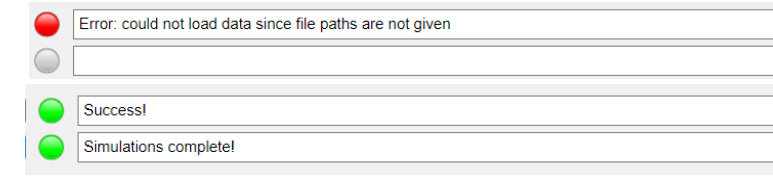
Infiltration

General reuse settings

Destination tank of wastewater after use
(toilet WW goes to blackwater tank per definition, gardening water is not recoverable)

Selection of water source per application

1.3 Scenario simulation and management



Load data for current scenario

Simulate the model for this scenario

(Save settings for current scenario, reload data if necessary)

Data loading progress info

Simulation progress info

Scenario overview/manipulation

When adding a scenario, the settings of the currently selected scenario will be copied

Load one or multiple scenario settings files

Bulk simulation of scenarios (see next slides)

Move selected scenarios up/down in list and plots

Save settings, schemes, KPI, results to file (see next slides)

Delete selected scenarios

Scenario simulation and management

Load data Success!

Simulate current Simulations complete!

Add Load Simulate Delete Save Up Down

Select	Scenario	Name	Simulated
<input type="checkbox"/>	1	0 - Centralized	<input checked="" type="checkbox"/>
<input type="checkbox"/>	2	1 - Rainwater use	<input checked="" type="checkbox"/>
<input type="checkbox"/>	3	2 - BW treatment for reuse	<input checked="" type="checkbox"/>
<input type="checkbox"/>	4	3 - Dec. treatment and infil.	<input checked="" type="checkbox"/>
<input type="checkbox"/>	5	4 - PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	6	5 - GW reuse and PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	7	6 - Dec. treatment + PW	<input checked="" type="checkbox"/>
<input type="checkbox"/>	8	7 - Extreme dec.	<input checked="" type="checkbox"/>
<input type="checkbox"/>	9	8 - Extreme dec. + BW reuse*	<input checked="" type="checkbox"/>

A " * " indicates settings were changed but not yet saved/simulated

Is scenario already simulated? Re-simulating will overwrite results

Bulk simulation

App Load/Save Simulation

Current scenario8 - Extreme dec. + BW reuse

Datasets

Scenario settings

Scenario simulation and management

KPI info

Publications and partners

Load data

Success!

Simulate current

Simulations complete!

Add

Load

Simulate

Delete

Save

↑

↓

Select	Scenario	Name	Simulated
<input type="checkbox"/>	1	0 - Centralized	<input checked="" type="checkbox"/>
<input type="checkbox"/>	2	1 - Rainwater use	<input checked="" type="checkbox"/>
<input type="checkbox"/>	3	2 - GW treatment for reuse	<input checked="" type="checkbox"/>
<input type="checkbox"/>	4	3 - Dec. treatment and infil.	<input checked="" type="checkbox"/>
<input type="checkbox"/>	5	4 - PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	6	5 - GW reuse and PW production	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	7	6 - Dec. treatment + PW	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	8	7 - Extreme dec.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	9	8 - Extreme dec. + BW reuse	<input checked="" type="checkbox"/>

Log

[2025-07-10 11:16:39] Data file selected: precipitation

[2025-07-10 11:16:55] Data file selected: precipitation

[2025-07-10 11:16:59] Starting simulations...

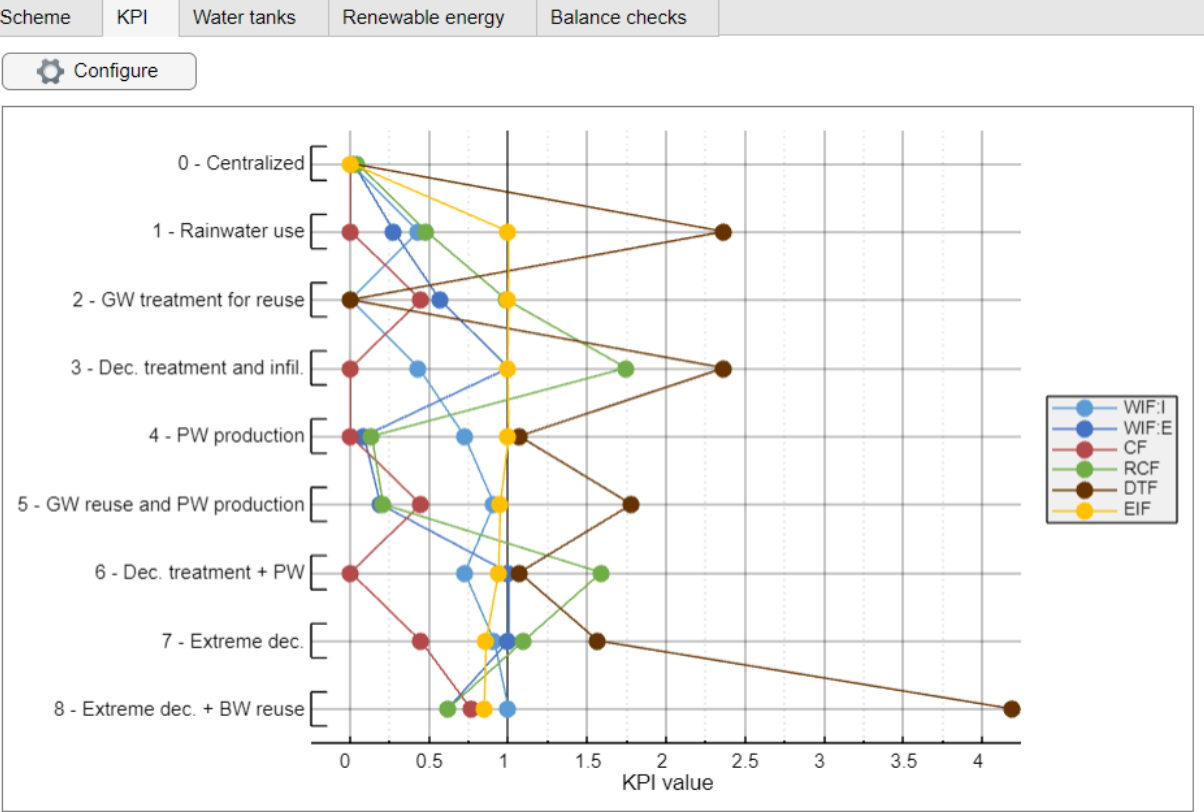
[2025-07-10 11:16:59] Scenario 7 already simulated

[2025-07-10 11:16:59] Scenario 8 already simulated

[2025-07-10 11:17:43] Scenario 3/3 completed in 43.2828 seconds

[2025-07-10 11:17:43] All scenarios were successfully simulated.

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Scenario	WIF:I	WIF:E	CF	RCF	DTF	EIF
0 - Centralized	0	0.0180	0	0.0416	0	0
1 - Rainwater use	0.4306	0.2746	0	0.4791	2.3634	1.0000
2 - GW treatment for reuse	0	0.5654	0.4447	0.9857	0	0.9986
3 - Dec. treatment and infil.	0.4306	1.0000	0	1.7444	2.3634	0.9943
4 - PW production	0.7212	0.0847	0	0.1344	1.0668	1.0000
5 - GW reuse and PW production	0.9084	0.1885	0.4447	0.2062	1.7775	0.9473
6 - Dec. treatment + PW	0.7209	1.0000	0	1.5867	1.0668	0.9360
7 - Extreme dec.	0.9085	1.0000	0.4425	1.0945	1.5643	0.8573

Saving files: save dialog screen

Save configuration

Browse folder Select folder

Select scenarios to save output for

Select output to save

Select variables in the data to save

Select	Name	Simulated
<input type="checkbox"/>	0 - Centralized	<input checked="" type="checkbox"/>
<input type="checkbox"/>	1 - Rainwater use	<input checked="" type="checkbox"/>
<input type="checkbox"/>	2 - GW treatment for reuse	<input checked="" type="checkbox"/>
<input type="checkbox"/>	3 - Dec. treatment and infil.	<input checked="" type="checkbox"/>
<input type="checkbox"/>	4 - PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	5 - GW reuse and PW production	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	6 - Dec. treatment + PW	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	7 - Extreme dec.	<input checked="" type="checkbox"/>

Scenarios

Save output

- ☒ KPI
- ☒ Data
- ☒ Settings
- ☒ Schemes

Data variables

- ☐ Model diagnostics
- ☒ Volumes
- ☒ Concentrations
- ☐ Treatments
- ☒ Energy
- ☒ Output flows
- ☐ Input flows
- ☐ Application flows
- ☒ Control flows

Save Cancel

Saving files: output

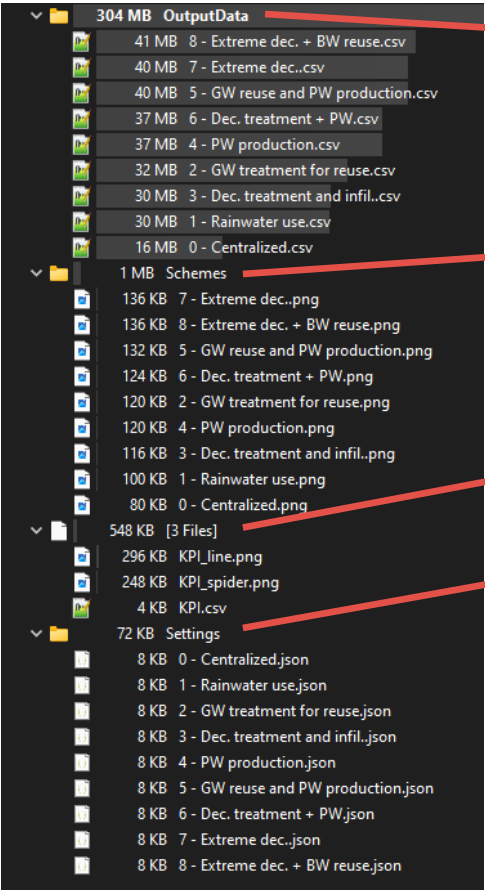
```
Log
[2024-11-05 15:18:04] Starting file saving...
[2024-11-05 15:18:05] [WARNING] Not saving KPI/Output data/Settings/Scheme simultaneously may cause mismatch between settings and results.
[2024-11-05 15:18:05] [WARNING] No scenario selected to save is visible on the KPI plot (not selected or not simulated). Skipping KPI saving
[2024-11-05 15:18:05] [WARNING] Previously saved scenarios detected in the current folder. Scenarios with the same name will be overwritten, KPI data and figure will be merged
[2024-11-05 15:18:12] [WARNING] Scenario 3/3 (Scenario 11) not simulated, no output data to save.
[2024-11-05 15:18:12] [WARNING] Unsaved (scenario already simulated but settings changed later) or unsimulated (scenario not yet simulated) scenario settings and schemes detected. Unsaved changes will be discarded. Unsimulated settings will be saved.
[2024-11-05 15:18:12] Scenario 2/3 (8 - Extreme dec. + BW reuse): reverting settings
[2024-11-05 15:18:14] Files saved successfully!
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```

All possible warnings triggered

```
"Applications": {
  "TL": {
    "Type": "Q_TL",
    "IE": 2.3,
    "Q_lpd": 21.3,
    "C_added": 30.0,
    "Actor": "PumpPGW",
    "Sourcewater": "PGW",
    "Wastewater": "BW"
  },
  "Energy": {
    "RenewableEnergy": true,
    "kwp_panels": 0.5,
    "UseBattery": true,
    "C_battery": 2.0,
    "eta_heat": 0.9,
    "eta_inverter": 0.95,
    "eta_battery": 0.9
  },
},

"Controls": {
  "RWPW": {
    "Priority": 1,
    "ControlType": "hysteresis",
    "Type": "fill/increase",
    "Tank": "PW",
    "Parameter": "V",
    "Flow": 0.6,
    "TriggerLowRenewable": 0.8,
    "TriggerHighRenewable": 1.0,
    "TriggerLowGrid": 0.5,
    "TriggerHighGrid": 0.8,
    "Steps": [
      {
        "Treat": {
          "Fraction": 1.0,
          "Actor": "ROPW",
          "Source": "RW",
          "Sink": "PW",
          "Waste": "BW"
        }
      }
    ]
  },
},
```

(full view - examples)



Datafiles: per scenario as .csv files, each variable = column

.png of schemes per scenario

KPI spider and line plot (.png) and KPI table (.csv)

Scenario settings as “human readable” .json files

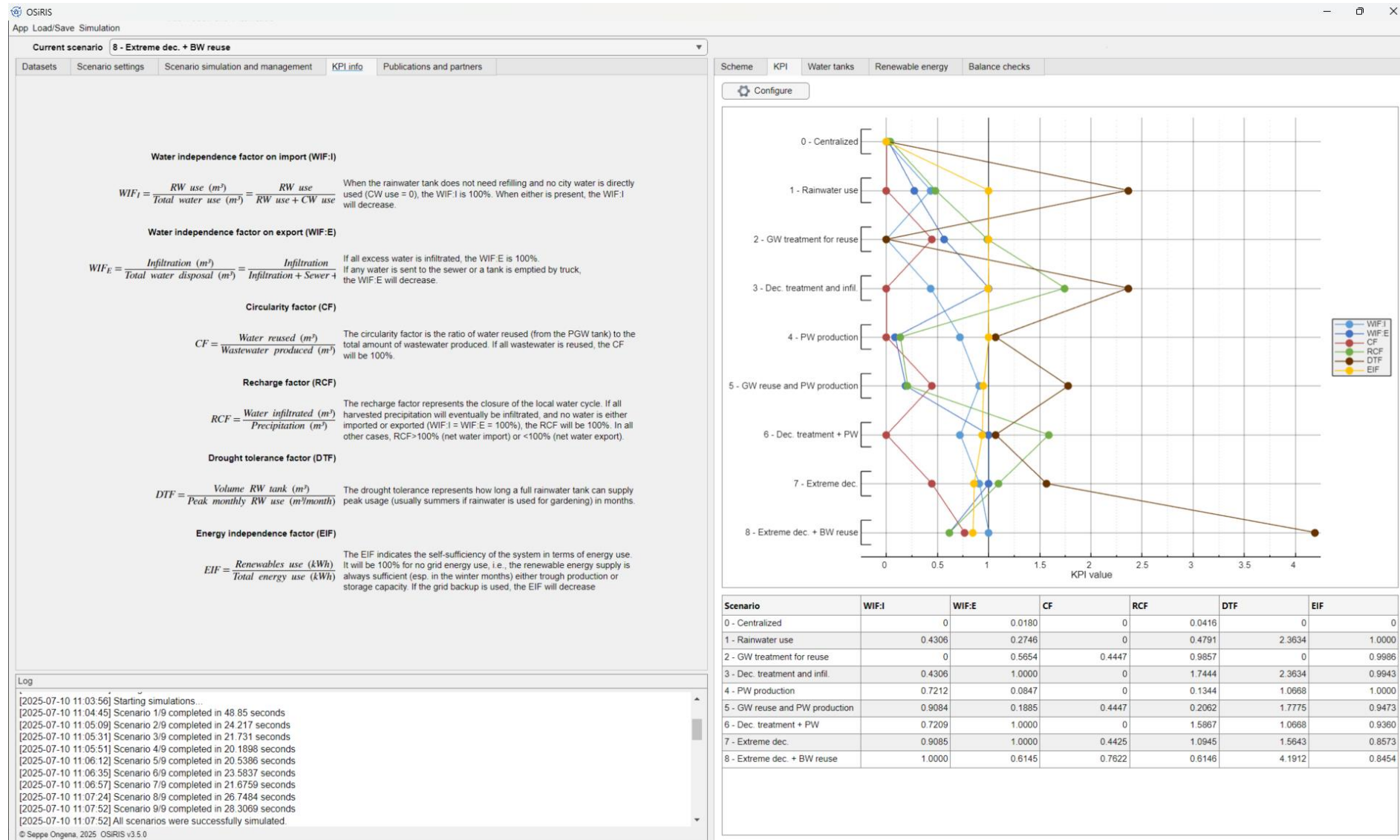
Progress is shown in log

```
[2024-11-05 15:33:44] Starting file saving...
[2024-11-05 15:33:44] Saving... Step 1/4: KPI plots
[2024-11-05 15:34:32] Saving... Step 2/4: Output data - Scenario 3/3
[2024-11-05 15:34:39] Saving... Step 3/4: Settings - Scenario 1/3
[2024-11-05 15:35:02] Saving... Step 4/4: Scheme - Scenario 2/3
[2024-11-05 15:35:52] Files saved successfully!
```

```
"Dataset": {
  "phi": 51.001111,
  "lambda": 4.084444,
  "z": 5.0,
  "dt": 900.0,
  "IrrigationThreshold": 5.0,
  "TimeZone": "Europe/Brussels",
  "WaterOptions": { ...
},
  "SolarOptions": { ...
},
  "Scenario": {
    "Tanks": { ...
    },
    "Technologies": { ...
    },
    "Applications": { ...
    },
    "Sources": { ...
    },
    "Sinks": { ...
    },
    "Energy": { ...
    },
    "Controls": { ...
    }
  }
}
```

(collapsed view)

1.4 KPI info



Best used in conjunction with KPI graph tab
(gives calculation method for each KPI and a brief explanation)

1.5 Publications and partners

Datasets

Scenario settings

Scenario simulation and management


KPI info

Publications and partners


For more information:

[Van de Walle et. al \(2022\). In silico assessment of household level closed water cycles: Towards extreme decentralization. Environmental Science and Technology, 10, 100148](#)


Ongena et. al (s.d.). Linking on site water recovery options to key resilience drivers using the OSiRIS tool. Unpublished.



De Watergroep



CAPTURE



GHENT
UNIVERSITY

List of publications with more in-depth information on model and used default values

List of contributing partners

2.0 Graph side

Tab selector

2.1 Scheme

2.2 KPI

2.3 Water tanks

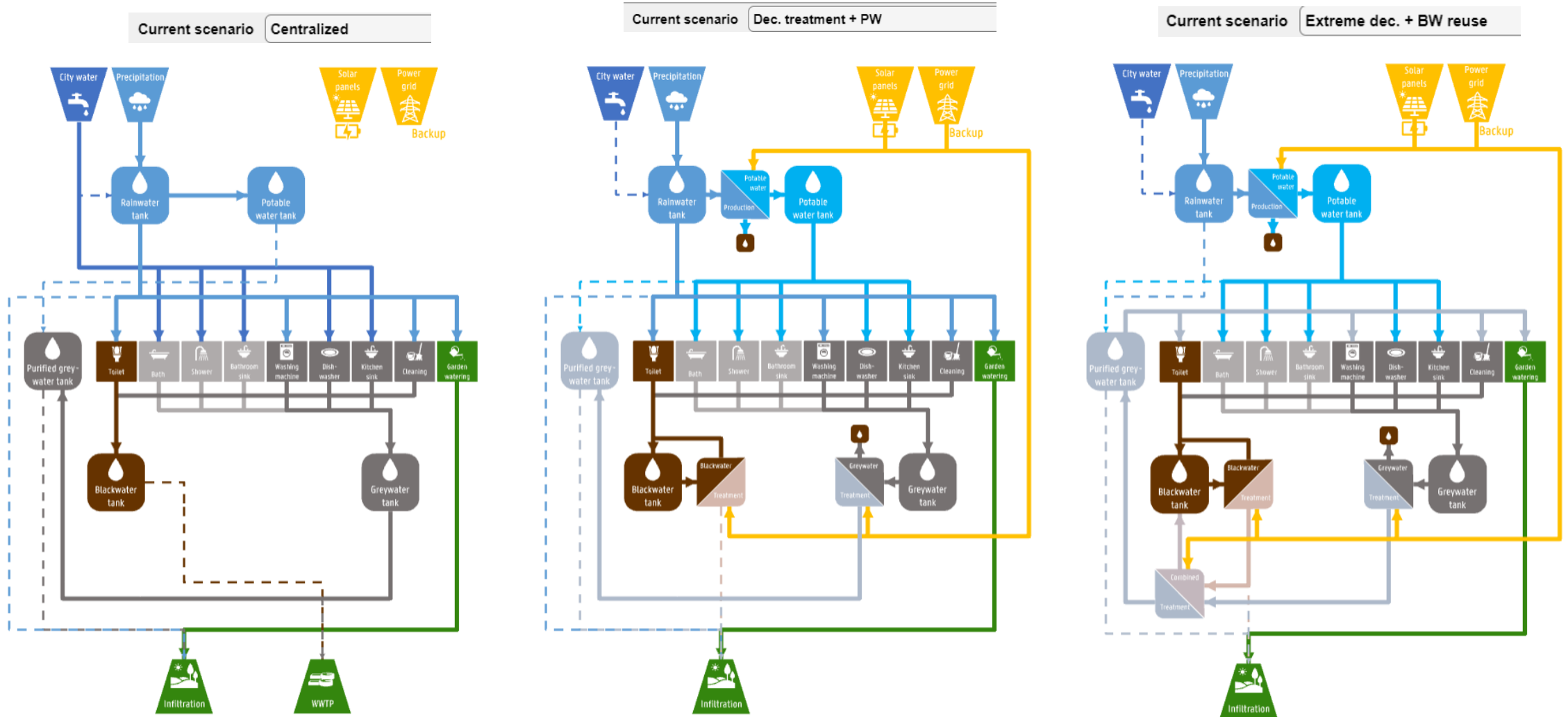
2.4 Renewable energy

2.5 Balance checks



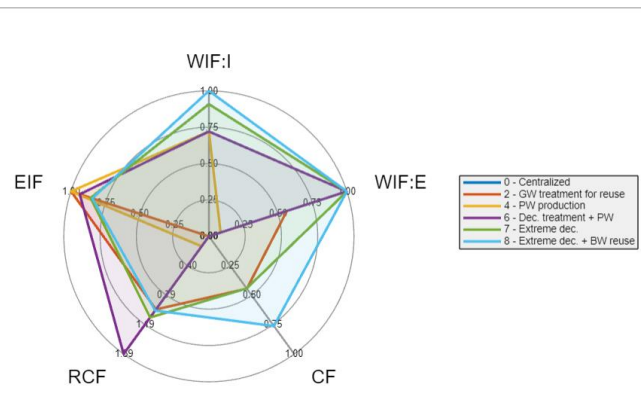
2.1 Graphs: scheme

Scheme updates based on selected settings

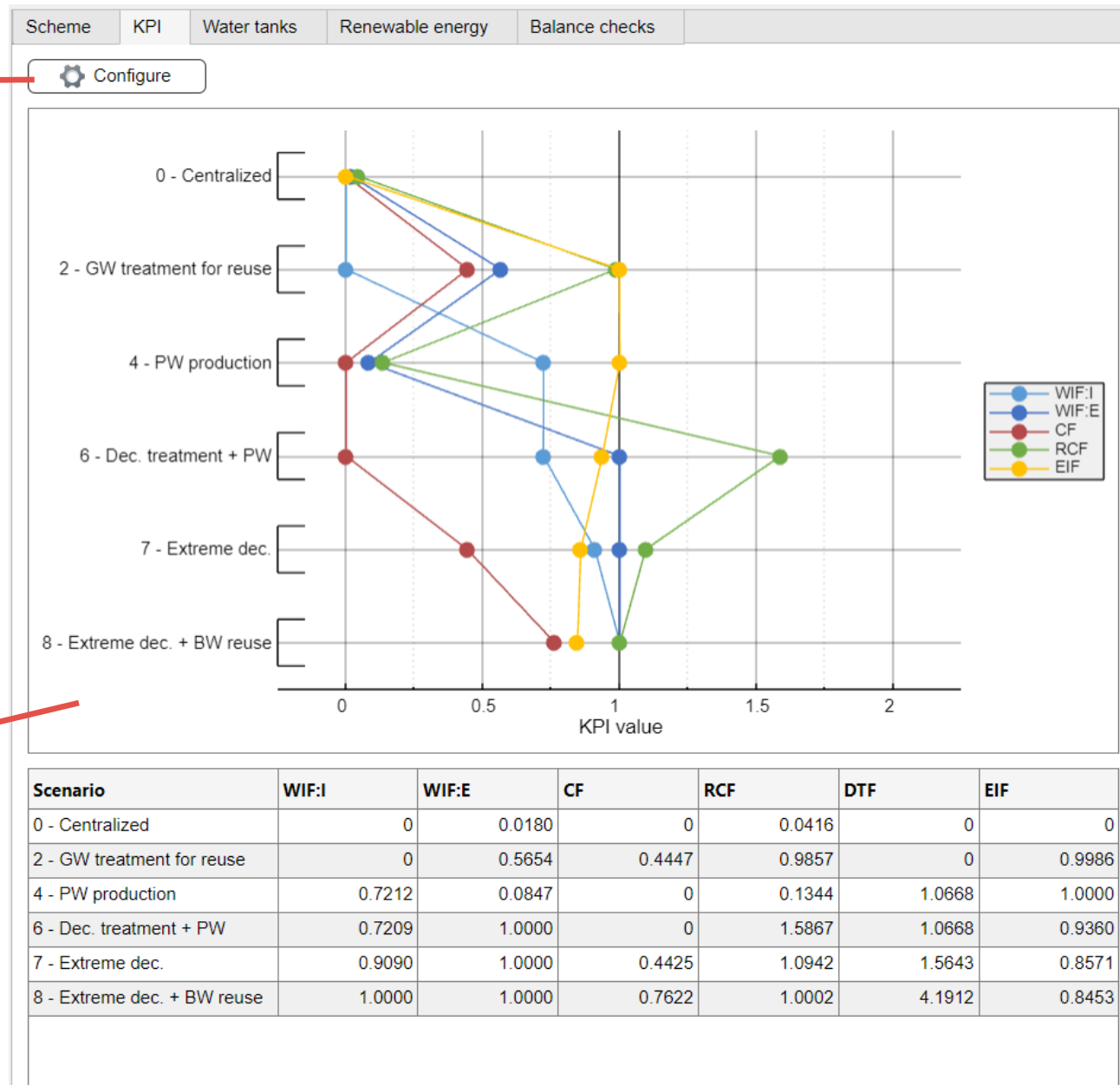


2.2 Graphs: KPI

Plot (line or spider), table



Configuration dialog



KPI plot configuration

Which scenario to plot in graph/show in table

Scenarios

Select	Scenario	Simulated
<input checked="" type="checkbox"/>	0 - Centralized	<input checked="" type="checkbox"/>
<input type="checkbox"/>	1 - Rainwater use	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	2 - GW treatment for reuse	<input checked="" type="checkbox"/>
<input type="checkbox"/>	3 - Dec. treatment and infil.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	4 - PW production	<input checked="" type="checkbox"/>
<input type="checkbox"/>	5 - GW reuse and PW production	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	6 - Dec. treatment + PW	<input checked="" type="checkbox"/>

KPI

Plot type: Spider (selected), Spider, Line

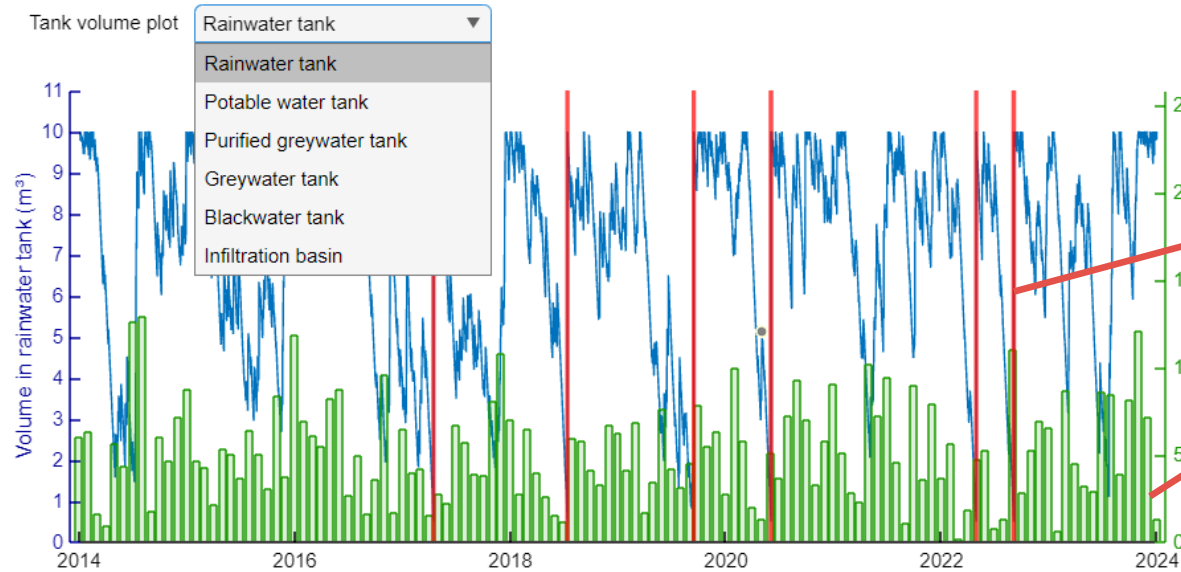
Which KPI to plot in graph

☒ WIF:I
☒ WIF:E
☒ CF
☒ RCF
☐ DTF
☒ EIF

Apply OK

2.3 Graphs: Water tanks

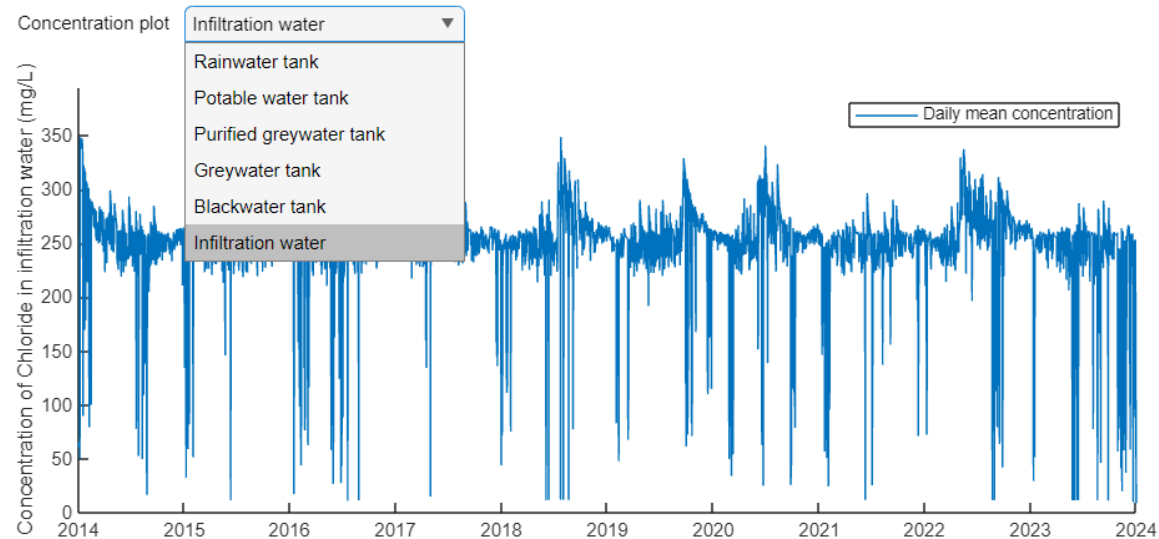
Plotting tank volumes over time



Rainwater tank refill

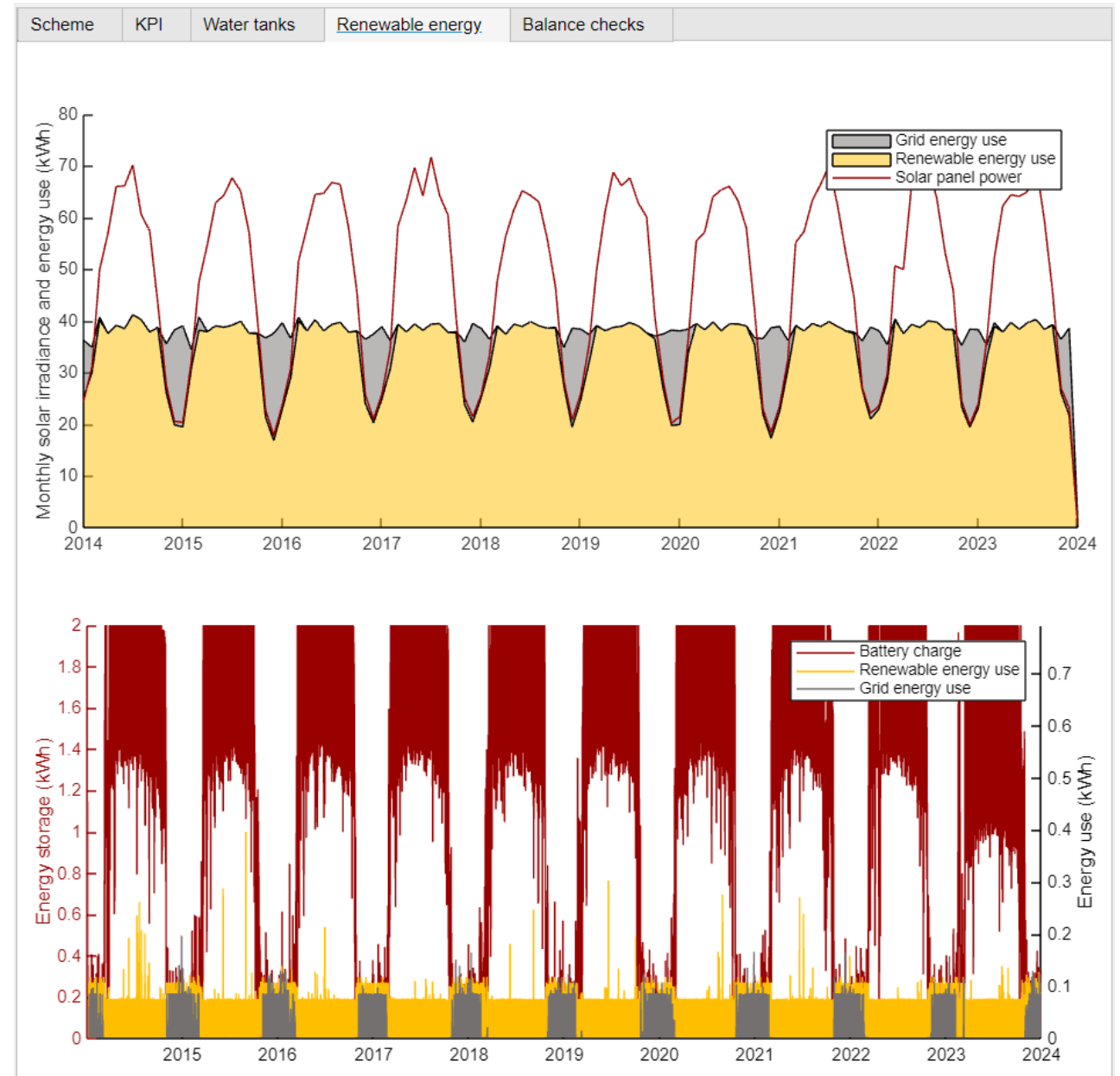
Total monthly precipitation

Plotting tank concentrations over time



2.4 Graphs: renewable energy

Total monthly solar irradiance (line), and stacked area renewables and grid use

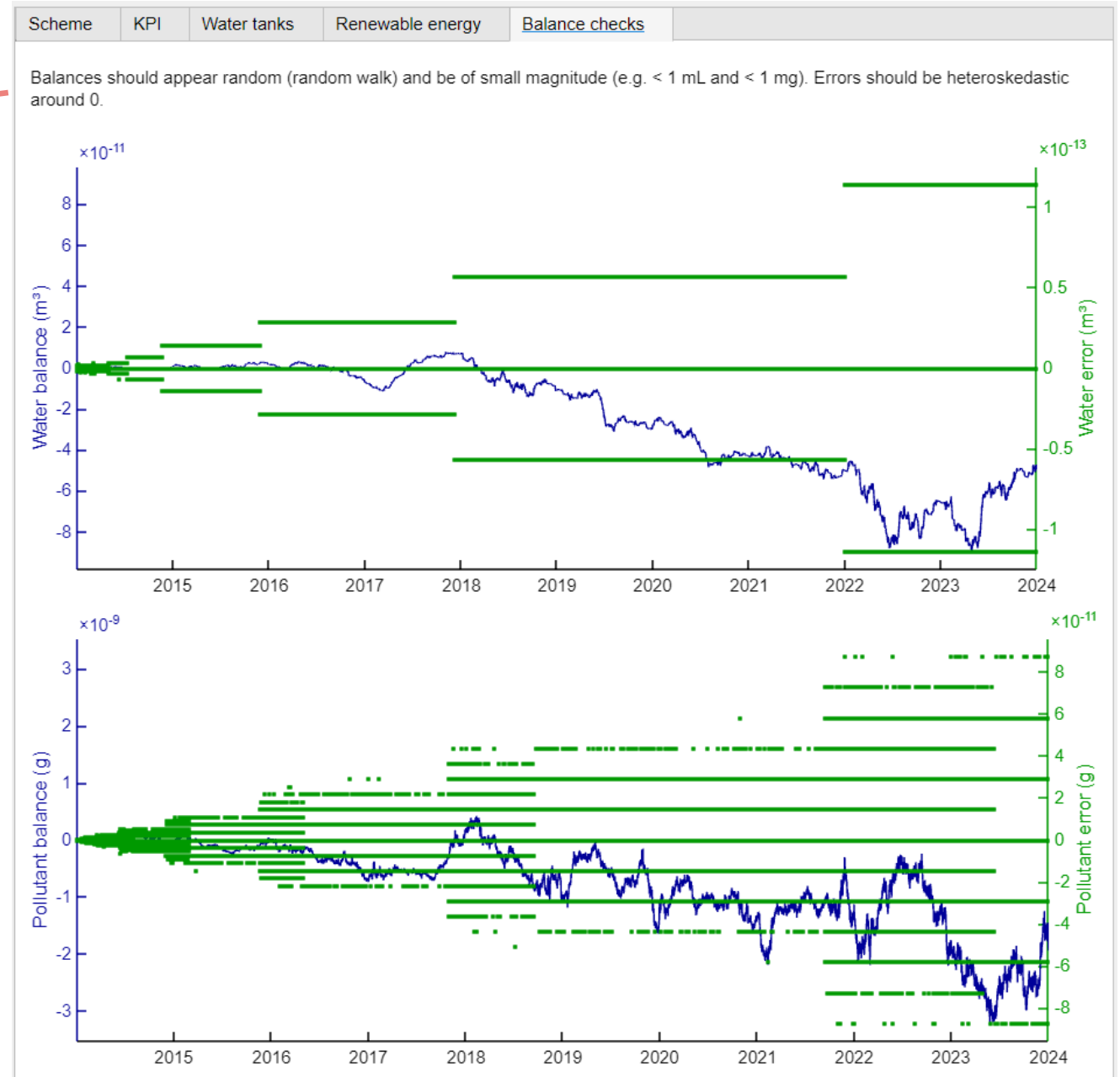


Battery charge and energy use over time

2.5 Graphs balance checks

Balance checks for model correctness

(see explanation)



Example workflow: step 0 – Initialization

The screenshot displays the OSIRIS software interface, which is divided into two main sections: a control panel on the left and a schematic diagram on the right.

Control Panel (Left):

- Current scenario:** Scenario 1*
- Buttons:** Load data, Simulate current, Add, Load, Simulate, Delete, Save, and navigation arrows.
- Table:**

Select	Scenario	Name	Simulated
<input type="checkbox"/>	1	Scenario 1*	<input type="checkbox"/>

Below the table, a large red text overlay reads: "Wait for app initialization (usually 30s after window appears)".

- Log:**

[2025-07-10 10:19:41] Initializing app (1/6): Setting up...
[2025-07-10 10:19:45] Initializing app (2/6): Generating initial plots...
[2025-07-10 10:19:59] Initializing app (3/6): Generating base scheme...
[2025-07-10 10:20:07] Initializing app (4/6): Loading default scenario...
[2025-07-10 10:20:10] Initializing app (5/6): Generating figures...
[2025-07-10 10:20:12] Initializing app (6/6): Done!

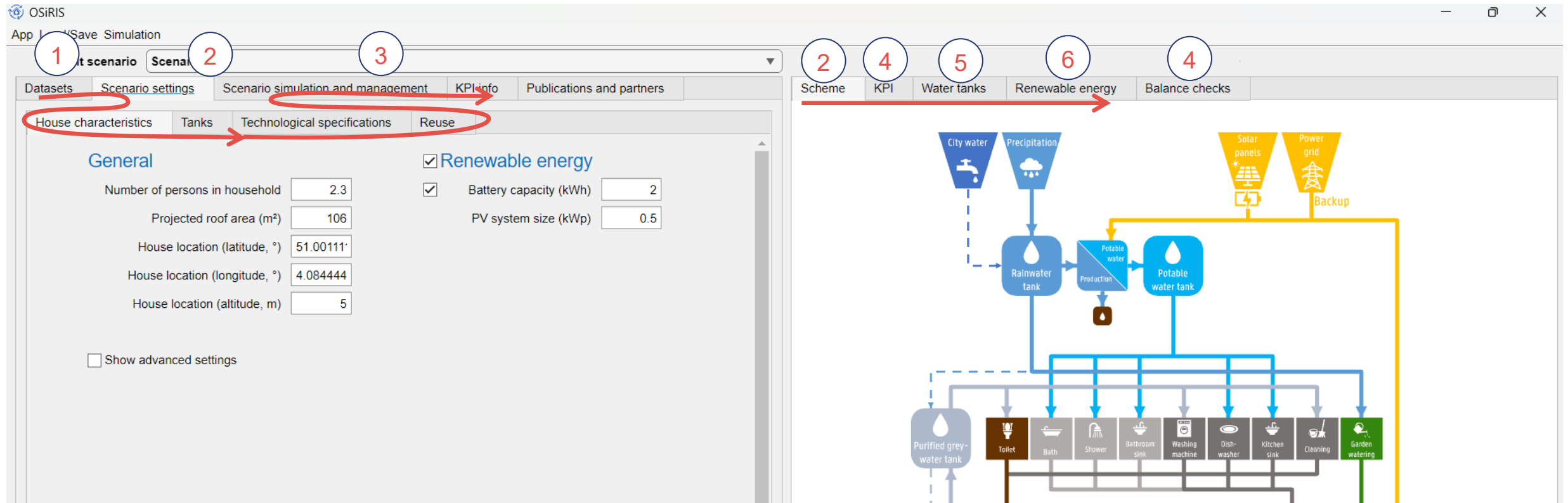
Schematic Diagram (Right):

The diagram illustrates a water management system with the following components and flows:

- Inputs:** City water (tap icon), Precipitation (cloud icon), Solar panels (solar icon), and Power grid (power line icon).
- Tanks and Storage:** Rainwater tank, Potable water tank, Purified grey-water tank, Blackwater tank, Greywater tank, and a Combined Treatment tank.
- Processes:** Production (arrow from Rainwater to Potable water tank), Treatment (arrows from Blackwater and Greywater tanks to the Combined Treatment tank), and Infiltration (arrow from the Combined Treatment tank to the ground).
- Usage and Distribution:** Water is distributed to various household fixtures: Toilet, Bath, Shower, Bathroom sink, Washing machine, Dish-washer, Kitchen sink, Cleaning, and Garden watering. A Backup system (yellow line) connects the Power grid to the Potable water tank.
- Flow Colors:** Blue lines represent potable water, brown lines represent blackwater, grey lines represent greywater, and green lines represent infiltration and garden watering.

Example workflow: overview

Within a scenario, go through tabs from left to right, changing settings where needed (see next slides)



Example workflow: step 1 – Input data

Select time zone area and time zone

current scenario Scenario 1*

Time zone Europe

Europe/Amsterdam

Europe/Amsterdam

Europe/Andorra

Europe/Astrakhan

Europe/Athens

Europe/Belgrade

Europe/Berlin

Europe/Bratislava

Europe/Brussels

Europe/Bucharest

Europe/Budapest

Europe/Busingen

Europe/Chisinau

Europe/Copenhagen

Europe/Dublin

Europe/Gibraltar

Europe/Guernsey

Europe/Helsinki

Europe/Isle_of_Man

Europe/Istanbul

Europe/Jersey

Europe/Kaliningrad

Europe/Kiev

Browse file

HH:mm:ss.SSSZZZ

5

Precipitation data

Delimiter ; Decimal sep. ,

Data should be a .csv file obtained from

Renewable energy

☒ Use photovoltaic panel model

Model settings Data settings

Panel slope (degrees)

Panel tilt angle (degrees)

☐ Advanced settings

Select precipitation file from example data

Current scenario Scenario 1*

Time zone Europe

Europe/Brussels

Precipitation data

Browse file

Delimiter ; Decimal sep. , Time format yyyy-MM-dd'THH:mm:ss.SSSZZZ

Data should be a .csv file obtained from [WaterInfo.be](https://waterinfo.be) or in a similar format.

Select precipitation data file to load

File name: 2. Water15M2015-2025Denderbelle.csv (*.csv)

Open Cancel

Make sure the formats are correct

Solar data can be loaded or left to the photovoltaic panel model to generate. **If using photovoltaic data, the temporal coverage should be equal or greater than the precipitation data!**

Example workflow: step 2 – Settings

Go over each tab and change settings where wanted (open the scheme tab for visual feedback)

Current scenarioScenario 1*

DatasetsScenario settingsScenario simulation and managementKPI infoPublications and partners

House characteristicsTanksTechnological specificationsReuse

☒ Greywater treatment

Design flow (m³/d)1.2

Energy use (kWh/m³)1.85

Water recovery0.9

Rejection0

☒ Water pumps

Design flow (m³/d)15

Energy use (kWh/m³)1.5

☐ Blackwater treatment

Design flow (m³/d)1.2

Energy use (kWh/m³)0.5

Water recovery0.9

Rejection0

☒ Potable water treatment

Design flow (m³/d)0.6

Energy use (kWh/m³)1.5

Water recovery0.8

Rejection0.95

☐ Combined grey- and blackwater treatment

Design flow (m³/d)1.2

☐ Show advanced settings

$$Q_{feed} \text{ or } c_{feed}$$
$$Q_{inflow} \text{ or } c_{inflow}$$
$$Q_{permeate} \text{ or } c_{permeate}$$
$$Q_{effluent} \text{ or } c_{effluent}$$
$$Q_{retentate} \text{ or } c_{retentate}$$
$$Q_{waste} \text{ or } c_{waste}$$

$$r = \frac{Q_{permeate}}{Q_{feed}} = 1 - \frac{Q_{retentate}}{Q_{feed}}$$
$$R = \frac{c_{feed} - c_{permeate}}{c_{feed}} = 1 - \frac{c_{permeate}}{c_{feed}}$$

Log

[2025-07-10 10:19:41] Initializing app (1/6): Setting up...
[2025-07-10 10:19:45] Initializing app (2/6): Generating initial plots...
[2025-07-10 10:19:59] Initializing app (3/6): Generating base scheme...
[2025-07-10 10:20:07] Initializing app (4/6): Loading default scenario...
[2025-07-10 10:20:10] Initializing app (5/6): Generating figures...
[2025-07-10 10:20:12] Initializing app (6/6): Done!
[2025-07-10 10:24:05] Data file selected: precipitation

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SchemeKPIWater tanksRenewable energyBalance checks

Example workflow: step 3 – Simulate

Press the “simulate current” button and change the scenario name by double clicking it in the table

App Load/Save Simulation

Current scenario: **My dream house**

Datasets | Scenario settings | Scenario simulation and management | KPI info | Publications and partners

Load data: Success!

Simulate current: Simulations complete!

Add | Load | Simulate | Delete | Save

Select	Scenario	Name	Simulated
<input type="checkbox"/>	1	My dream house	<input checked="" type="checkbox"/>

Log

- [2025-07-10 10:25:30] Data loading finished successfully
- [2025-07-10 10:25:30] Initializing simulation (2/2): Passing settings...
- [2025-07-10 10:25:31] Running simulations...
- [2025-07-10 10:25:37] Simulation completed in 6.4417 seconds.
- [2025-07-10 10:25:56] Retrieving data completed in 18.821 seconds
- [2025-07-10 10:26:00] KPI calculation completed in 3.9354 seconds.
- [2025-07-10 10:26:00] Plotting data...

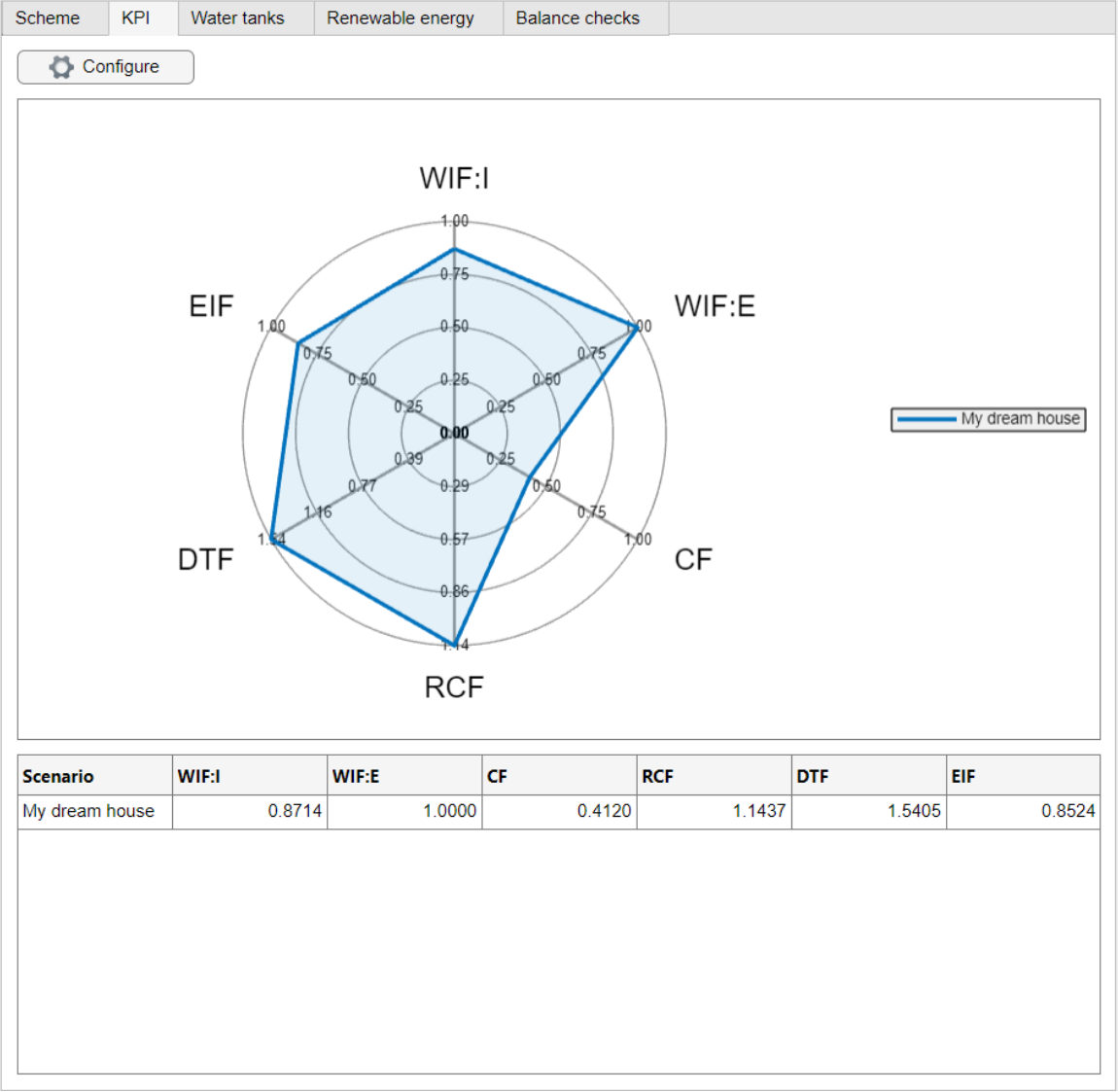
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Scheme | KPI | Water tanks | Renewable energy | Balance checks

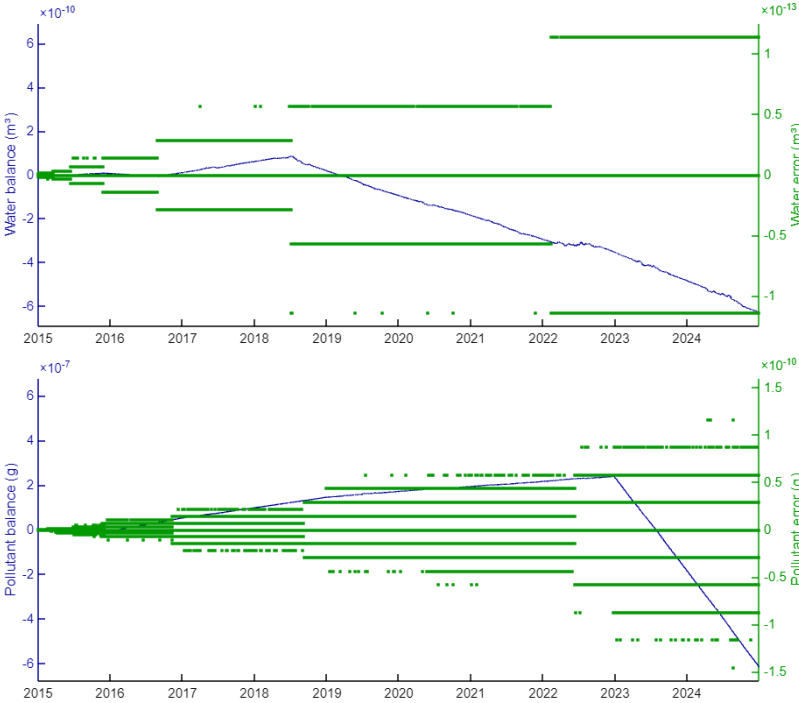
The diagram illustrates a comprehensive water management system for a house. It starts with water sources at the top: 'City water' (blue tap icon) and 'Precipitation' (blue cloud icon) feed into a 'Rainwater tank' (blue tank with a water drop icon). 'Solar panels' (yellow trapezoid with solar icon) and a 'Power grid Backup' (yellow trapezoid with power icon) provide energy to the system. The 'Rainwater tank' feeds into a 'Potable water tank' (blue tank with a water drop icon) via a 'Production' unit (blue trapezoid with a water drop icon). The 'Potable water tank' feeds into a distribution network that supplies water to various household fixtures: 'Toilet', 'Bath', 'Shower', 'Bathroom sink', 'Washing machine', 'Dish-washer', 'Kitchen sink', and 'Cleaning'. The 'Toilet' and 'Bath' fixtures feed into a 'Blackwater tank' (brown tank with a water drop icon), which then feeds into a 'Blackwater treatment' unit (brown trapezoid with a water drop icon). The 'Shower', 'Bathroom sink', 'Washing machine', 'Dish-washer', 'Kitchen sink', and 'Cleaning' fixtures feed into a 'Greywater tank' (grey tank with a water drop icon), which then feeds into a 'Greywater treatment' unit (grey trapezoid with a water drop icon). The 'Blackwater treatment' unit feeds into a 'Combined treatment' unit (blue trapezoid with a water drop icon). The 'Greywater treatment' unit also feeds into the 'Combined treatment' unit. The 'Combined treatment' unit feeds into a 'Purified grey-water tank' (blue tank with a water drop icon). The 'Purified grey-water tank' feeds into the distribution network, which also supplies water to the 'Garden watering' unit (green trapezoid with a water drop icon). The 'Garden watering' unit feeds into an 'Infiltration' unit (green trapezoid with a water drop icon). The diagram is color-coded: blue for water flow, orange for power flow, green for garden watering, and brown for blackwater flow.

Example workflow: step 4 – Evaluate KPI

Evaluate the KPI graph (right side of app) and table. Are these results what you expected?

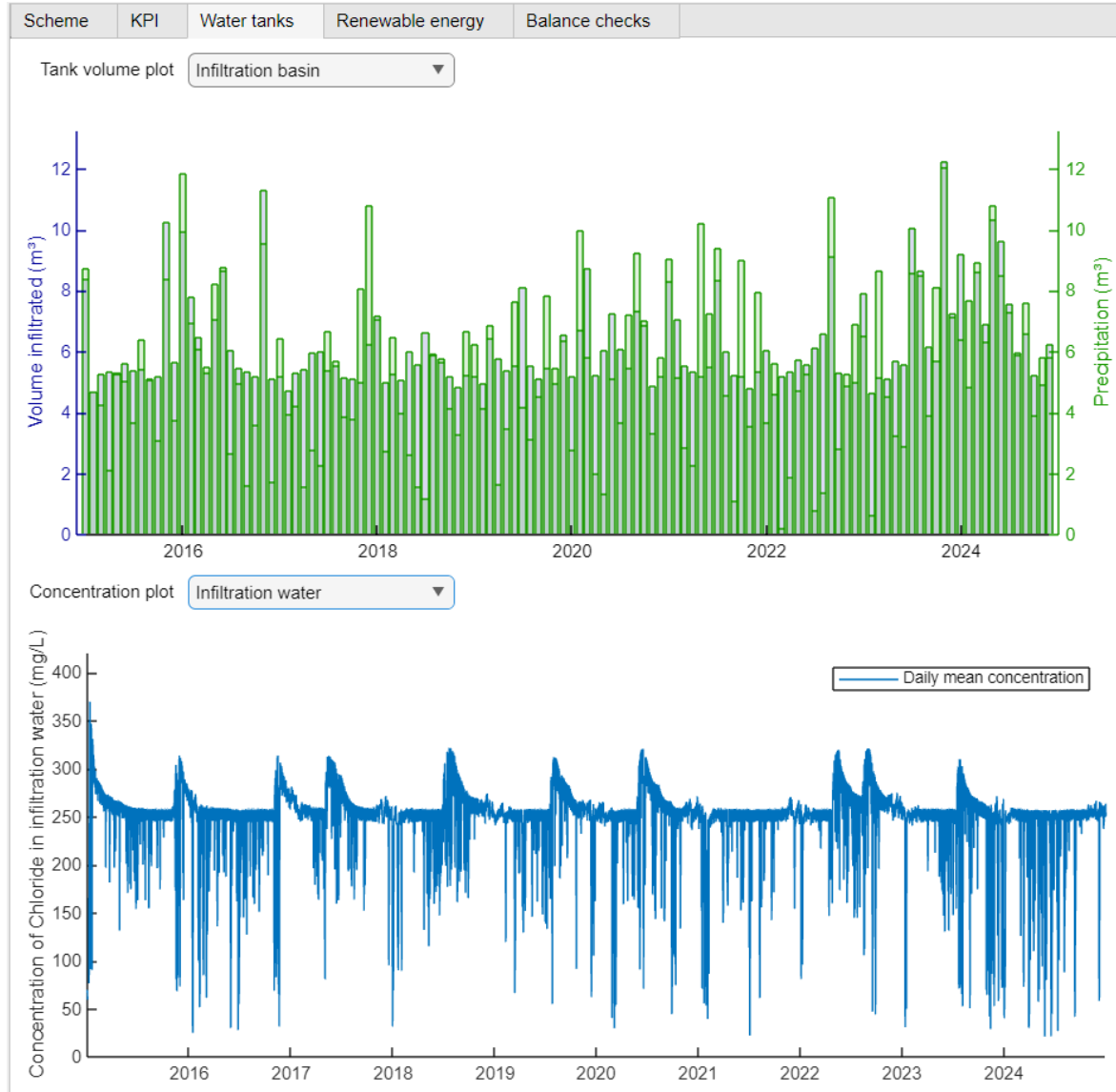


If the results seem weird to you, you can always check the balance to see if I forgot to account for something in the model.



Example workflow: step 5 – Delve into water tanks

Take a closer look at the levels and concentrations of each tank – and the infiltration basin

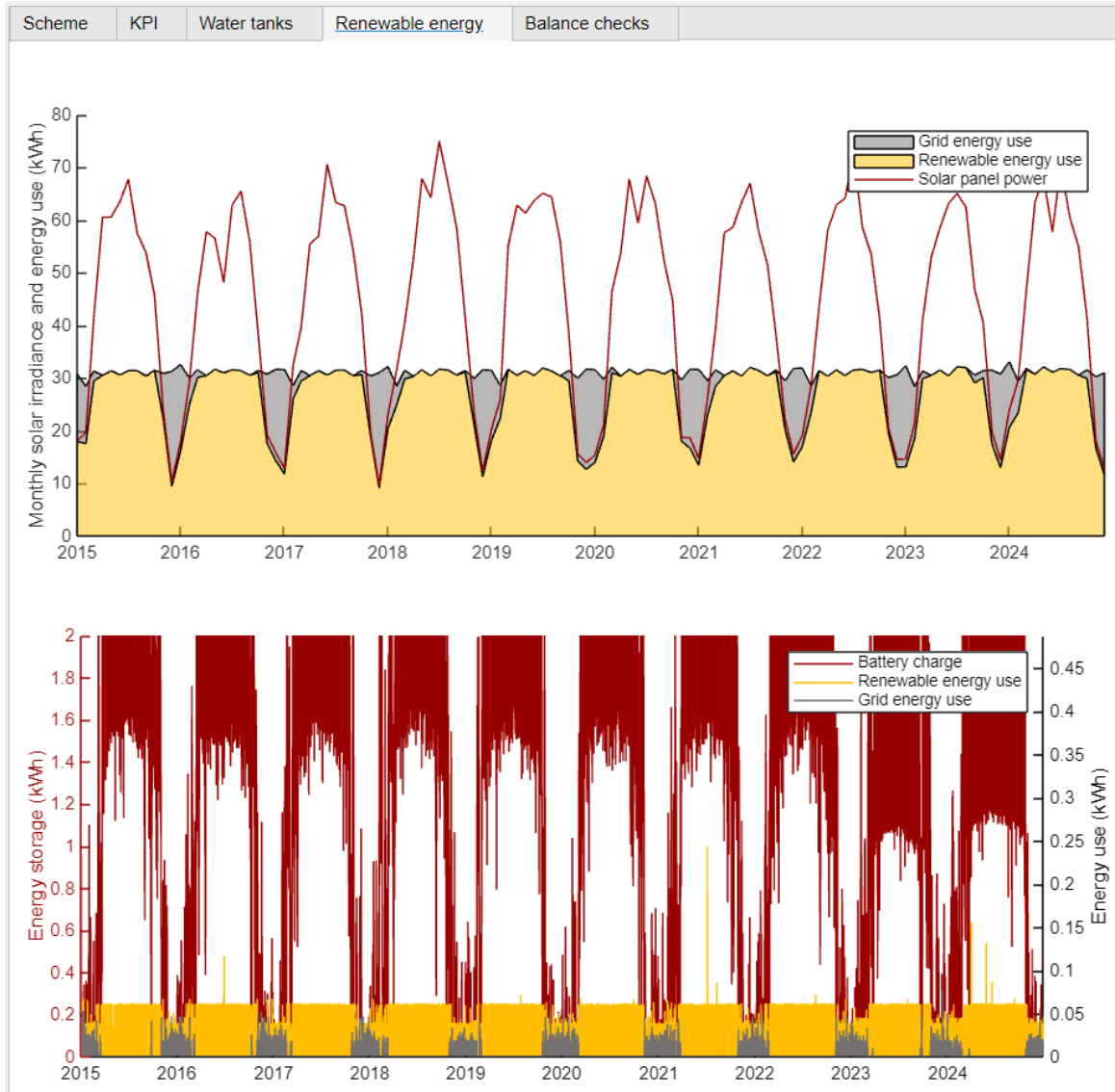


Admire the buffering effect of a decentralized household

Local regulations may apply here!

Example workflow: step 6 – Feeling energetic

Examine the energy usage



Grid energy used in winter. Notice the intersection of solar panel power and total energy requirement (use) and the disparity between renewable energy use and available solar power.

Battery is discharged most in winter, plenty full in summer.

Example workflow: step 7 – Save results

Press save, choose folder, select scenarios to save, which outputs, and which variables to save

The screenshot shows the OSIRIS software interface with the 'Save configuration' dialog box open. The main window displays a simulation setup for 'My dream house' with various components like City water, Precipitation, Rainwater tank, Potable water tank, Solar panels, Power grid, Backup, Bath, Shower, Bathroom sink, Washing machine, Dish-washer, Kitchen sink, Cleaning, Garden watering, Blackwater treatment, Greywater treatment, Greywater tank, and Infiltration.

The 'Save configuration' dialog box is divided into four sections:

- Scenarios:** A table with columns 'Select', 'Name', and 'Simulated'. It lists two scenarios: 'My dream house' and 'My current house (sad)'. A red arrow points to the 'My current house (sad)' row.
- Save output:** A list of checkboxes for 'KPI', 'Data', 'Settings', and 'Schemes'. A red arrow points to the 'Data' checkbox.
- Data variables:** A list of checkboxes for 'Model diagnostics', 'Volumes', 'Concentrations', 'Treatments', 'Energy', 'Output flows', 'Input flows', 'Application flows', and 'Control flows'. A red arrow points to the 'Concentrations' checkbox.
- Buttons:** 'Save' and 'Cancel' buttons at the bottom.

Numbered steps in the workflow:

1. Press 'Save' in the main window.
2. Click 'Browse folder' in the 'Save configuration' dialog.
3. Select scenarios and data variables to save.
4. Click 'Save' in the dialog.



Ir. Seppe Ongena

E: Seppe.Ongena@ugent.be

T: +32 9/264 59 76



Seppe Ongena

www.cmet.ugent.be

www.capture-resources.be

