NAWI WaterTAP User Interface

for Model Analysis and Comparison

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Motivation and Goals

WaterTAP models are written in Python code using the IDAES framework (IDAES-IP).

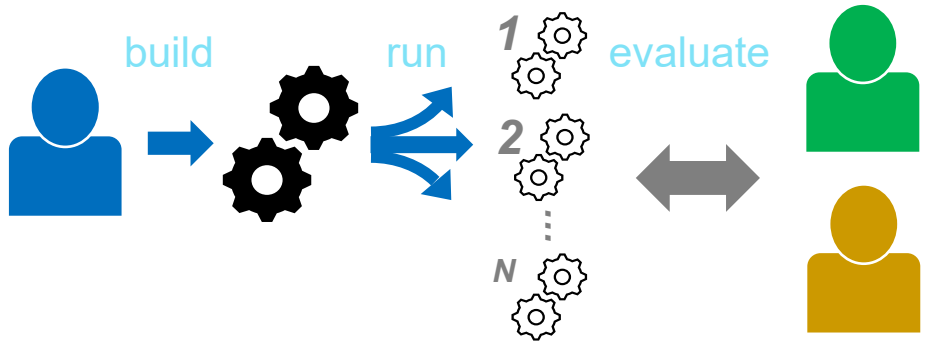
- WaterTAP library
- IDAES Integrated Platform
- Pyomo + Optimization Solvers

They are highly configurable, and powerful, but also quite complex to configure and run

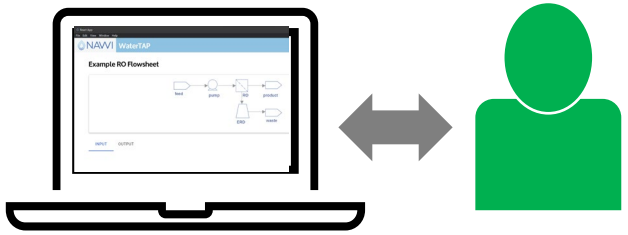
```
= ConcreteModel()
fs = FlowsheetBlock(default={"dynamic": False})
fs.properties = props.SeawaterParameterBlock()
fs.costing = WaterTAPCosting()

unit models
fs.feed = Feed(default={"property_package": m.fs.properties})
fs.pump = Pump(default={"property_package": m.fs.properties})
fs.RO = ReverseOsmosis0D(default={
      "property_package": m.fs.properties,
      "has_pressure_change": True,
      "pressure_change_type": PressureChangeType.calculated,
      "mass_transfer_coefficient": MassTransferCoefficient.calculated,
      "concentration_polarization_type": ConcentrationPolarizationType.calculated})
fs.erd = EnergyRecoveryDevice(default={"property_package": m.fs.properties})
fs.product = Product(default={"property_package": m.fs.properties})
```

Models, once created, are often run many times with different parameters -- perhaps by others



The WaterTAP UI interactively runs, analyzes, and compares existing models



Capabilities Overview

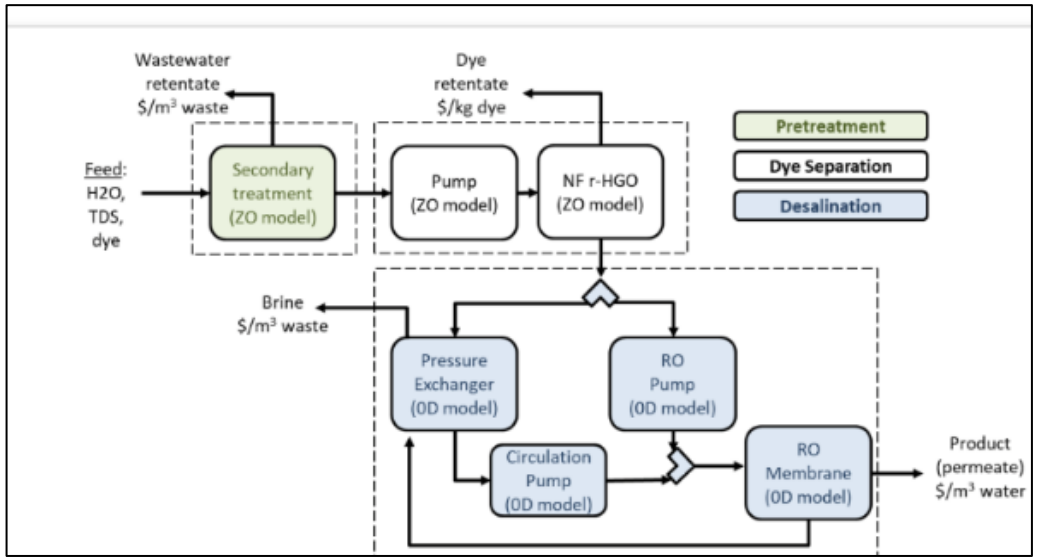
MODEL

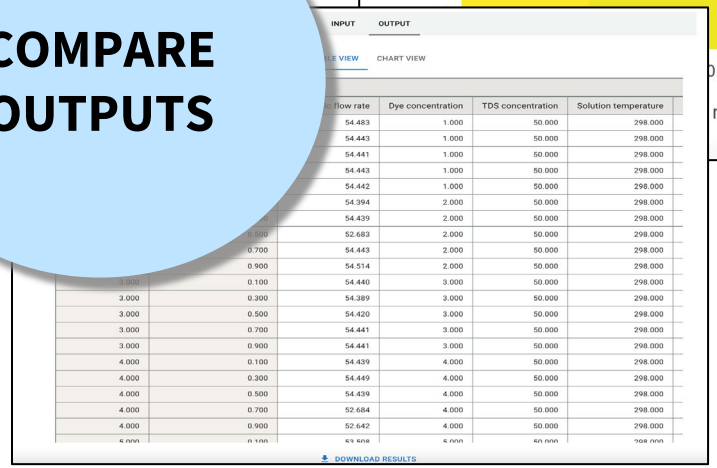
EDIT MODEL PARAMETERS

SOLVE

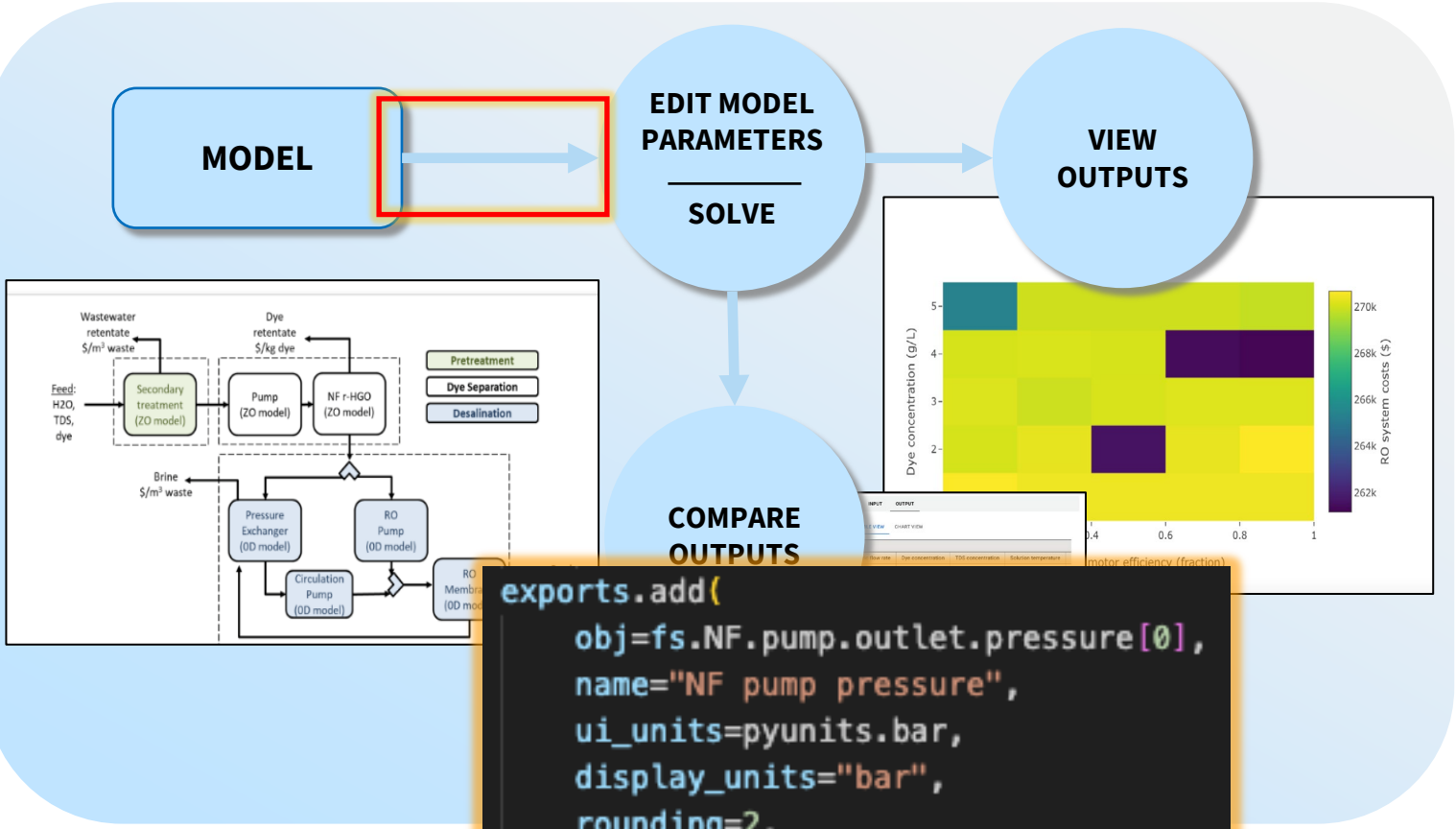
VIEW OUTPUTS

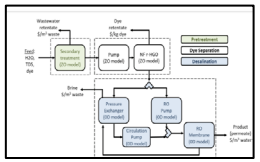
COMPARE OUTPUTS

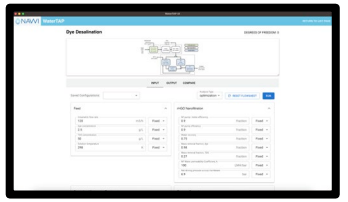




Capability: Export Existing Model to UI







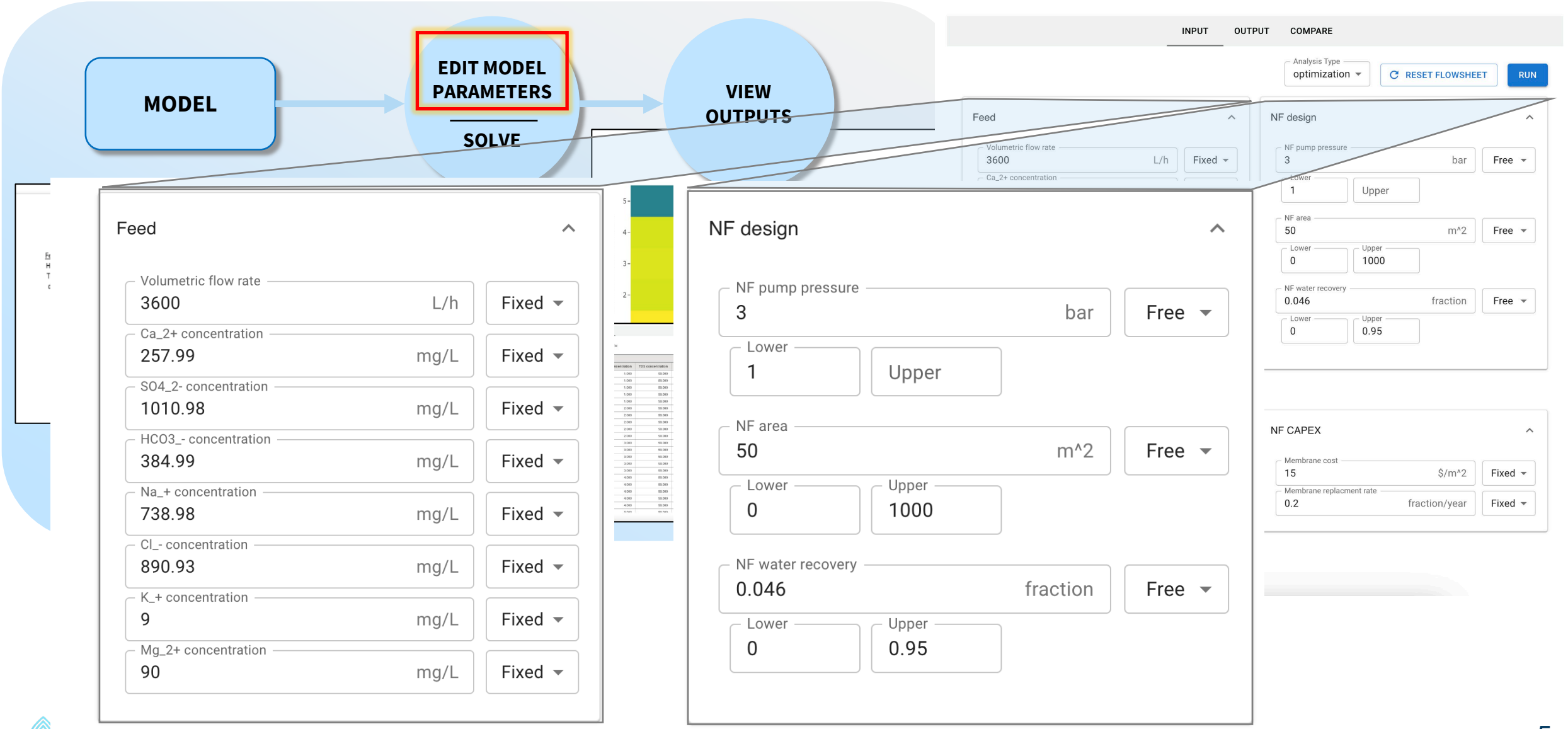
```
exports.add(
    obj=fs.NF.pump.outlet.pressure[0],
    name="NF pump pressure",
    ui_units=pyunits.bar,
    display_units="bar",
    rounding=2,
    description="NF pump pressure",
    is_input=True,
    input_category="NF design",
    is_output=True,
    output_category="NF design",
)
```

Developer **chooses**

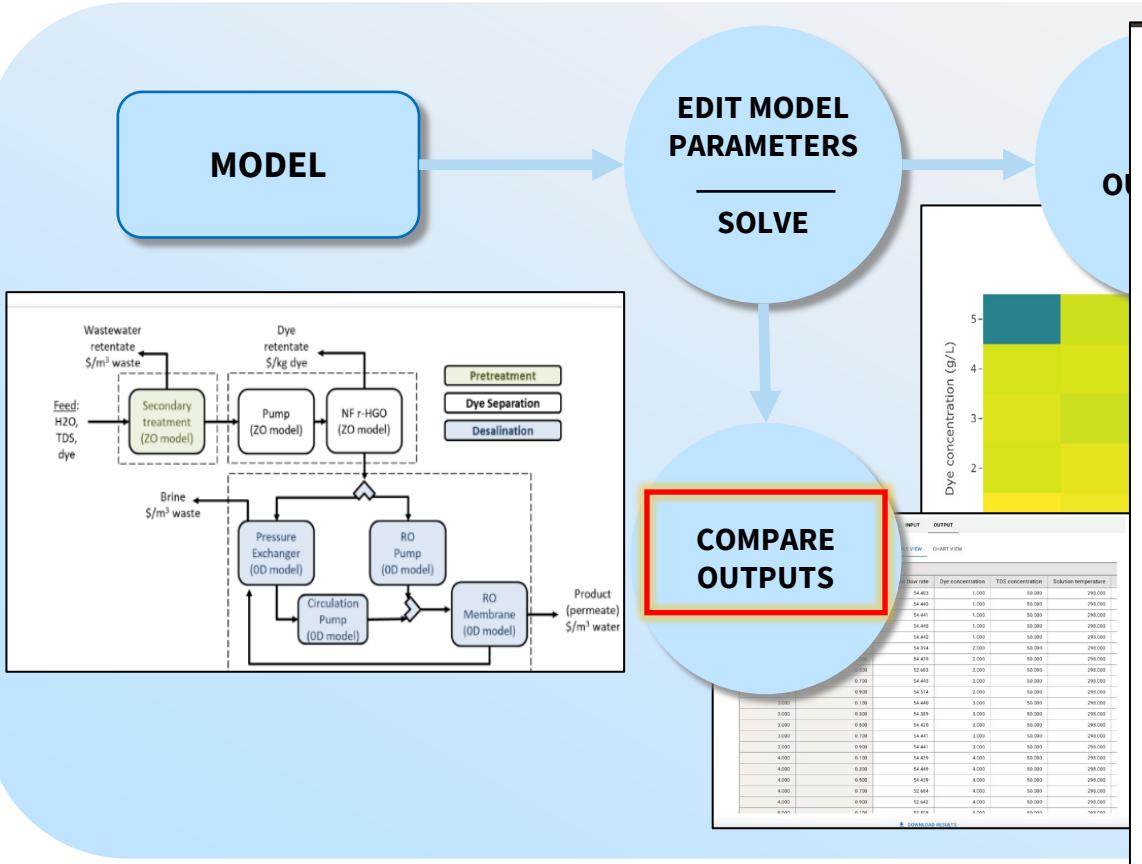
- Variables, constraints, or combinations, to show
- Variables that can be edited and made fixed/free
- Variable ranges
- Units for variables (can be different from internal model units)

Example export Python code for pump outlet pressure

Capability: Edit model parameters (variables)



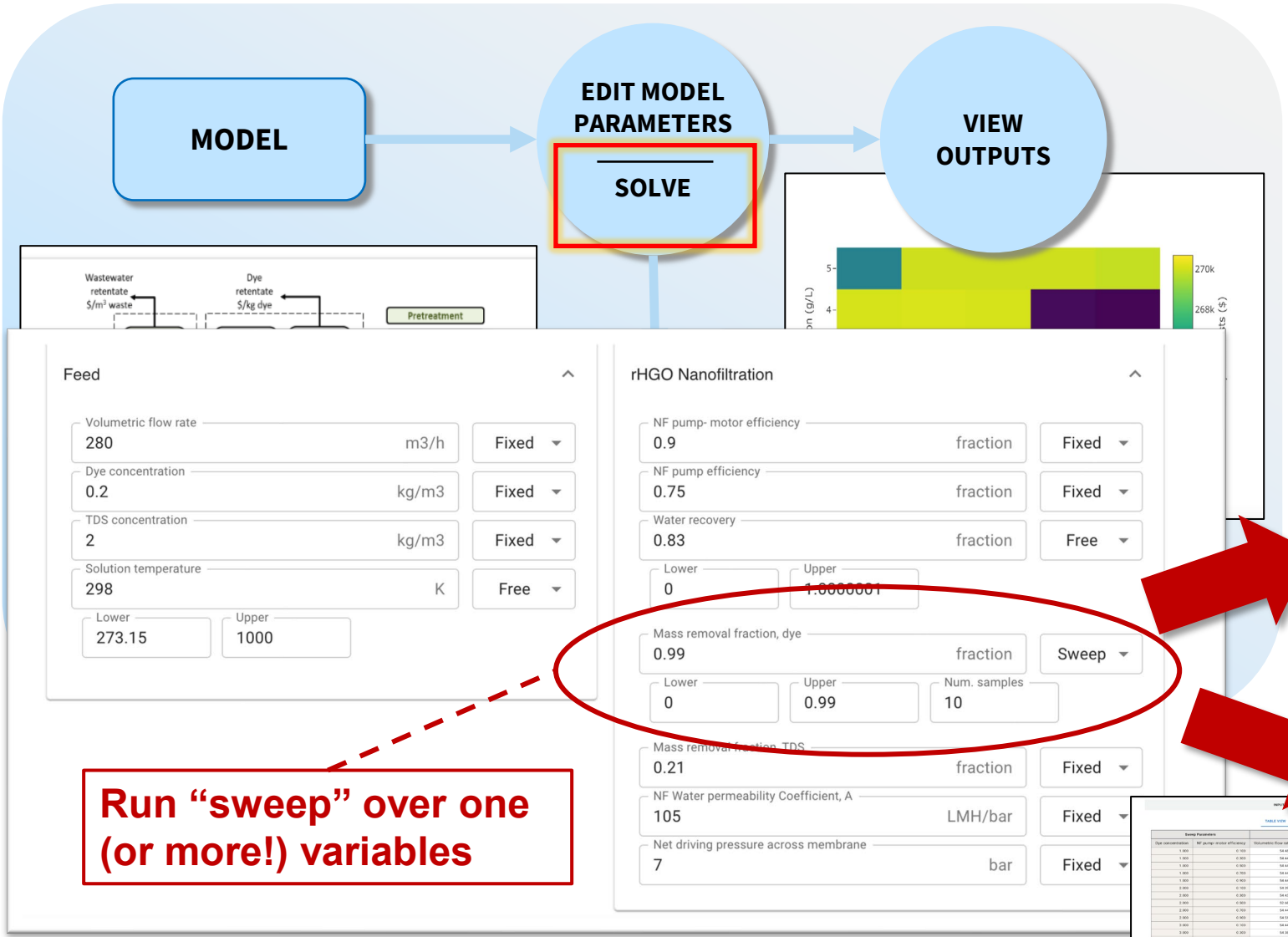
Capability: View and compare outputs

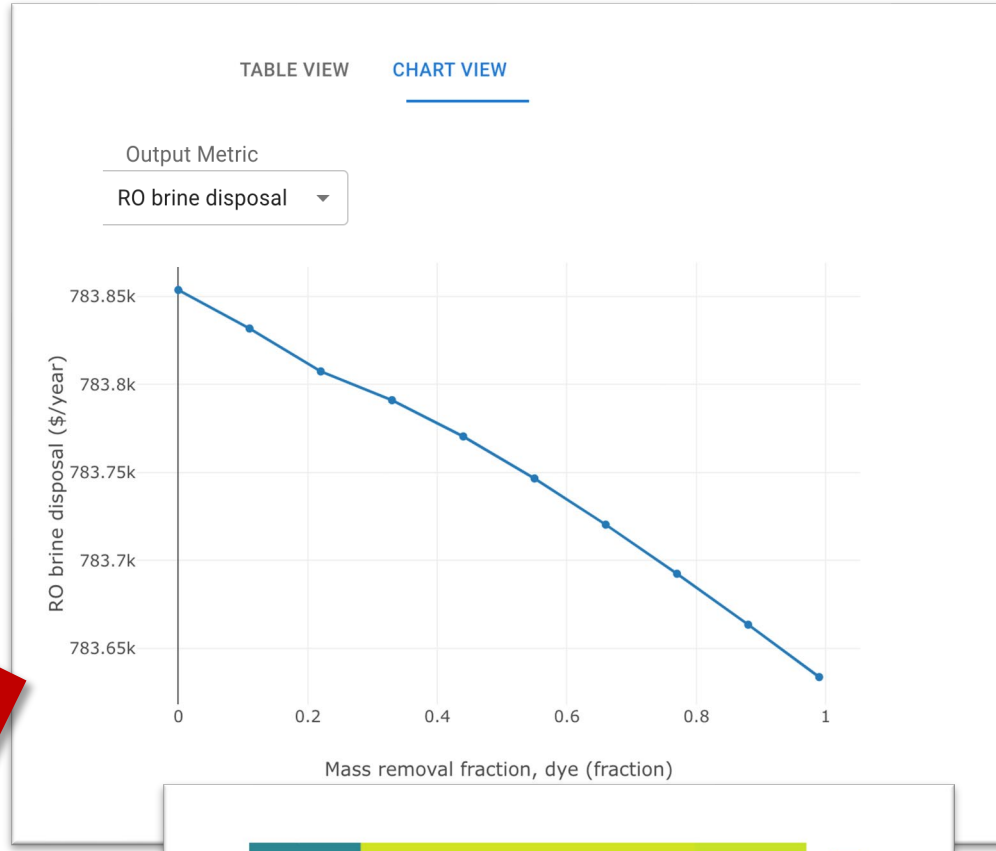


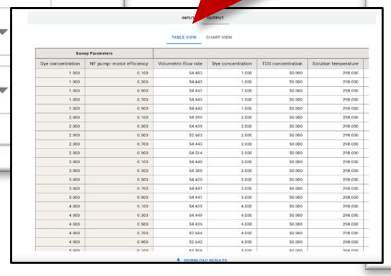
	Metric	Dye Desalination 2	Dye Desalination 1	Value Difference
Feed	Volumetric flow rate	53 m3/h	120 m3/h	-67.31
	Dye concentration	1 g/L	2.5 g/L	-1.50
	TDS concentration	50 g/L	50 g/L	0.00
	Solution temperature	298 K	298 K	0.00
rHGO Nanofiltration	NF pump- motor efficiency	0.5 fraction	0.9 fraction	-0.40
	NF pump efficiency	0.4 fraction	0.9 fraction	-0.50
	Water recovery	0.9 fraction	0.75 fraction	0.15
	Mass removal fraction, dye	0.5 fraction	0.98 fraction	-0.48
	Mass removal fraction, TDS	0.27 fraction	0.27 fraction	0.00
	NF Water permeability Coefficient, A	0.58 LMH/bar	100 LMH/bar	-99.42
	Net driving pressure across membrane	6.9 bar	6.9 bar	0.00
	Solute Rejection- dye	0.44 fraction	0.98 fraction	-0.54
	Solute Rejection- tds	0.18 fraction	0.02 fraction	0.16
	Membrane area	11728.39 m**2	128.89 m**2	11599.50
Secondary Wastewater Treatment	Specific energy consumption per inlet flow rate	1897.81 kWh/m3	0.14 kWh/m3	1897.67
Reverse Osmosis	RO Water permeability coefficient, A	4e-12 m**2*s/kg	4e-12 m**2*s/kg	0.00
	RO Salt permeability coefficient, B	4e-8 m/s	4e-8 m/s	0.00
	RO high-pressure pump efficiency	0.8 fraction	0.8 fraction	0.00
	RO booster pump efficiency	0.8 fraction	0.8 fraction	0.00
	Isobaric pressure exchanger efficiency	0.95 fraction	0.95 fraction	0.00
	Pump cost	94 $/(m^3/hr)	94 $/(m^3/hr)	0.00

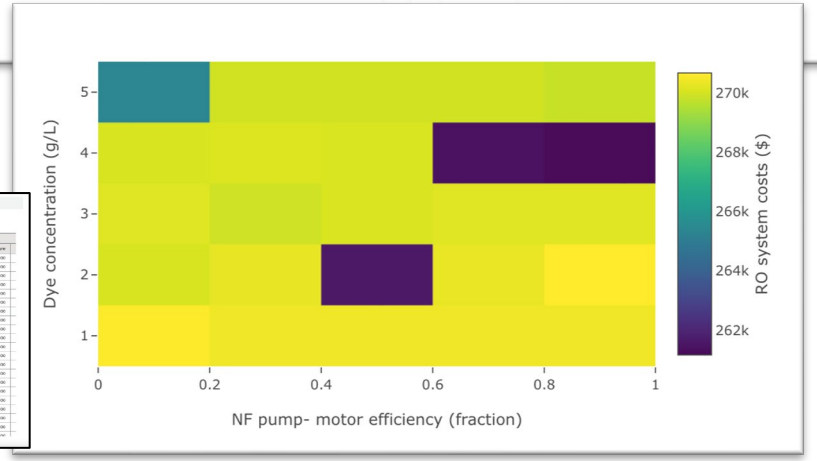
- Save inputs and outputs for later
- Compare side-by-side
- Export results to a table

Capability: Sensitivity analysis (parameter sweeps)









Potential Future Work

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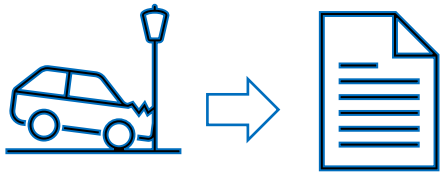
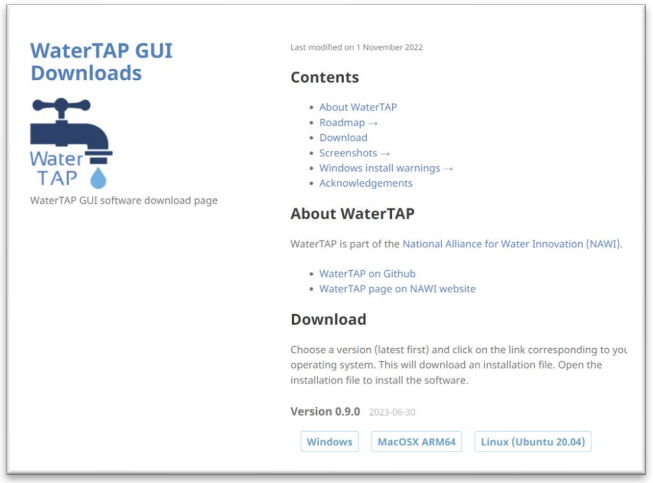


- Improve adding new flowsheet
  - Graphical “flowsheet export” tool
  - Select variables etc.
  - Output code that can be easily edited for advanced features not covered by the GUI (e.g. custom calculations for objects to export, specialized build & solve logic)
  - (Beginnings of common structure that could be used for graphical flowsheet builder)
- Improve error & non-convergence reporting
  - Help non-developer user communicate details of what went wrong
  - Include inputs, outputs, logs, diagnostics report
  - Provide instructions for how to send, etc.

Summary

- WaterTAP UI provides a no-code ability to:
  - View WaterTAP model parameters, change them, and solve the model
  - Compare outputs from different parameter choices
  - Perform “parameter sweeps” for sensitivity analyses
  - Export results from all of the above as tables for other analyses/tools



The WaterTAP UI can be **easily** installed for Windows, Mac OSX, and UNIX using a native (graphical) installer

Acknowledgements

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Thank you