Gebruikers meeting: JIP Slim malen RTC-Tools developments

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3, October 2017

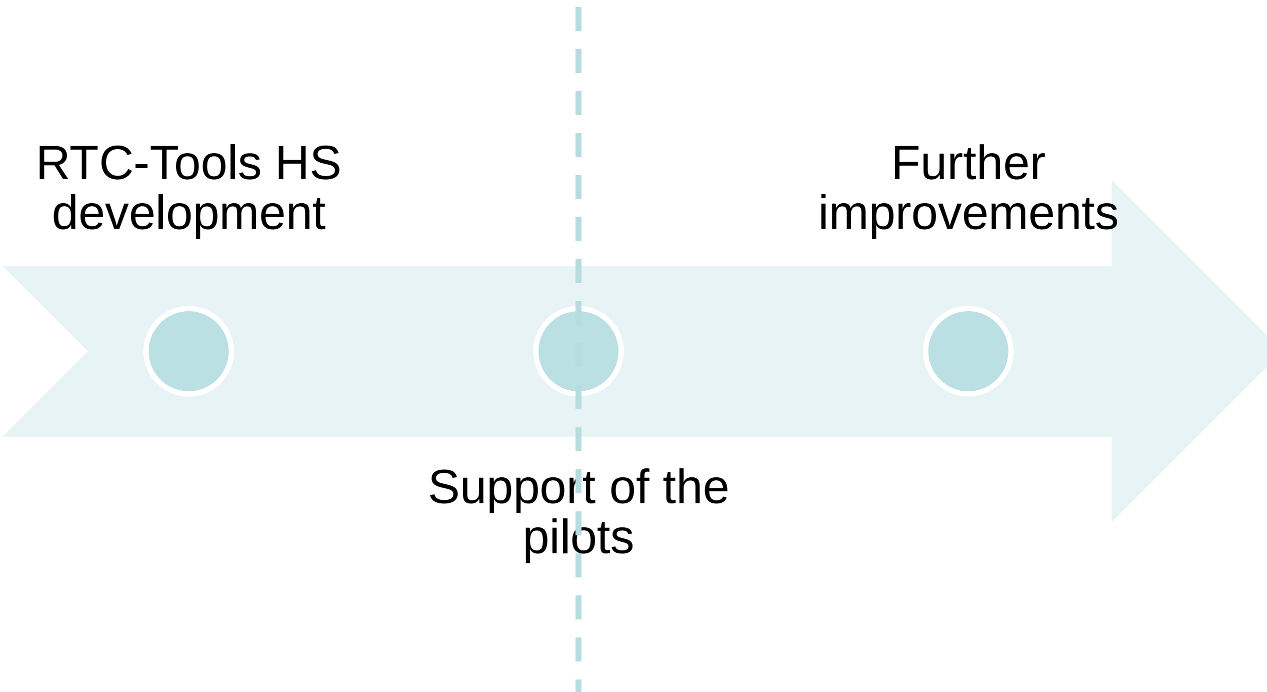
RTC-Tools Hydraulic Structures Library v1.0

Technische Universiteit
Eindhoven
University of Technology

10 november 2017

Deltares

RTC-Tools HS timeline



RTC-Tools Hydraulic structures

Weirs

Approximation concept, controllable weirs

2017 March

Full development

Including weir with zero flow

Improving the approximation

Error approximation

2017 October

Further test and improvement

Test orifice + pump combination

Performance

Documentation

http://rtc-tools-hydraulic-structures.readthedocs.io/en/stable/examples/weir/basic-weir.html

RTC-Tools Hydraulic Structures

stable

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EXAMPLES

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Pumping Station

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Modeling

Optimization

Results

Interpretation of the results

Basic Weir

Note

This example focuses on how to implement a controllable weir in RTC-Tools using the Hydraulic Structures library. It assumes basic exposure to RTC- Tools. If you are a first-time user of RTC-Tools, please refer to the RTC-Tools documentation.

The weir structure is valid for two flow conditions:

- Free (critical) flow
- No flow

Warning

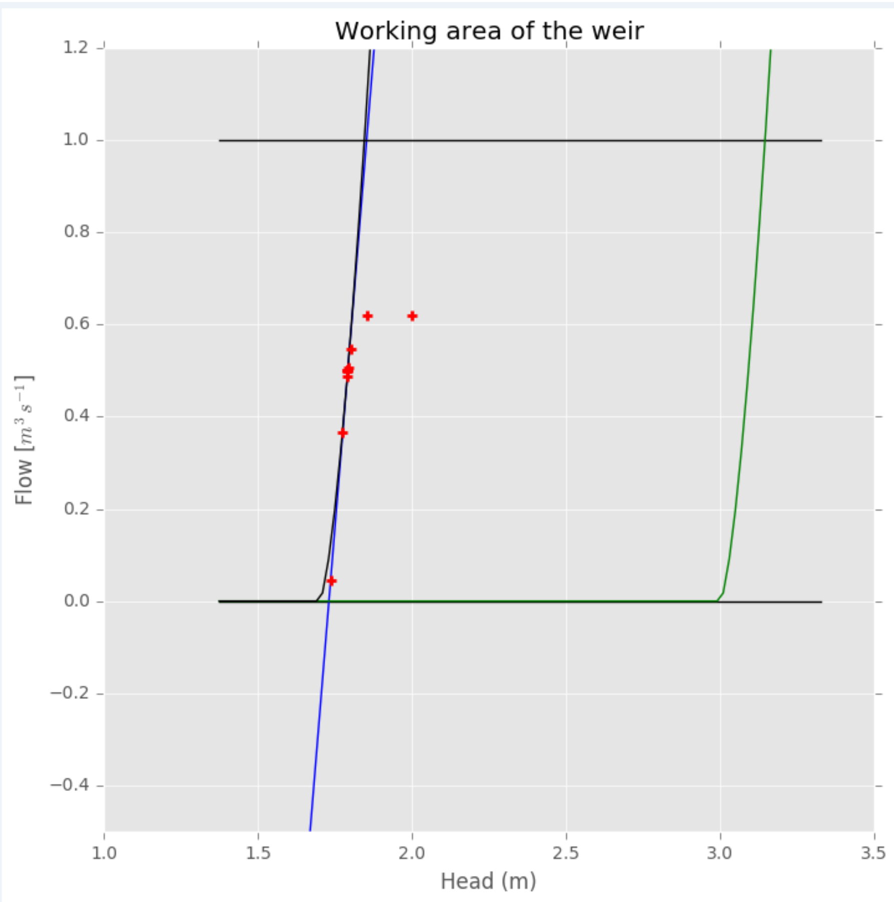
Submerged flow is not supported.

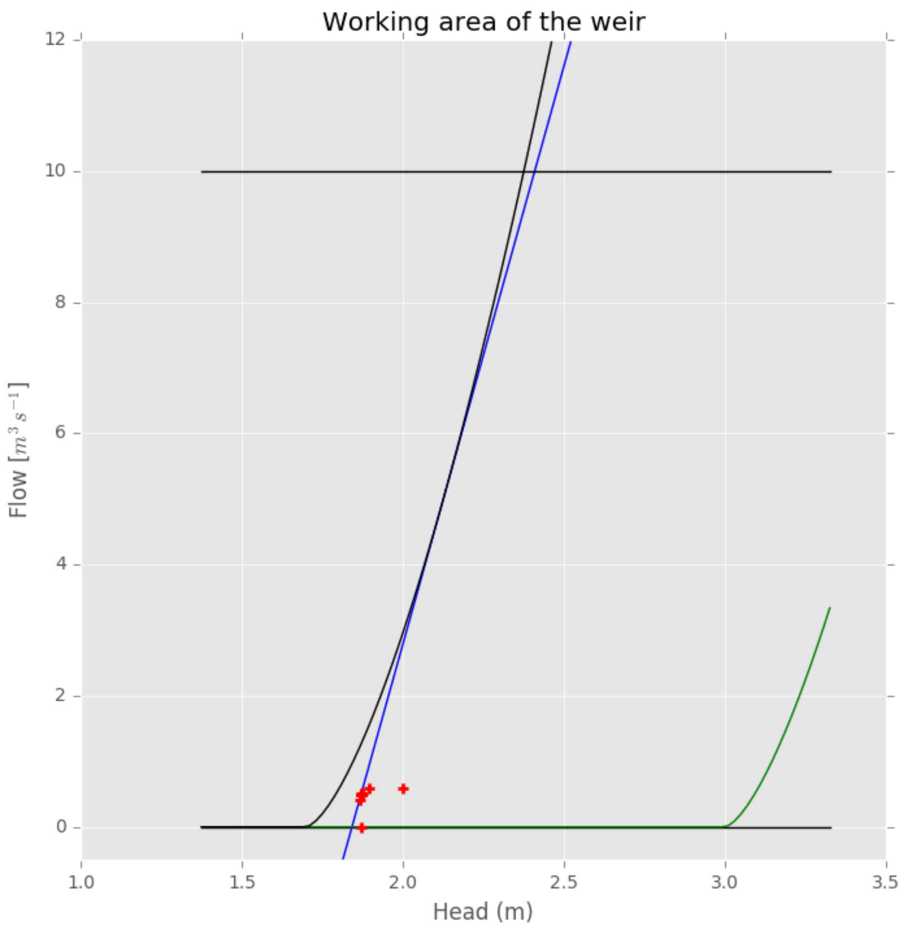
Modeling

Building a model with a weir

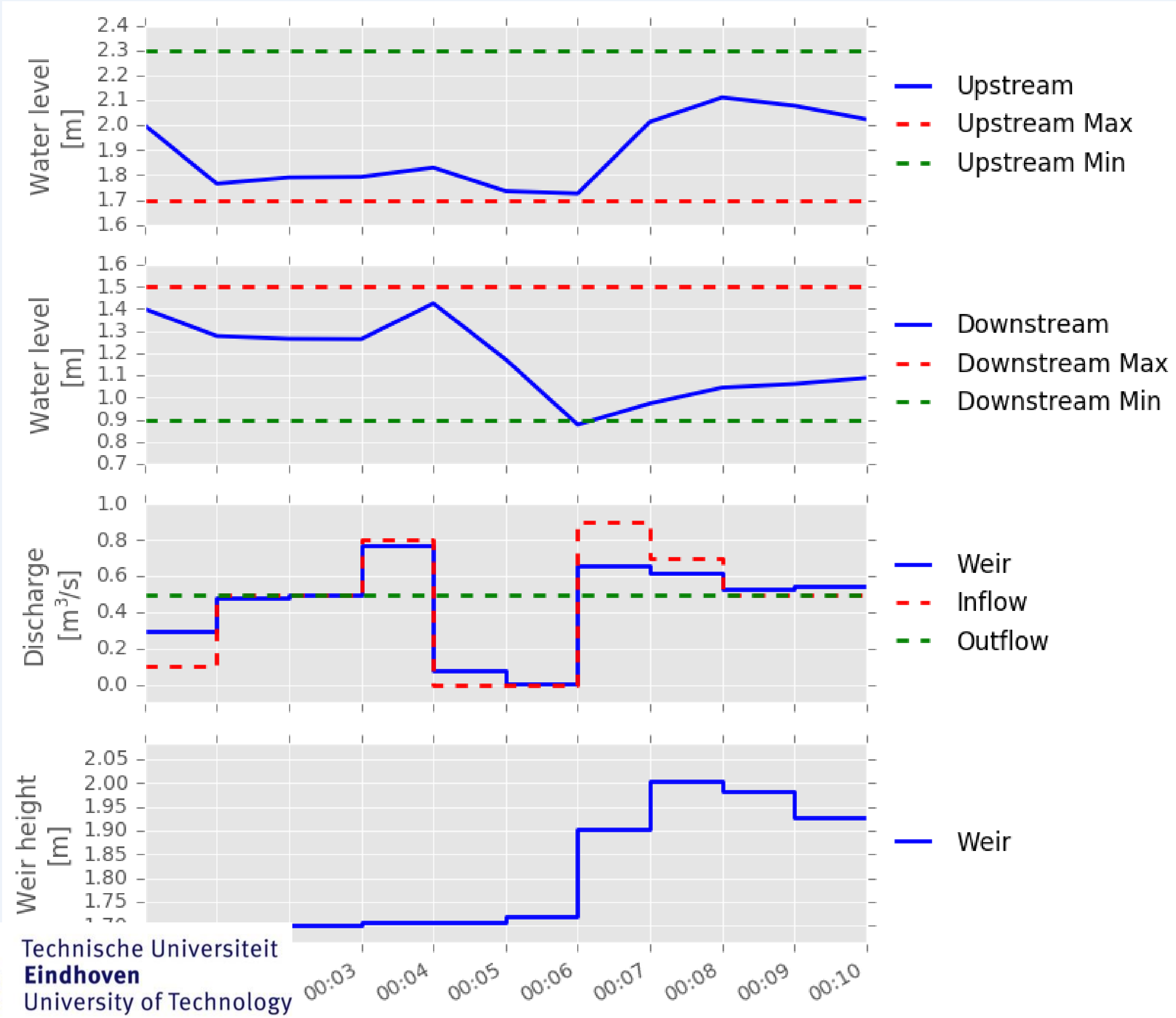
In this example we are considering a system of two branches and a controllable weir in between. On the upstream side is a prescribed input flow, and on the downstream side is a prescribed output flow. The weir should move in such way that the water level in both branches is kept within the desired limits.

Error approximation





Including weir with zero flow



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Pumps

One pump, always on

2017 March — Pump is able to turn off

More pumps

Minimum on time

Error approximation

Different kinds of pumps

Pump switching matrix

Resistance

2017 October — Further test and improvement

Performance

Documentation

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EXAMPLES
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    - Two Pumps
  - Weir

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Basic Pumping Station

Note

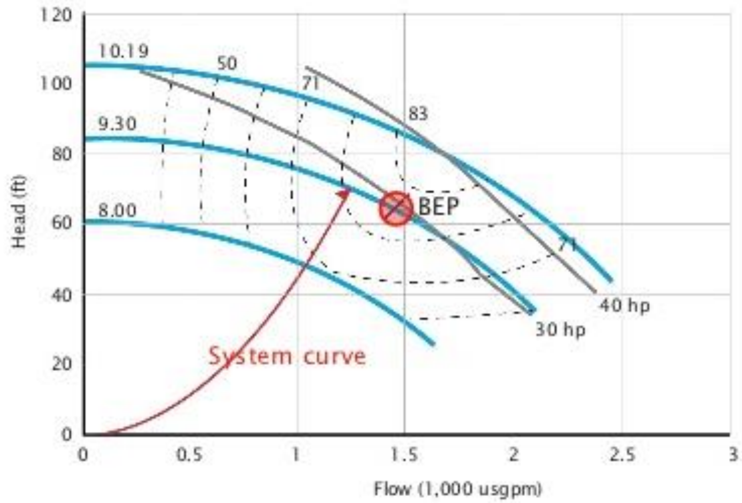
This example focuses on how to implement optimization for pumping stations in RTC-Tools using the Hydraulic Structures library. It assumes basic exposure to RTC-Tools. If you are a first-time user of RTC-Tools, please refer to the RTC-Tools documentation.

The purpose of this example is to understand the technical setup of a model with the Hydraulic Structures Pumping Station object, how to run the model, and how to interpret the results.

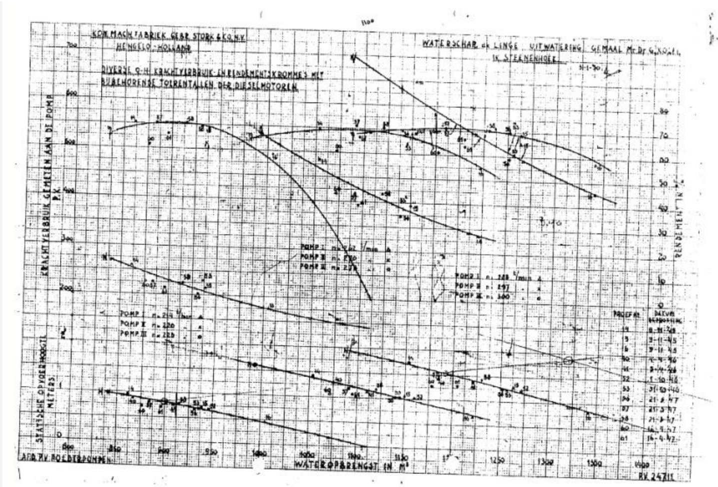
The scenario is the following: A pumping station with a single pump is trying to keep an upstream polder in an allowable water level range. Downstream of the pumping station is a sea with a (large) tidal range, but the sea level never drops below the polder level. The price on the energy market fluctuates, and the goal of the operator is to keep the polder water level in the allowable range while minimizing the pumping costs.

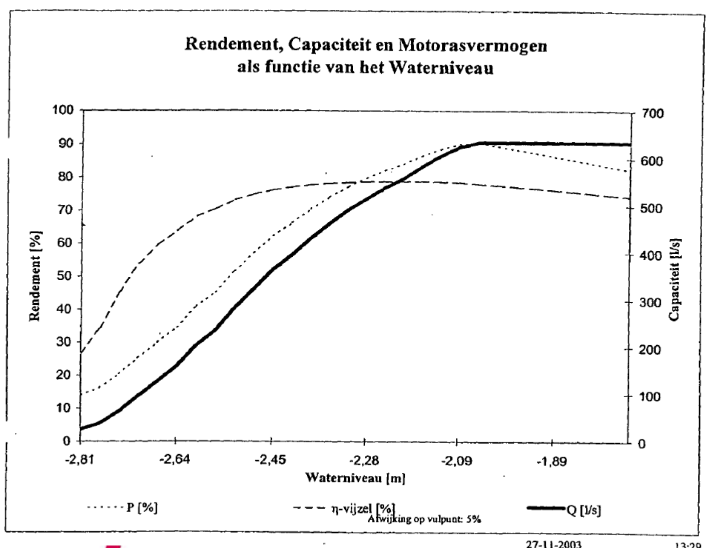
The folder `examples/pumping_station/basic` contains the complete RTC-Tools optimization problem.

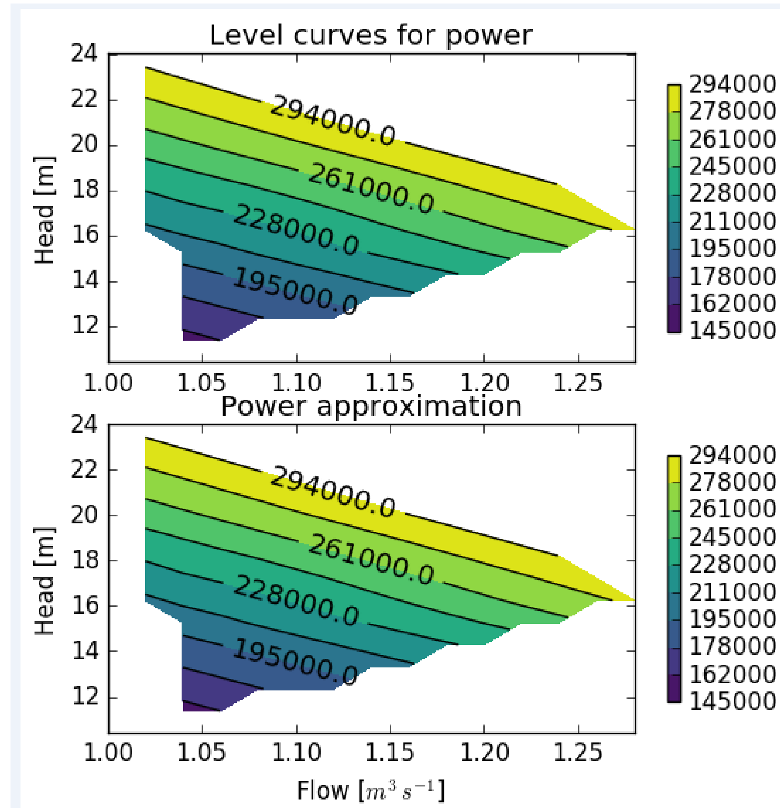
Pump types


120
100
80
60
40
20
0
Head (ft)
0
0.5
1
1.5
2
2.5
3
Flow (1,000 usgpm)
10.19
9.30
8.00
50
71
83
71
BEP
40 hp
30 hp
System curve

Pump fitting tools - preprocessing





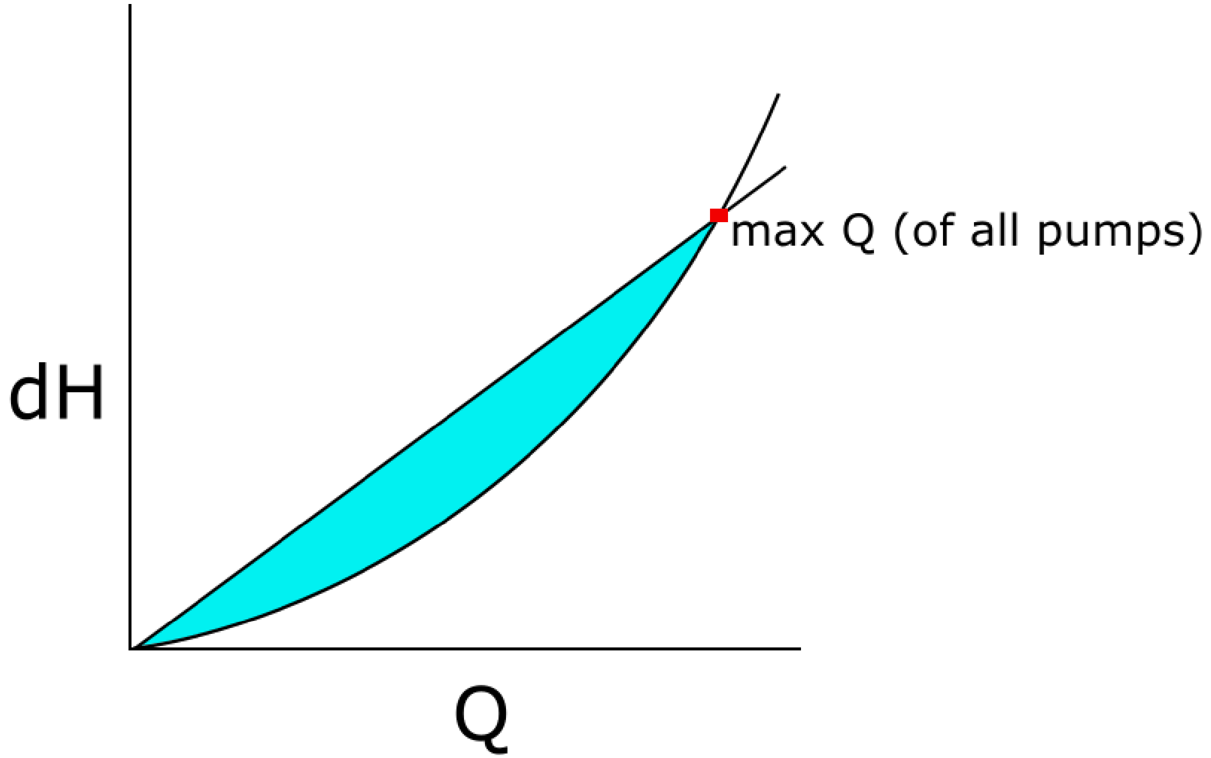


Resistance

$$dH = C \cdot Q^2$$

$$dH \geq C \cdot Q^2$$

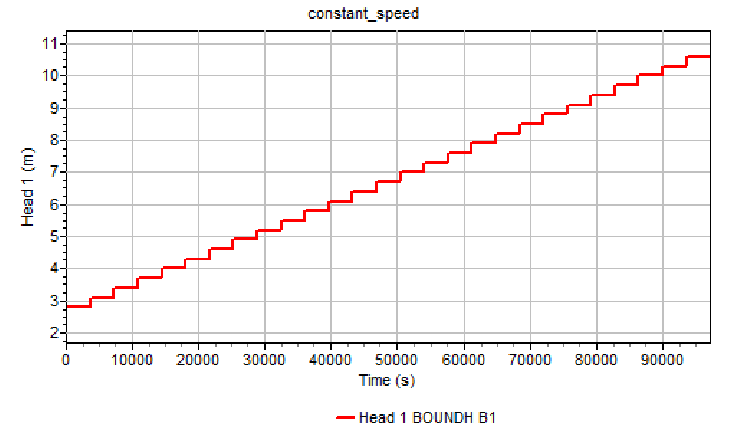
$$\lim_{Q \to 0} dH = 0$$



Error pumps (fixed speed pump)

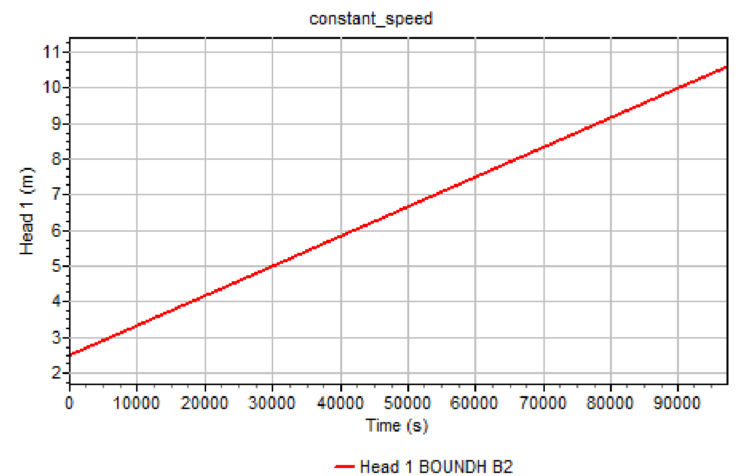
Water level fixed (RTC-Step)

One day (24 time steps pump on)			
	RTC	Wanda	Error
Total power	1445.685	1492.418313	3.23%
Water pumped	61689.2	63423.7581	2.81%
Water level upstream	0.790677	0.790700018	0.00%

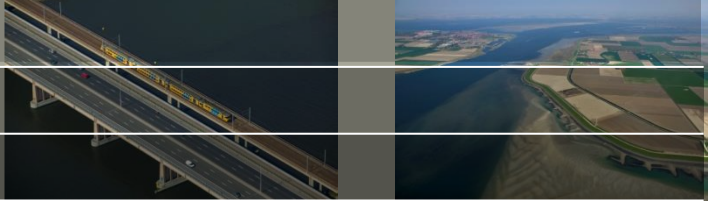


Water level interpolated

One day (24 time steps pump on)			
	RTC	Wanda	Error
Total power	1445.685	1486.044	2.79%
Water pumped	61689.2	64189.27	4.05%
Water level upstream	0.790677	0.773898	2.17%



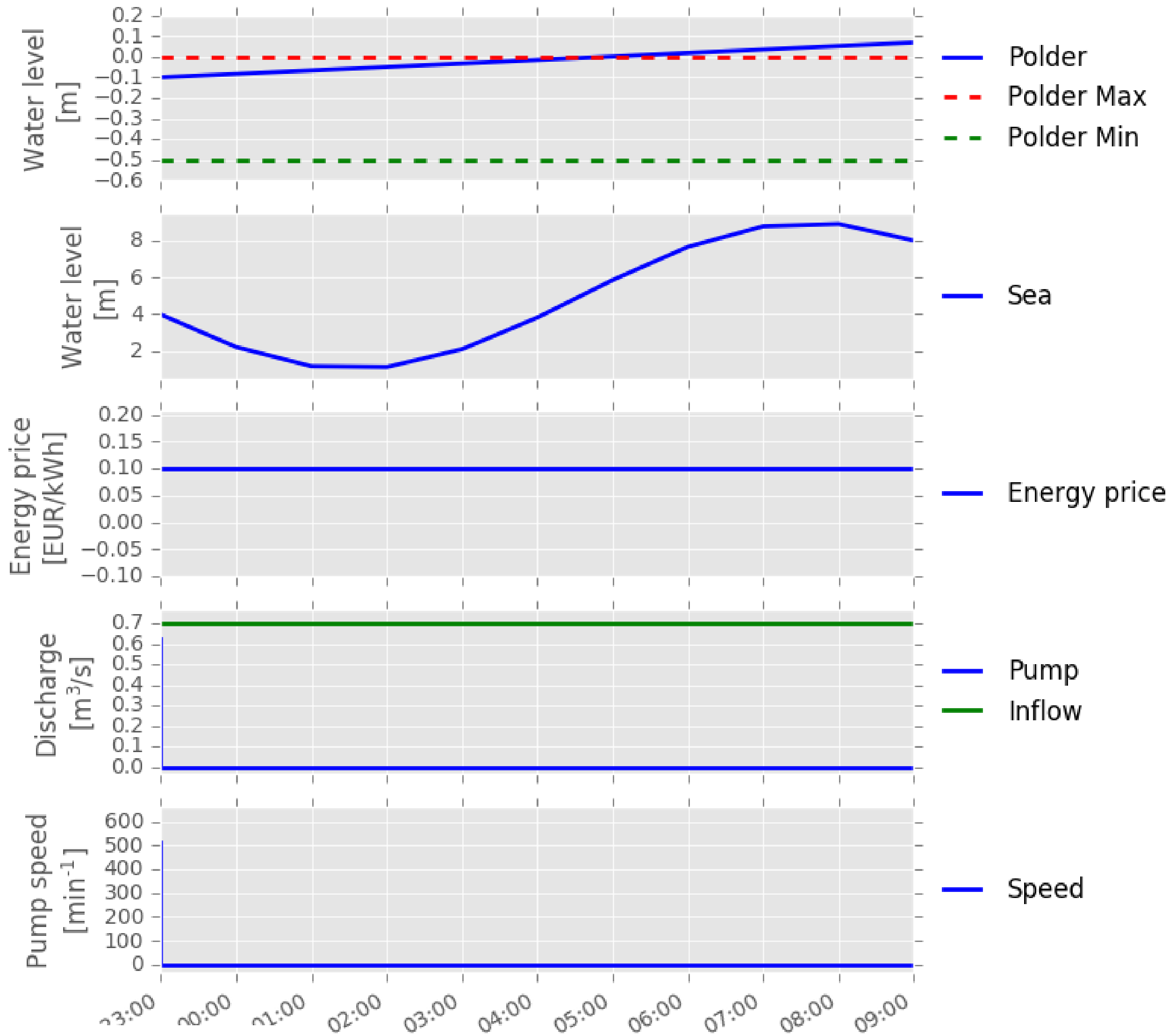
Examples



- 3 examples

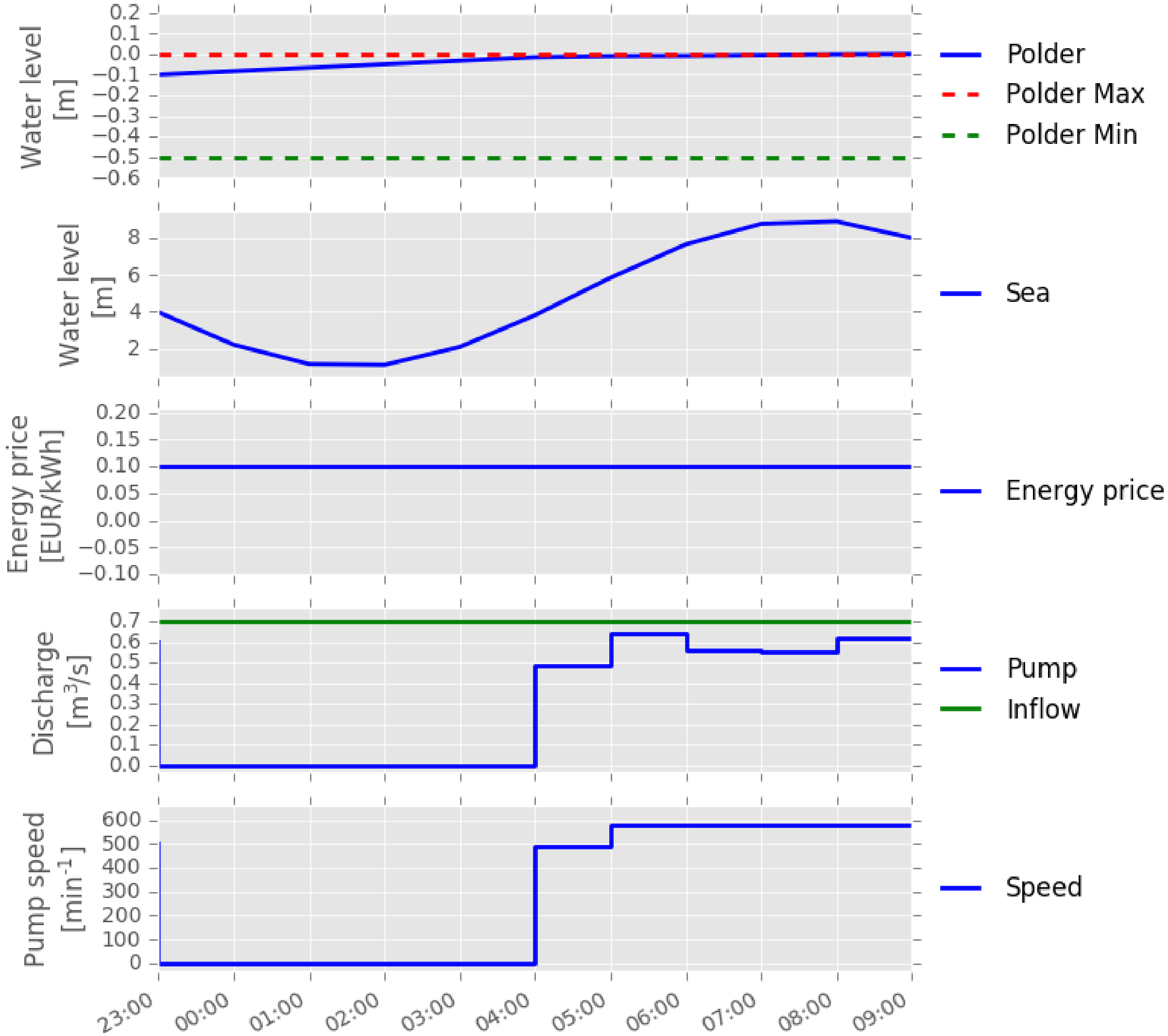
- Each of them shows a situation:
  - Without pumping
  - Possible manual operation
  - With optimization

Example 1, no pumping



Example 1, “manual” operation

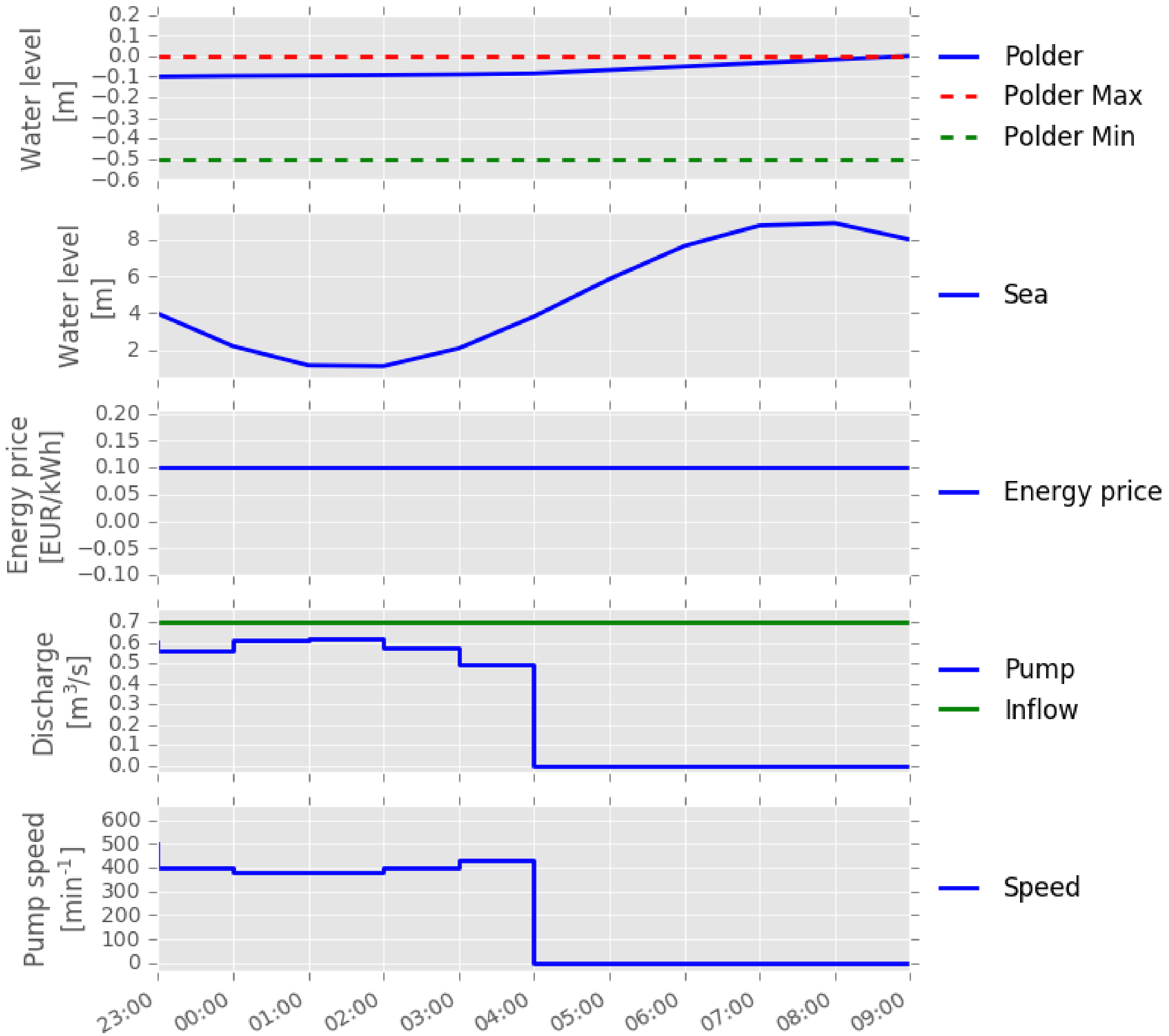
Total power = 304.5 kWh
Total money spent = €30.40



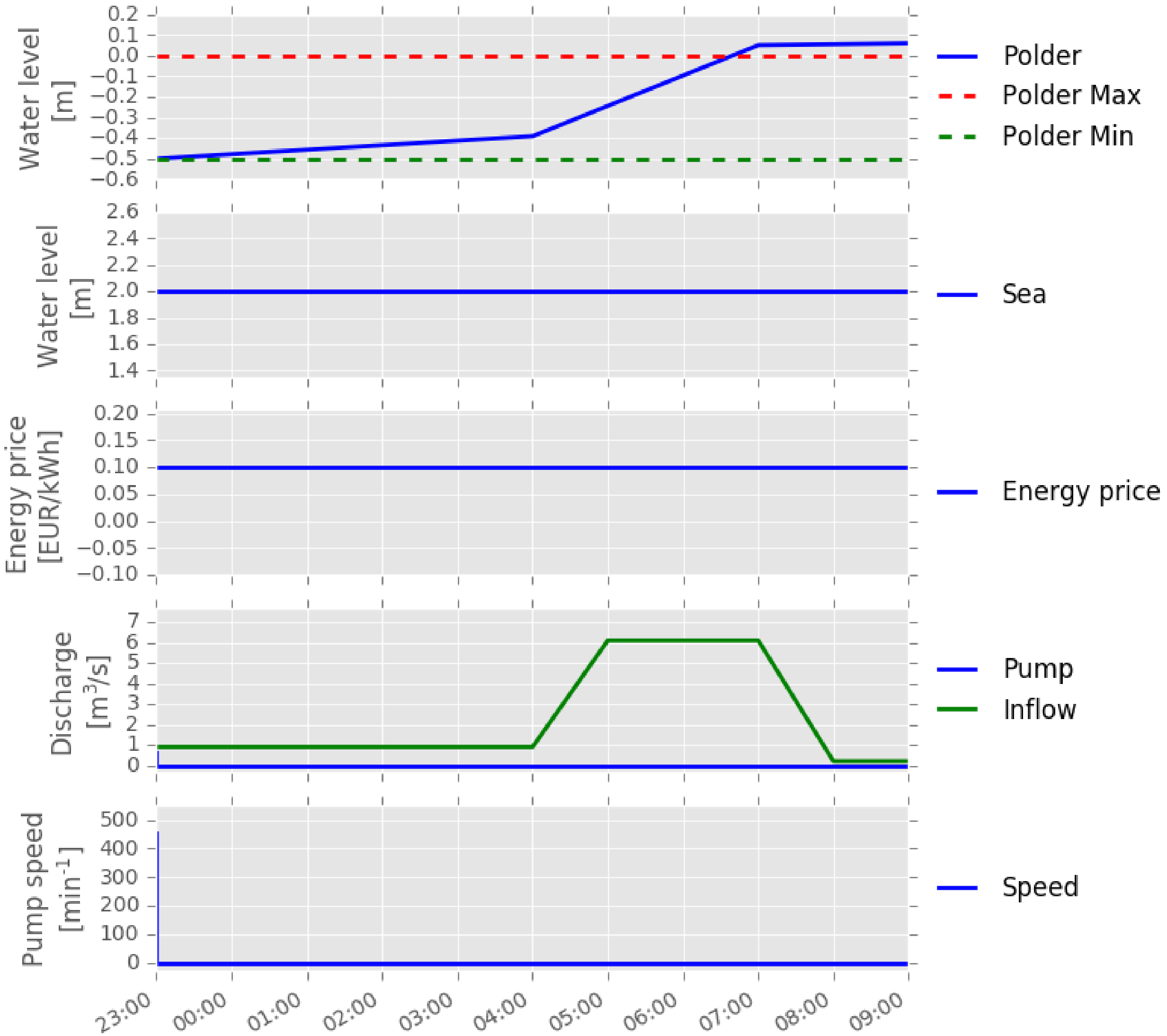
Example 1, optimization

Total power = 95.9 kWh
Total money spent = €9.50

Saving: 68%

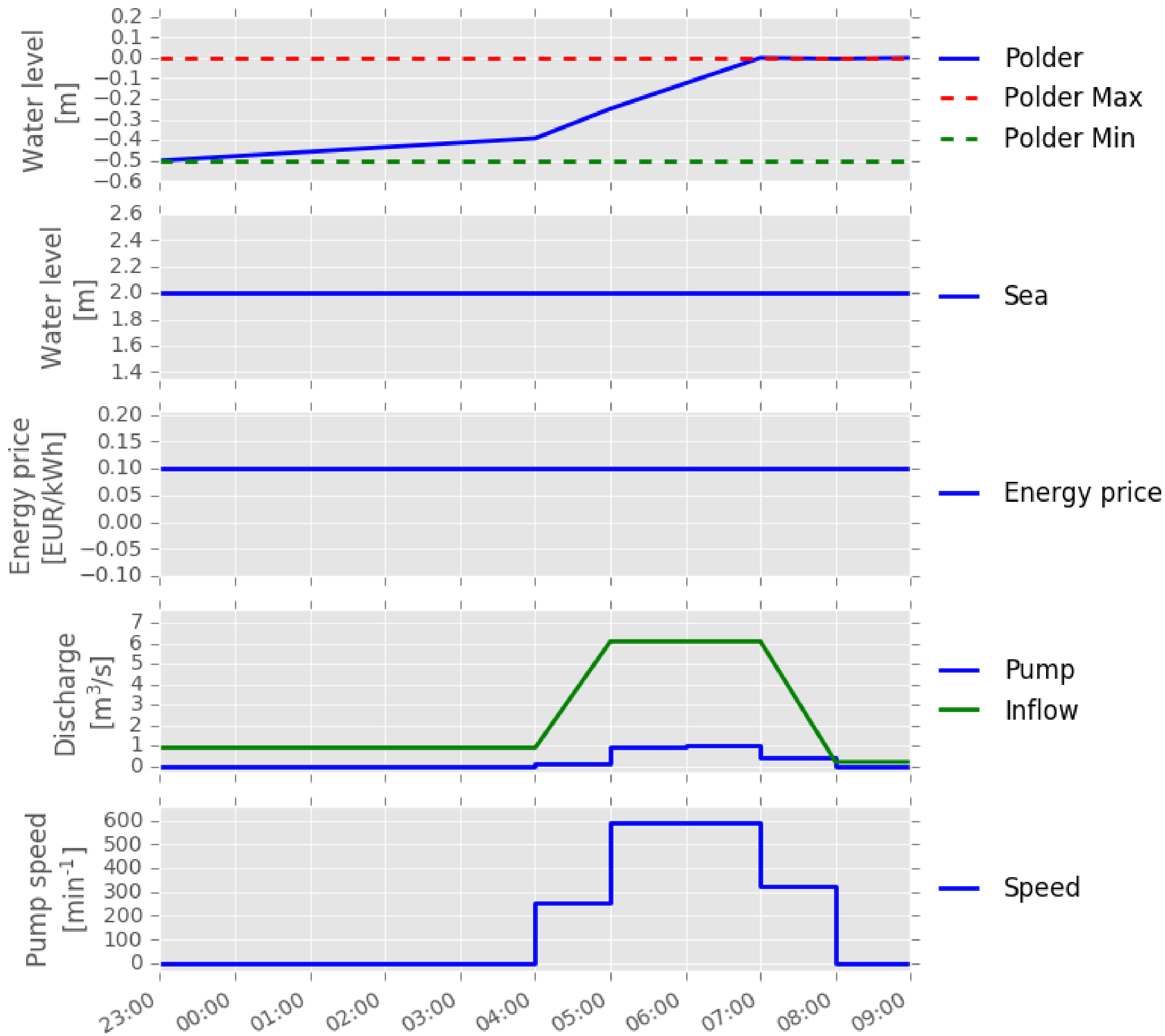


Example 2, no pumping



Example 2, “manual” operation

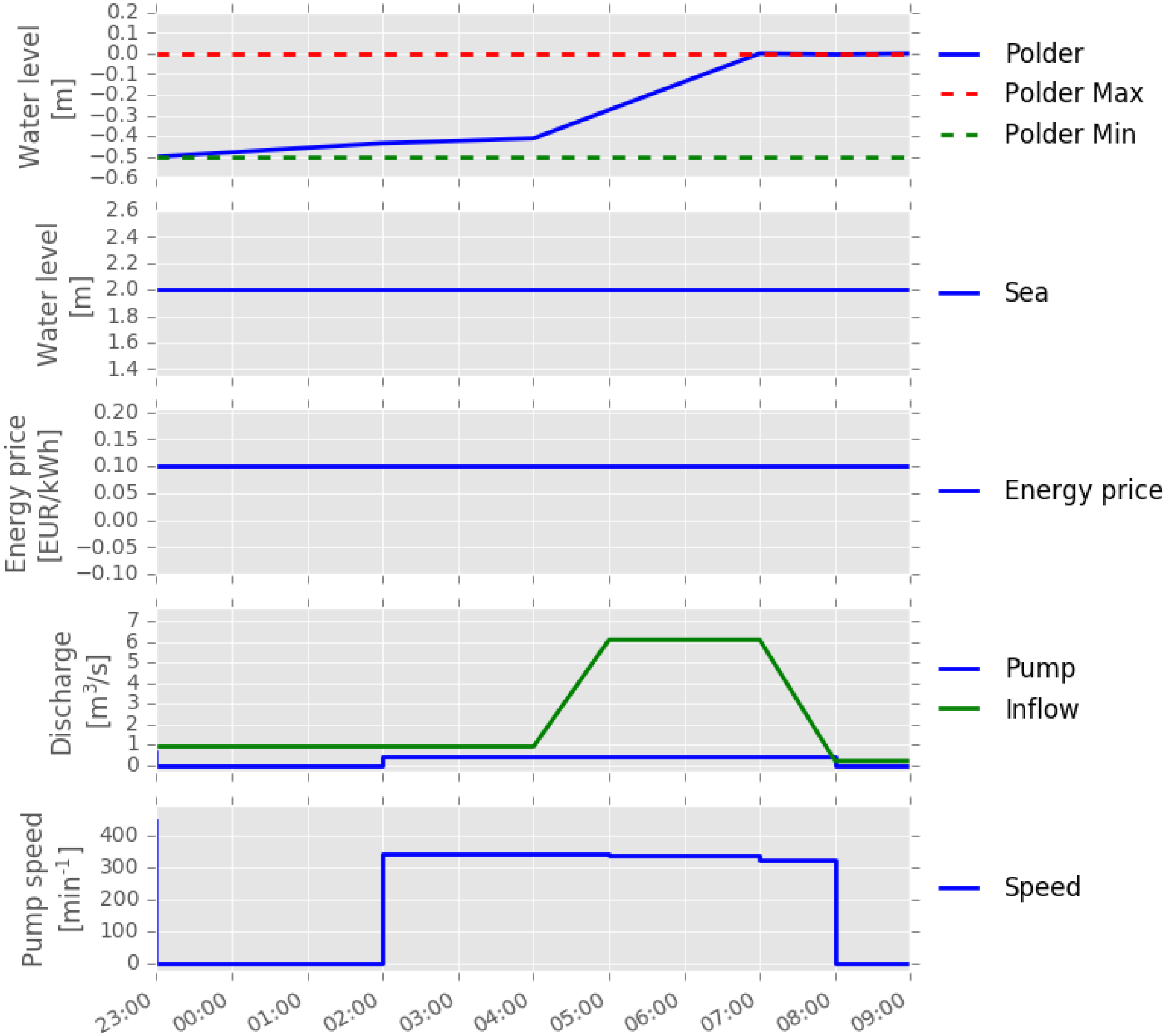
Total power = 122.38 kWh
Total money spent = €12.20



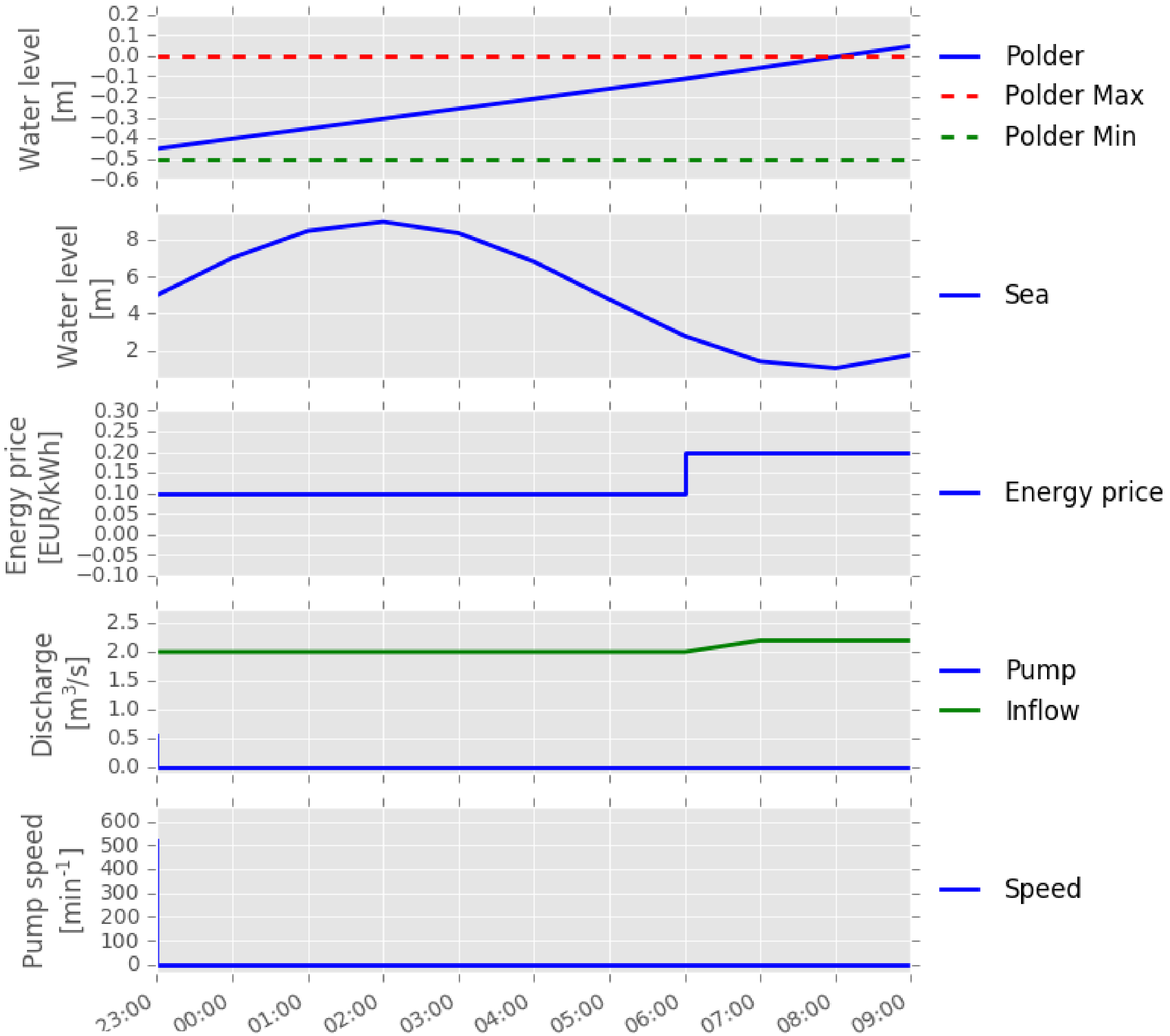
Example 2, optimization

Total power = 73.8 kWh
Total money spent = €7.40

Total saving: 40%

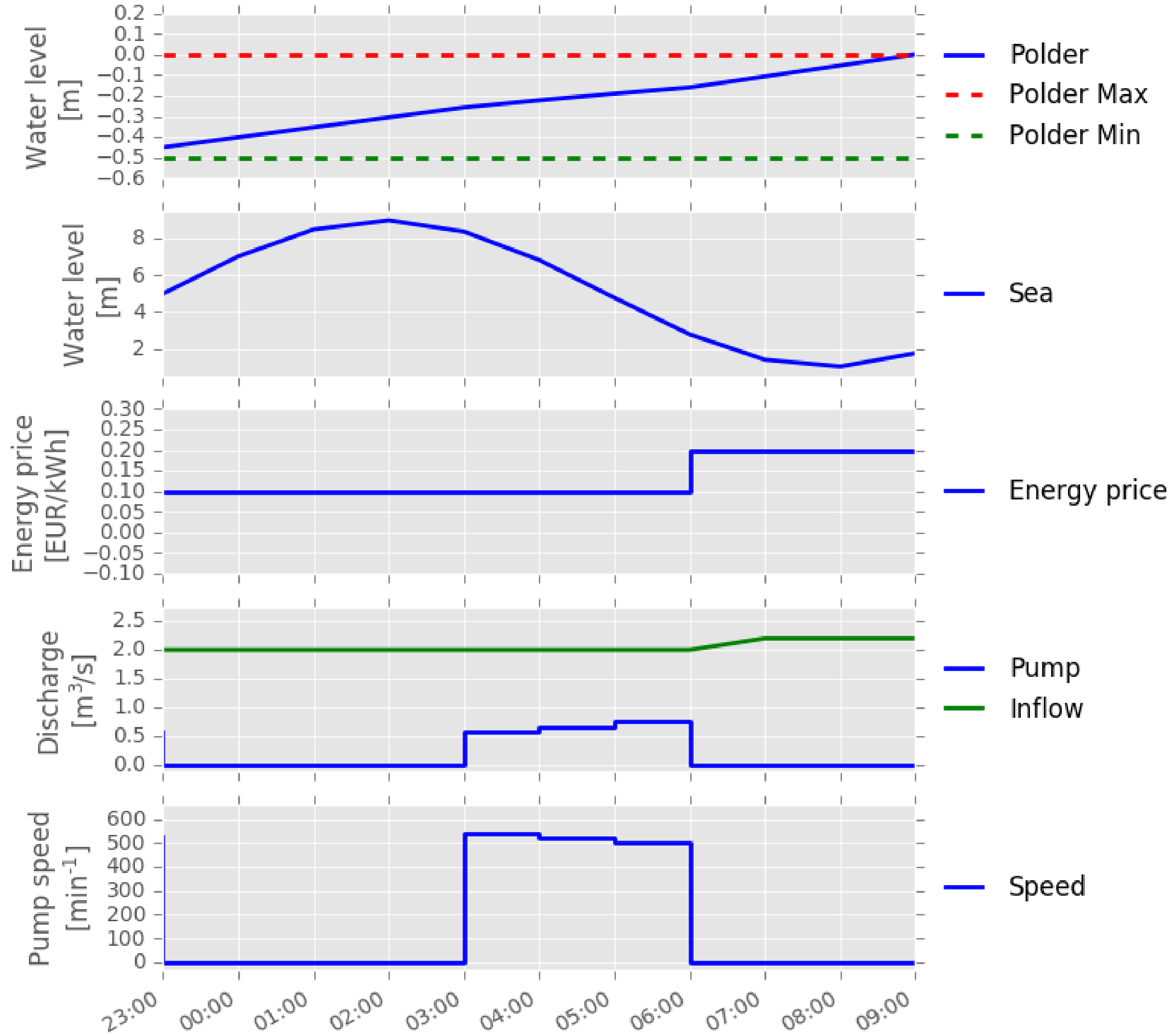


Example 3, no pumping



Example 3, “manual” operation

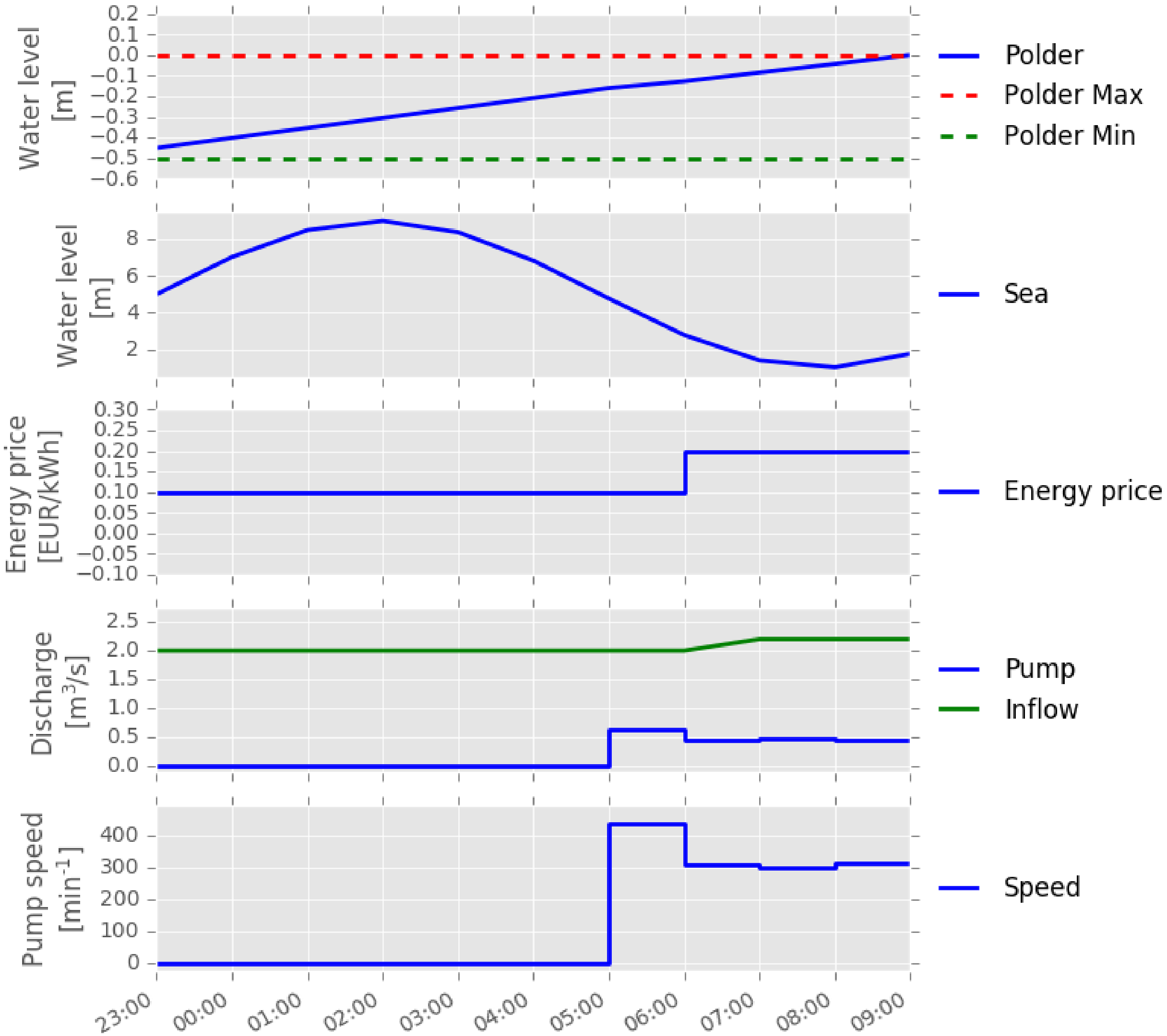
Total power = 134.4 kWh
Total money spent = €13.40



Example 3, optimization

Total power = 50.2 kWh
Total money spent = €5.00

Total saving: 63%



Future steps

2017 March

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Full development

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Improving the approximation

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2017 October

Pilot support

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