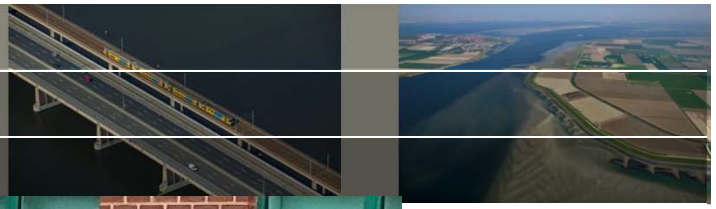
Deltares
Enabling Delta Life

Onder de motorkap van RTC Tools

Klaudia Horváth

Bart van Esch, Ivo Pothof, Tjerk Vreeken, Jorn Baayen

Introduction



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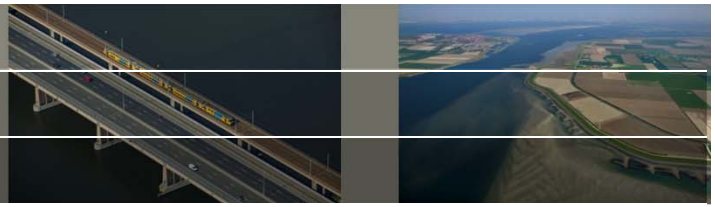
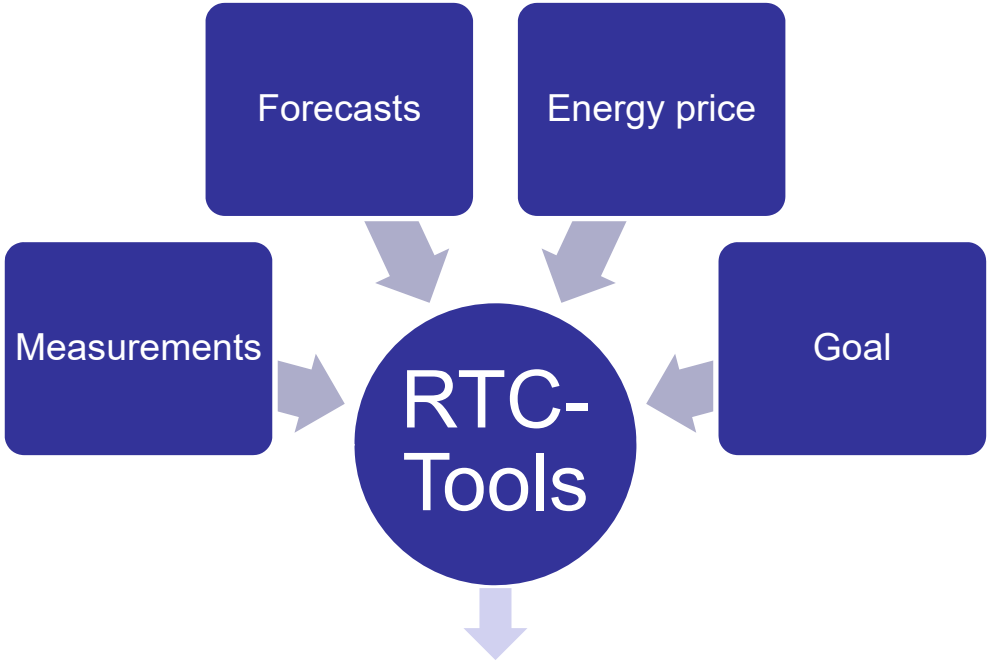
WATERSCHAP ZUIDERZEELAND UW WATERSCHAP

Deltares

RTC-Tools




Forecasts
Energy price
Measurements
RTC-Tools
Goal
Pump, weir and gate settings

How does it work, why does it work?

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22 maart 2019

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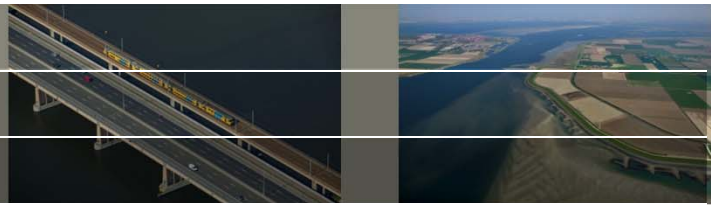
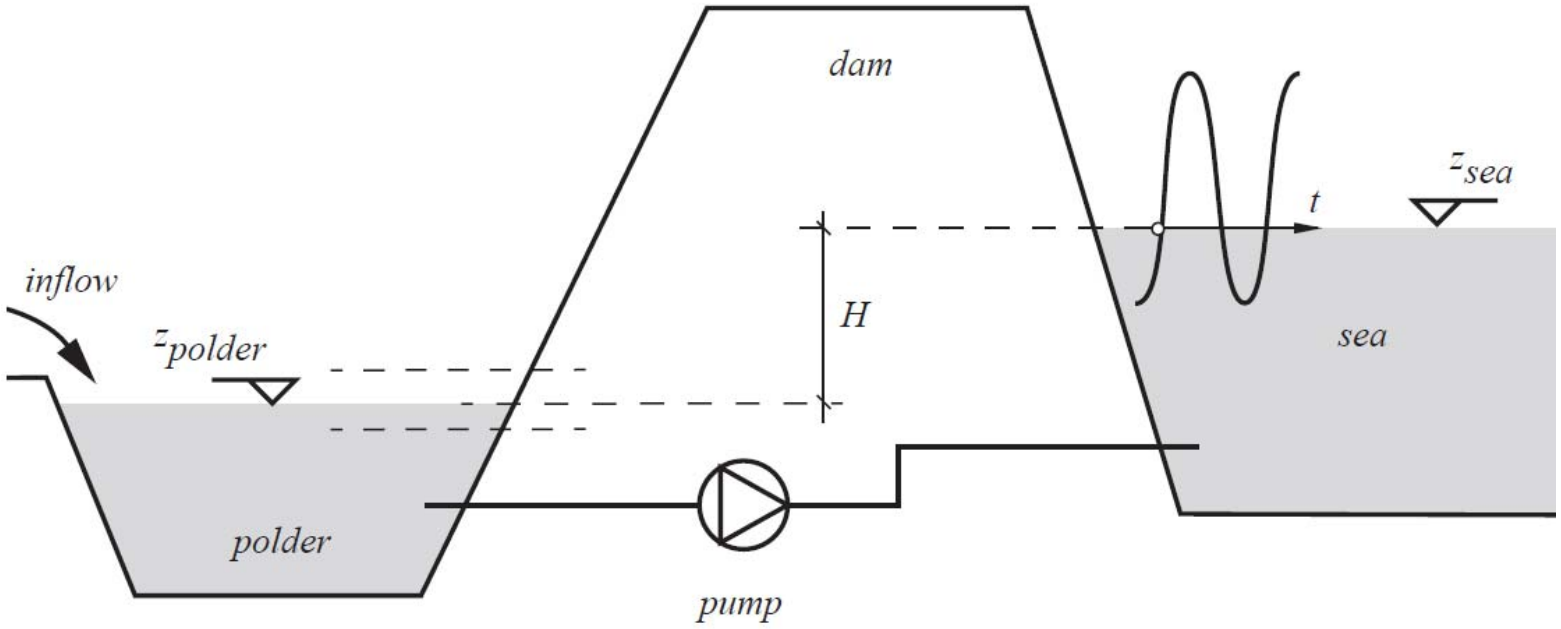
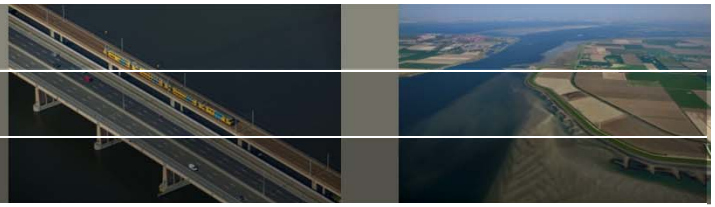
Deltares

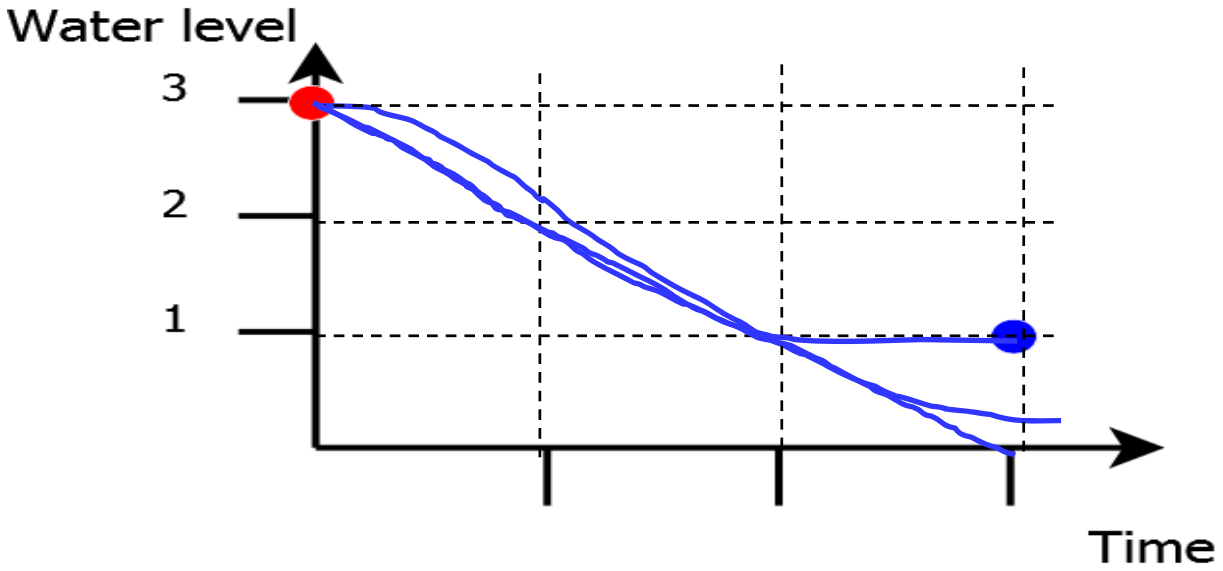
Example

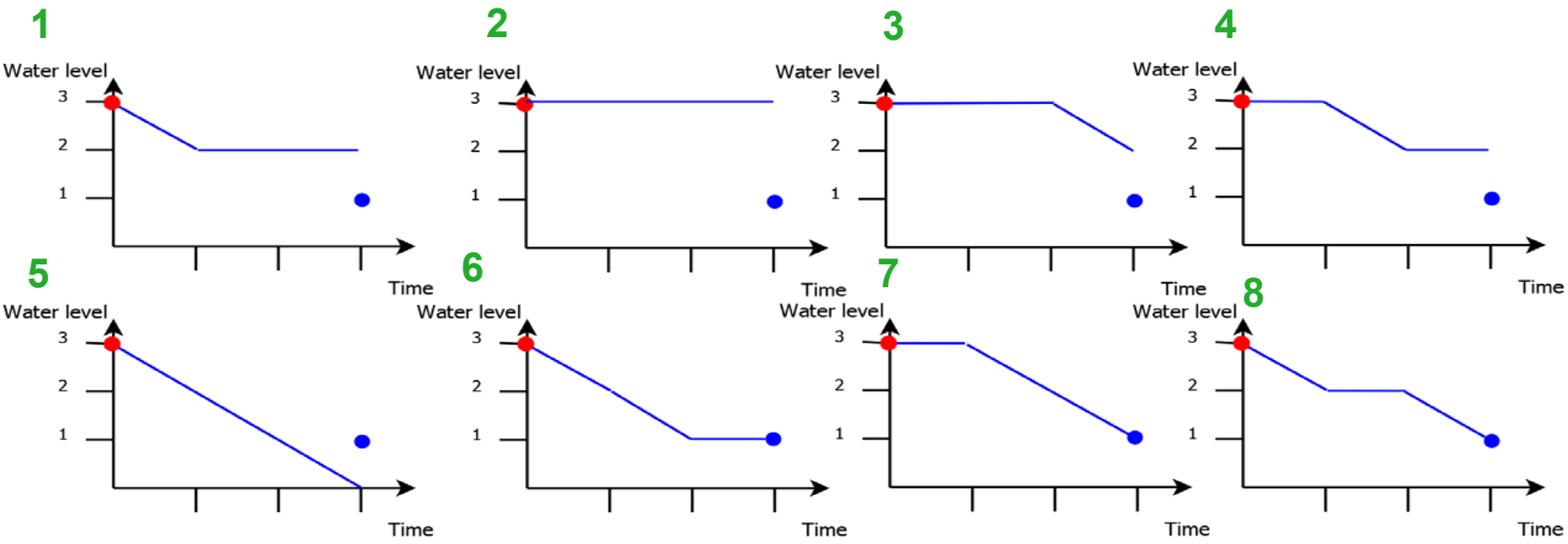




Example



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Water level
3
2
1
Time
2
Water level
3
2
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3
Water level
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3
2
1
Time
5
Water level
3
2
1
Time
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8
Water level
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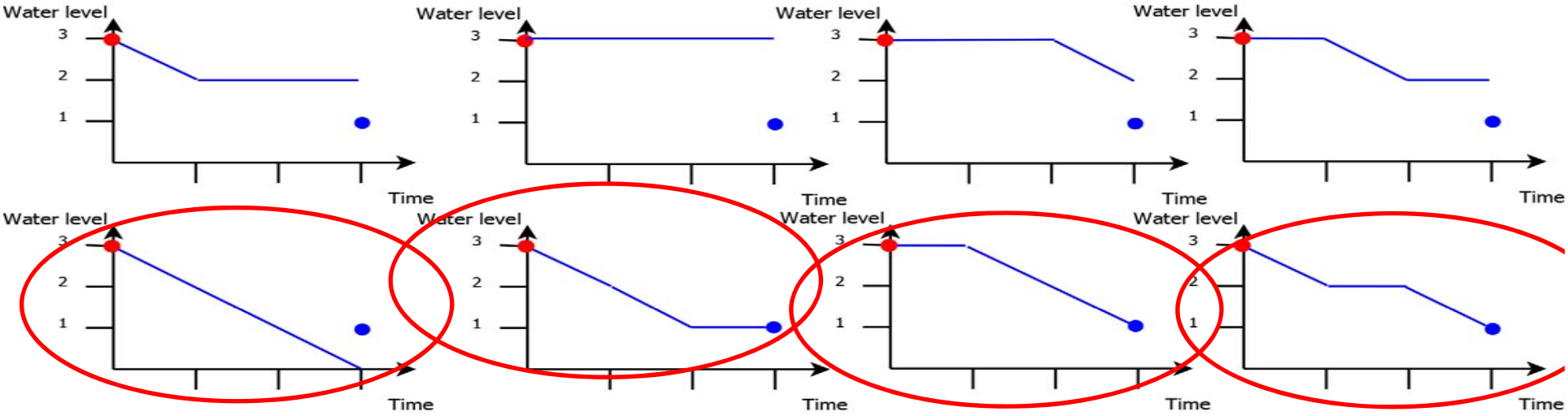
1
Time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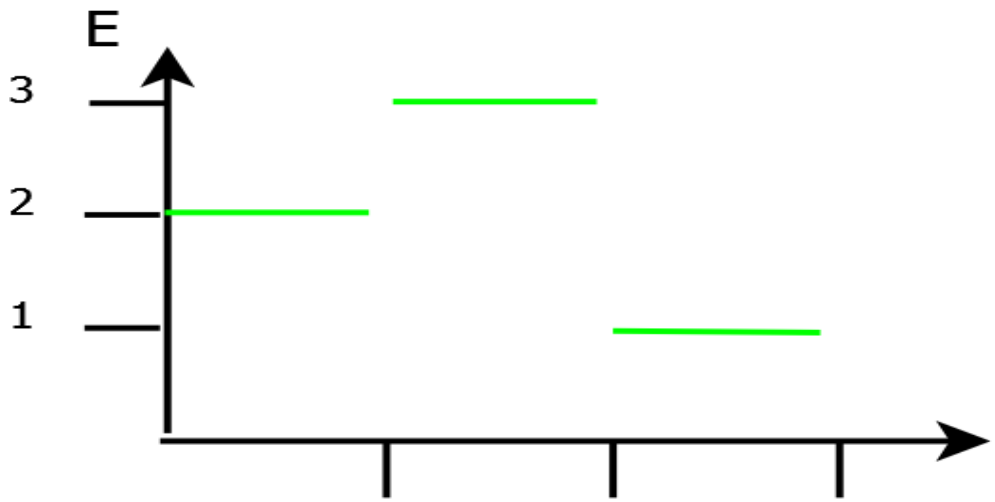
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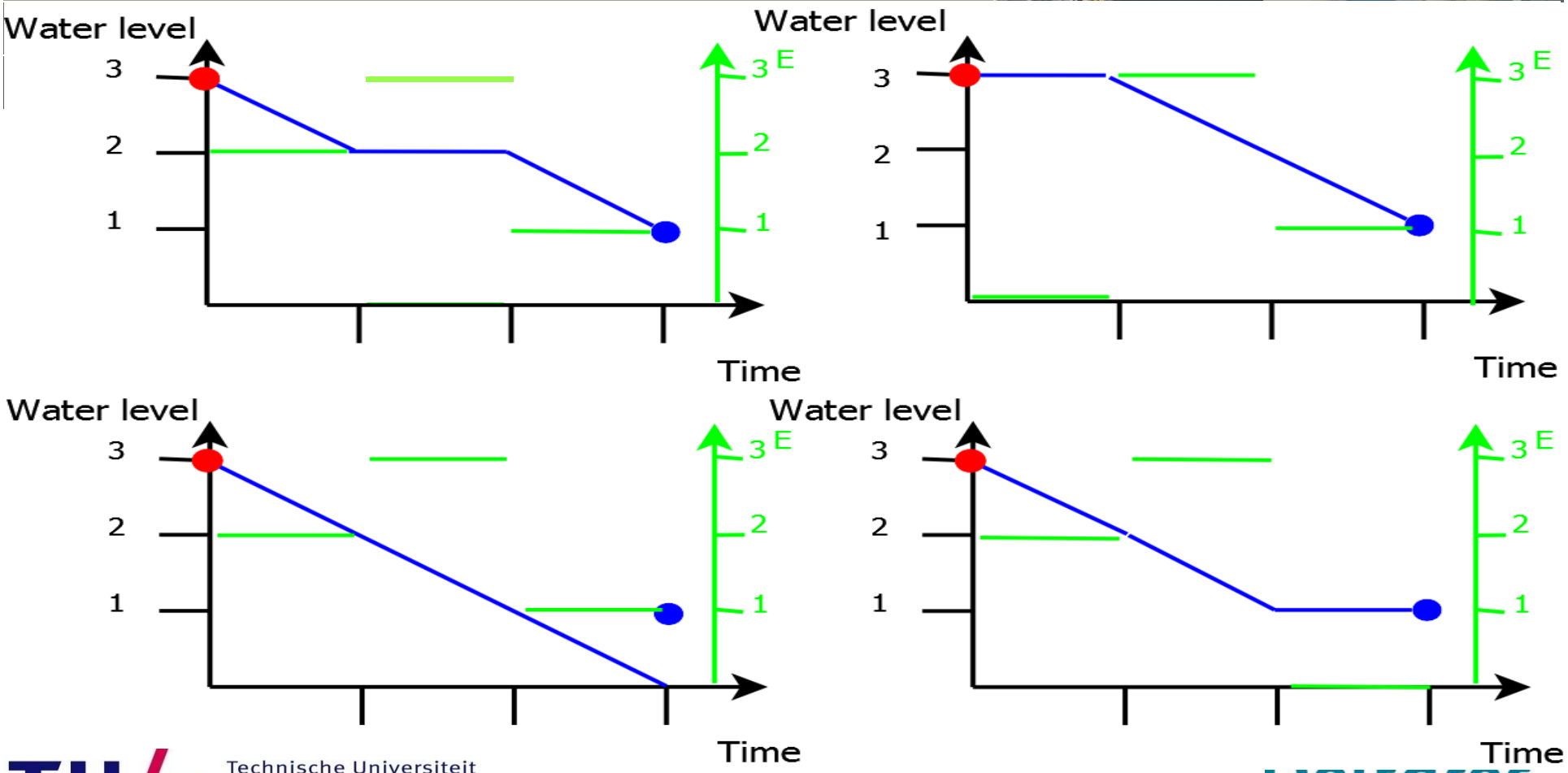
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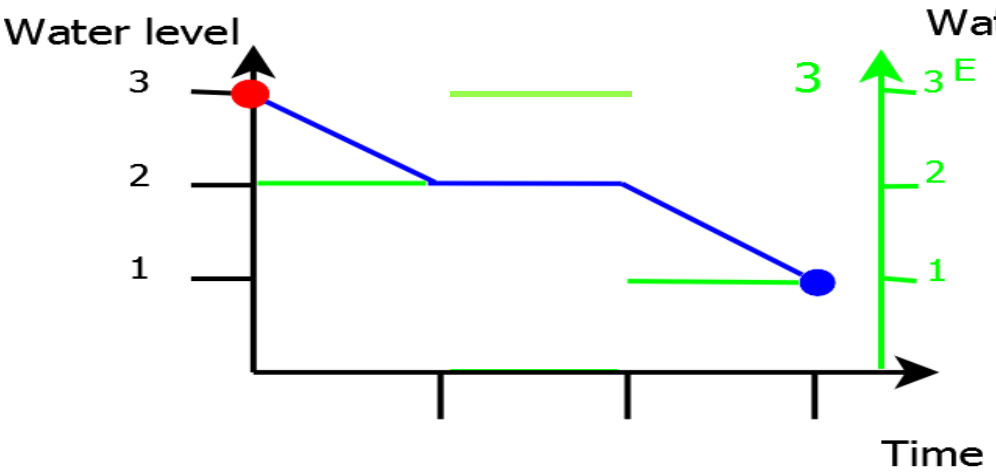
Time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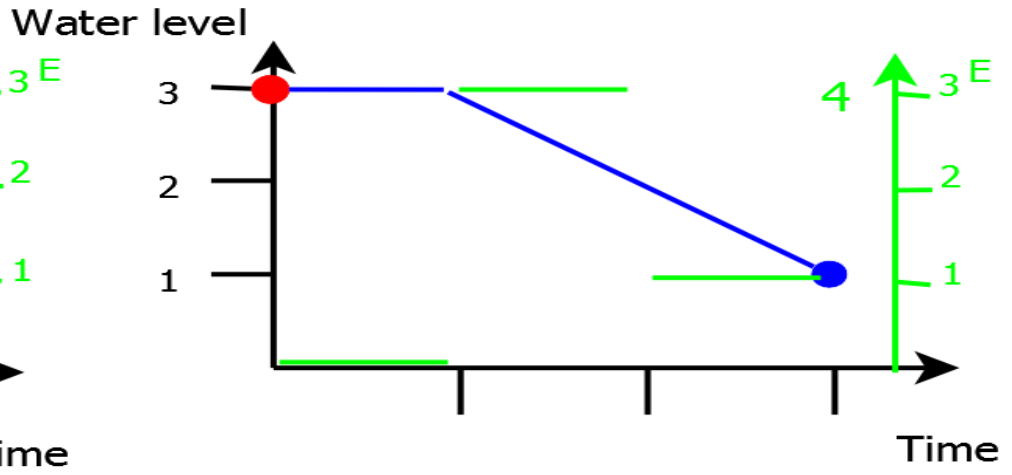
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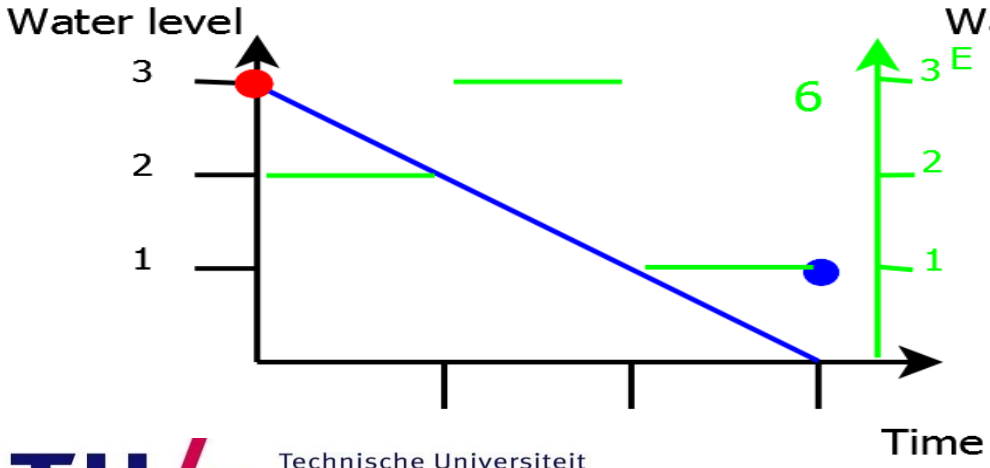
2
1
Time


Water level
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6
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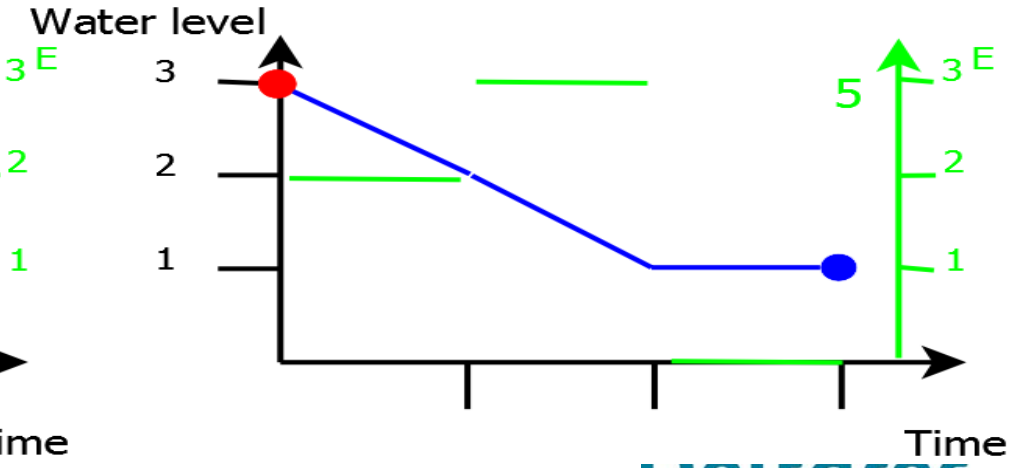
2
1
Time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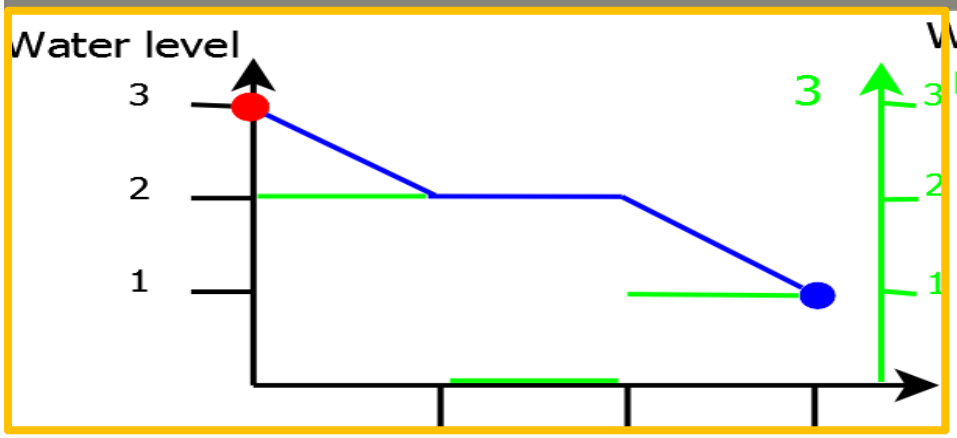
Time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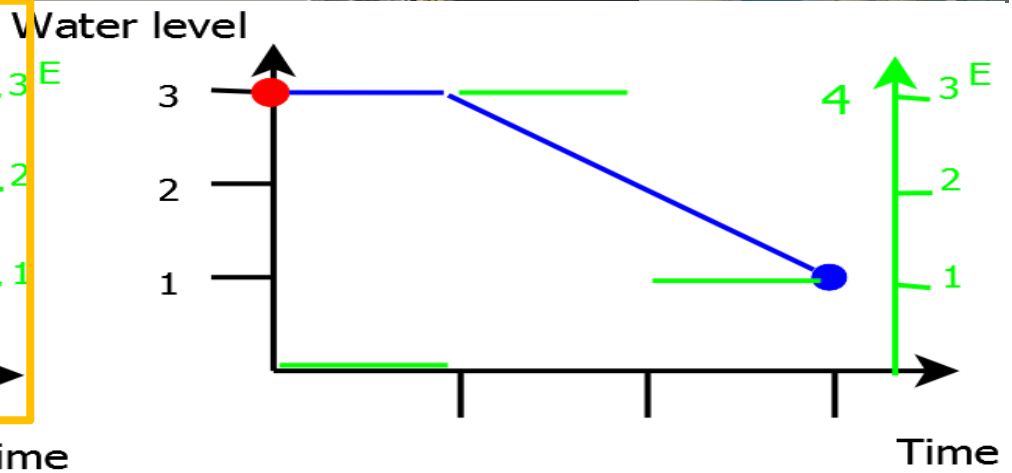
Time


Water level
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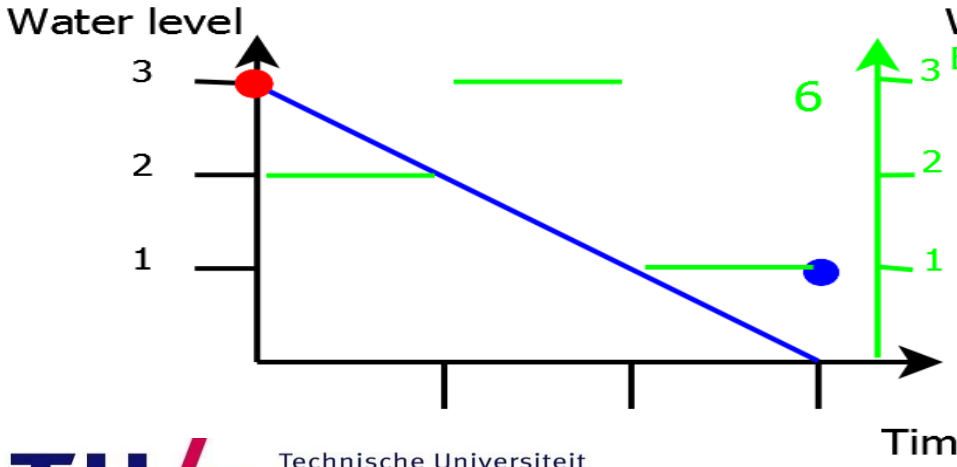
Time


Water level
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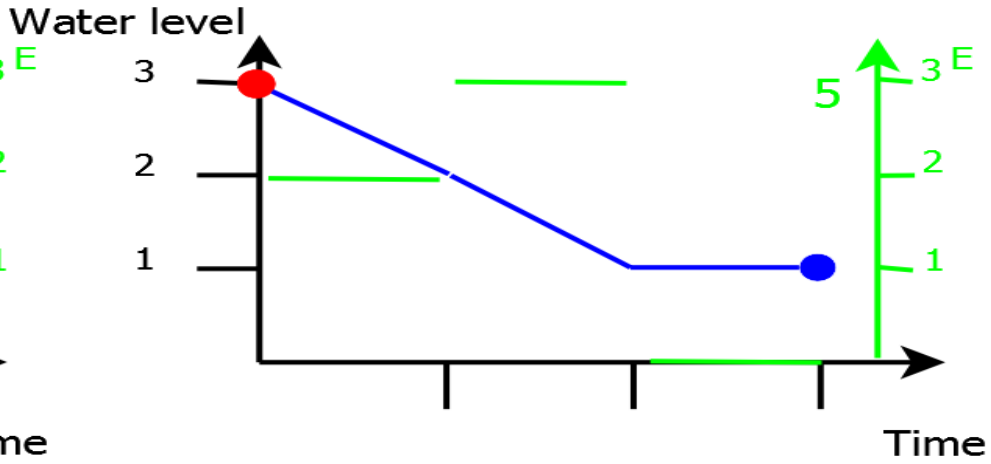
1
Time


Water level
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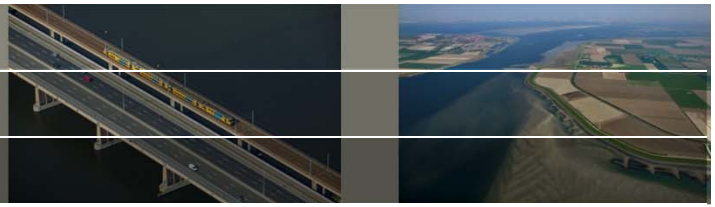
3 E
2
1
Time

Possibilities



$2^{24} \approx 1.7 * 10^{7}$

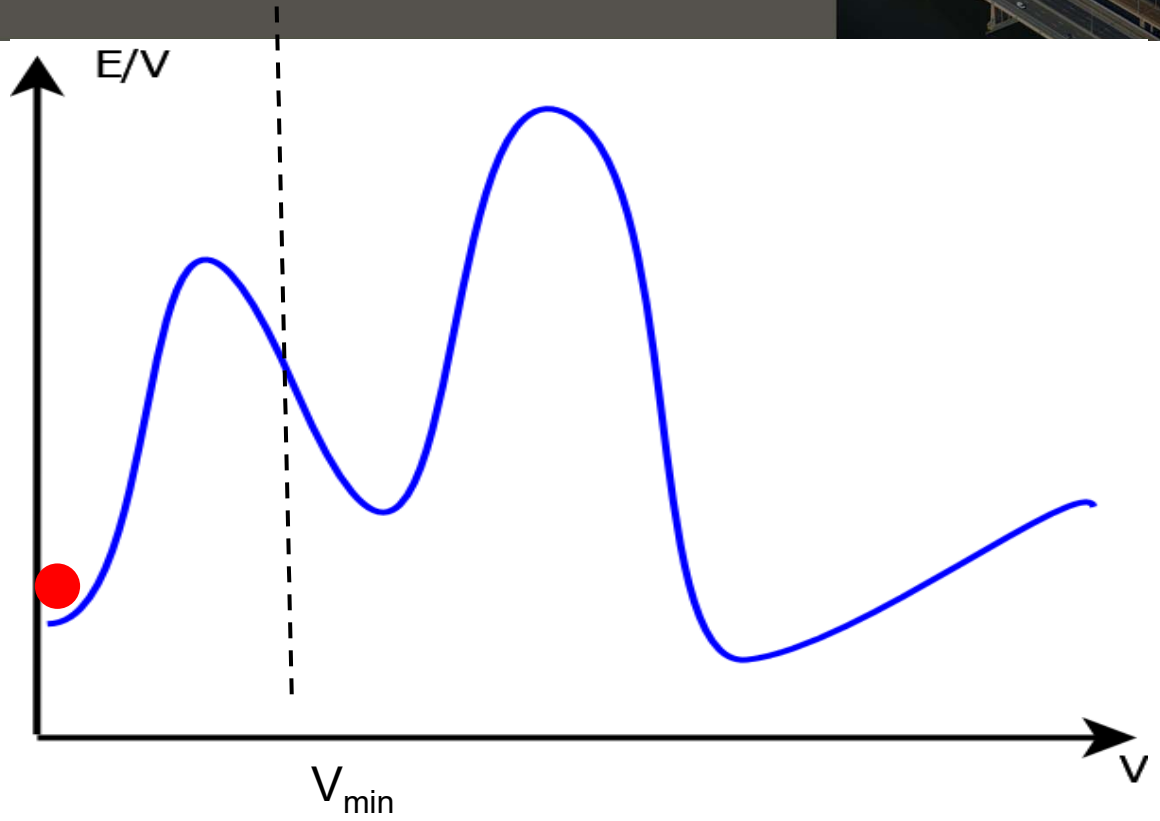
3 pumps, no interaction

$$\left(2^{24}\right)^{3} \approx 5 * 10^{21}$$

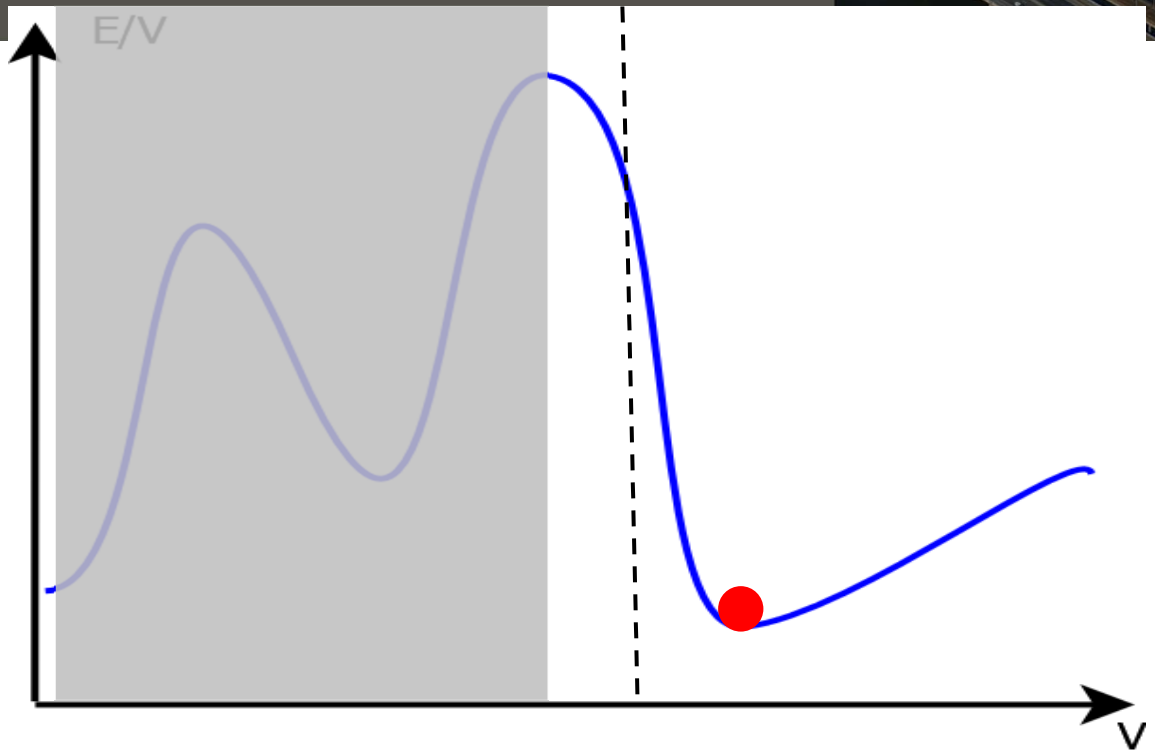
5000 trillion

$1.5 * 10^{14}$ years: 100 billion years, 100 000 000 million years

Energy used for pumping per volume water

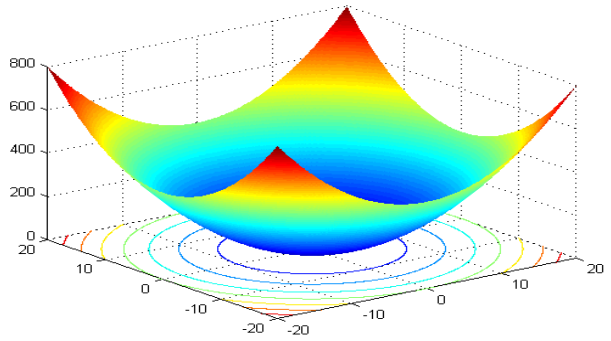


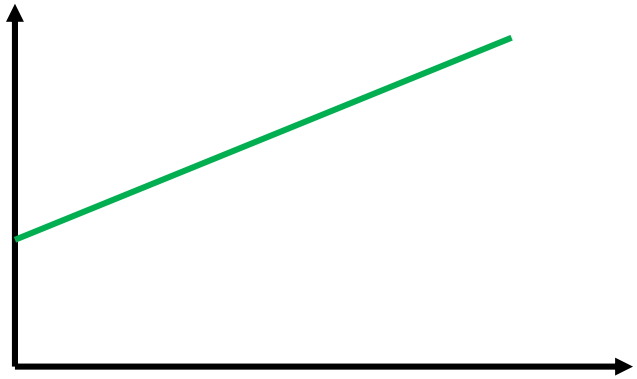
Convexity



V_{min}

Convex functions





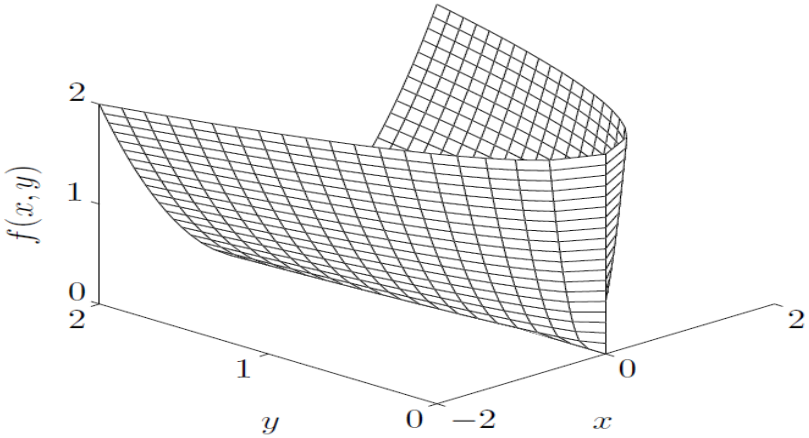
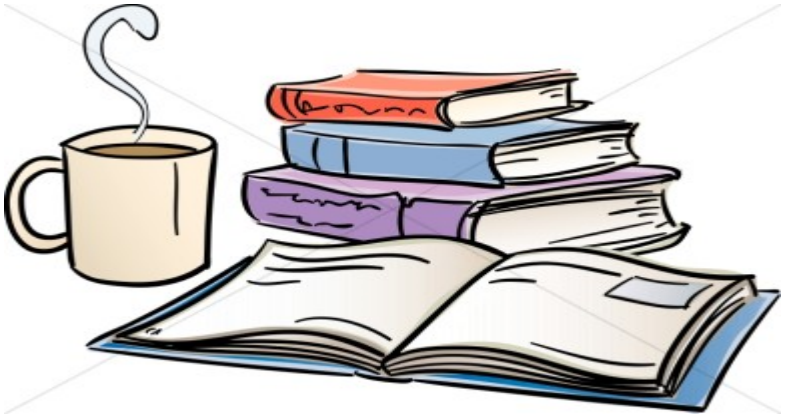
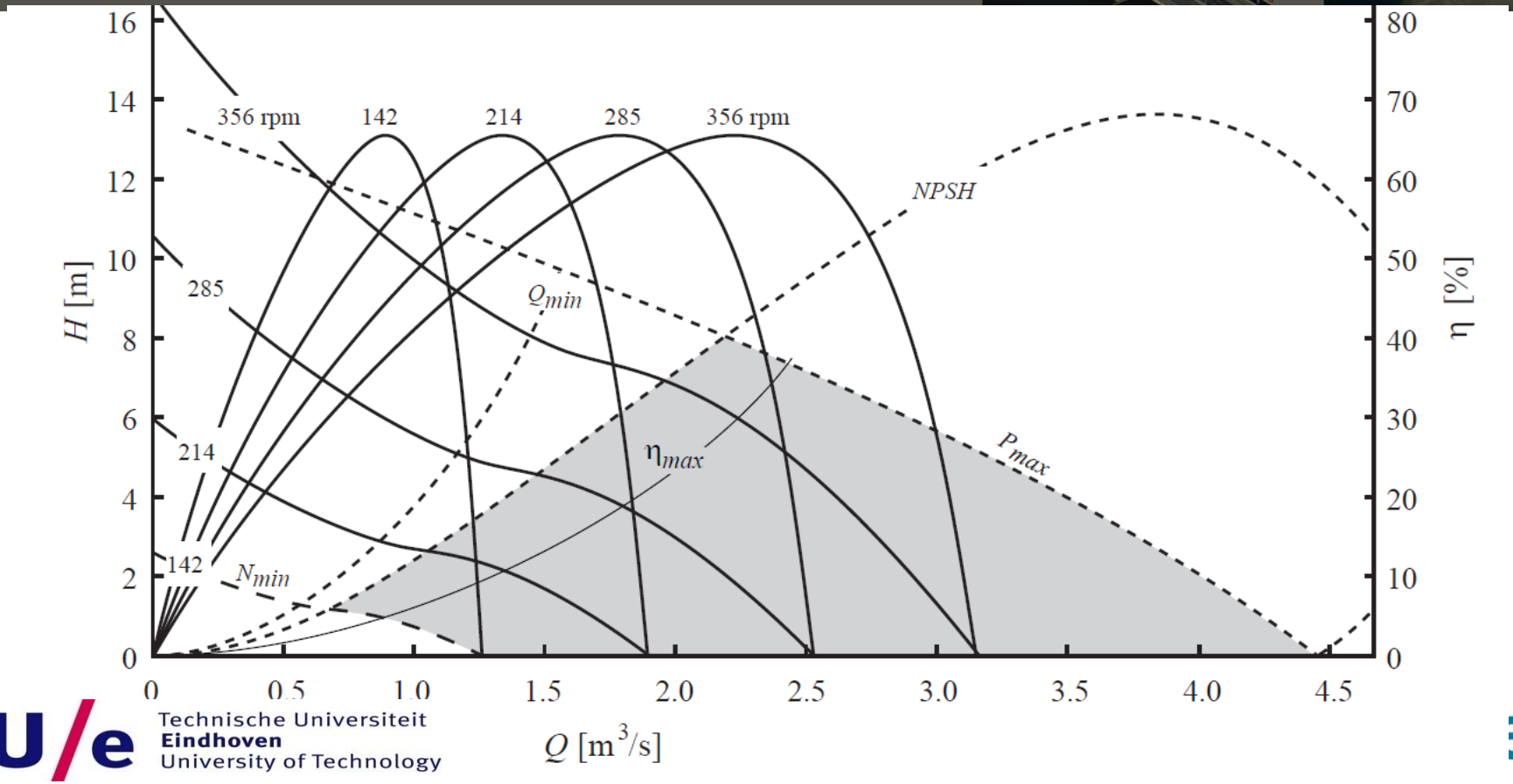


Figure 3.3 Graph of $f(x, y) = x^2/y$.

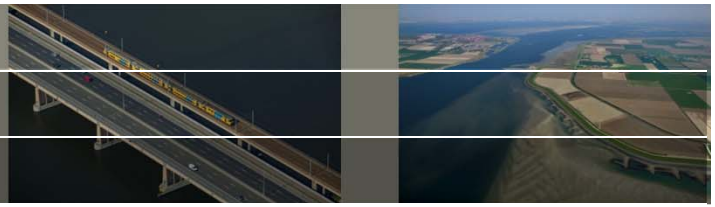
Convexity

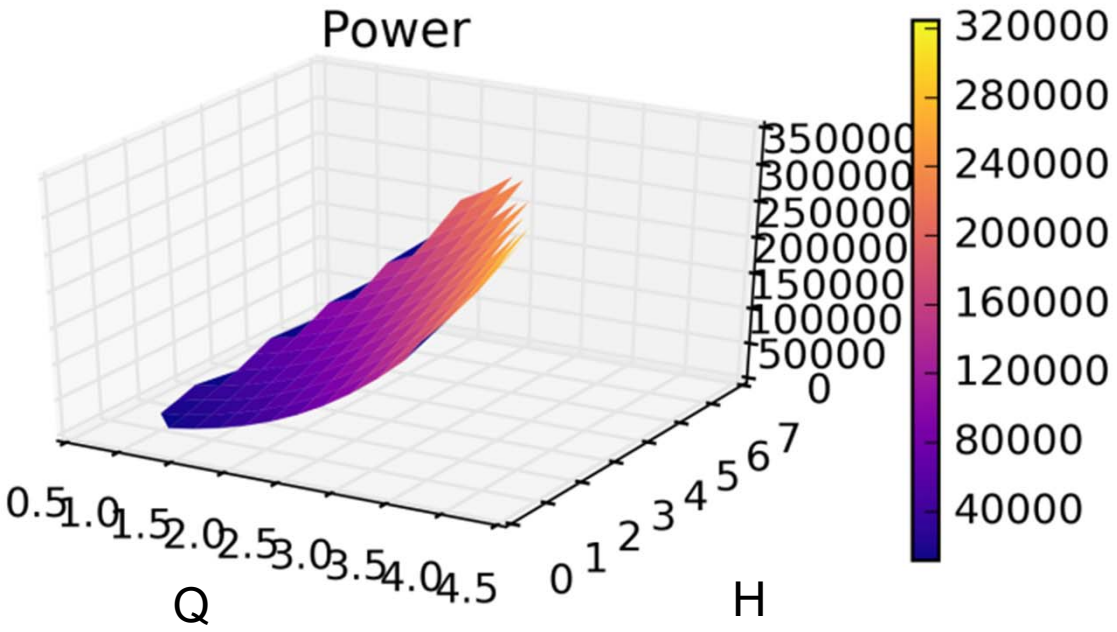


Characteristic curves of a pump

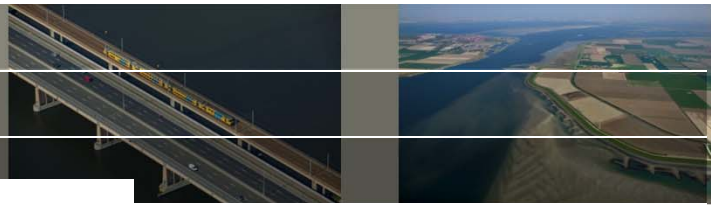


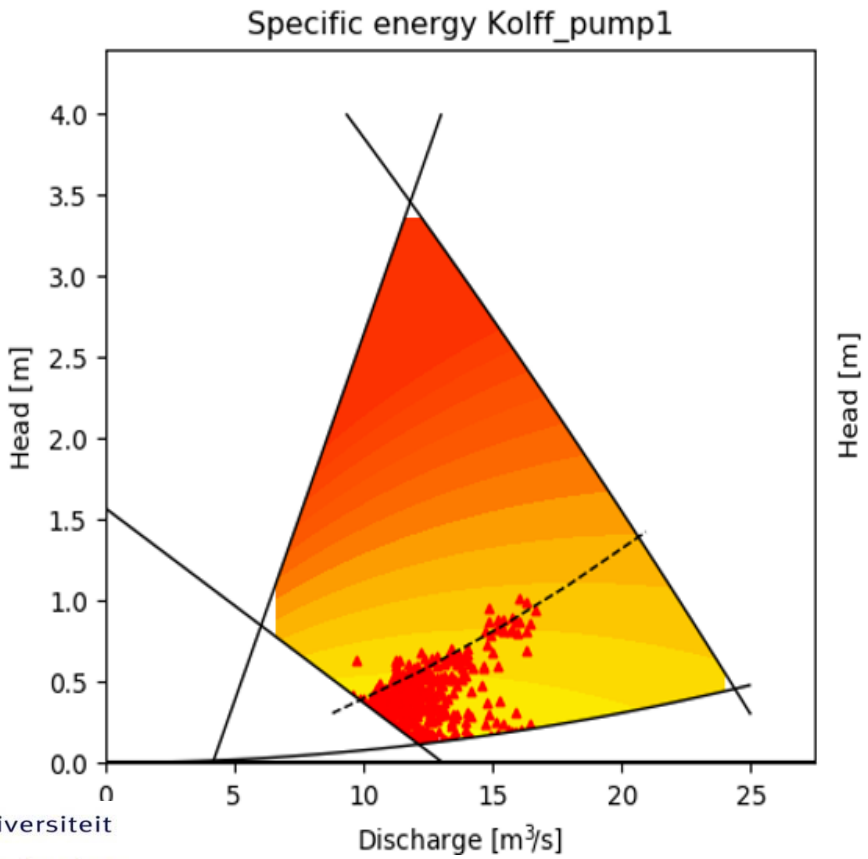
Power of a pump



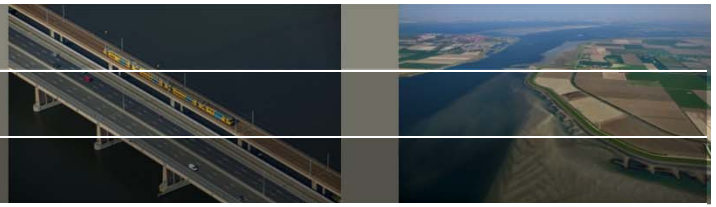


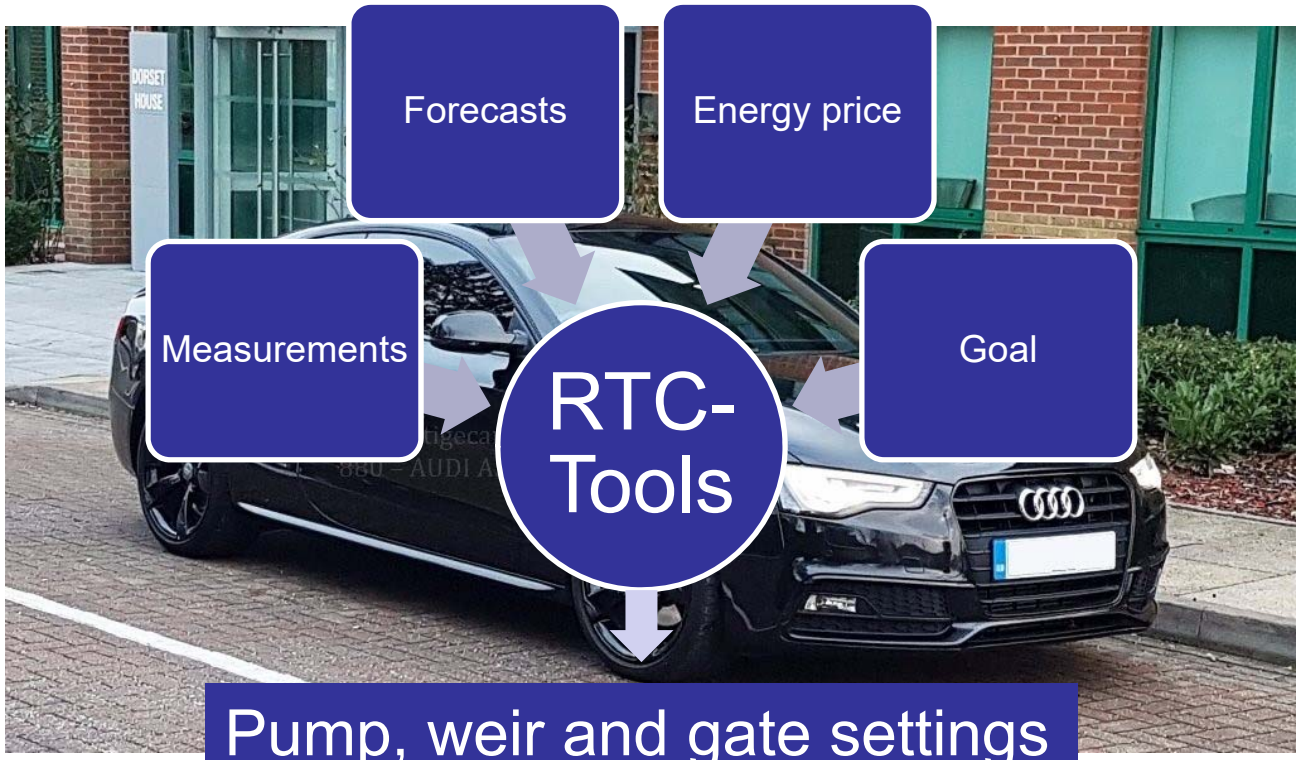
Working points of a pump





Take-home message





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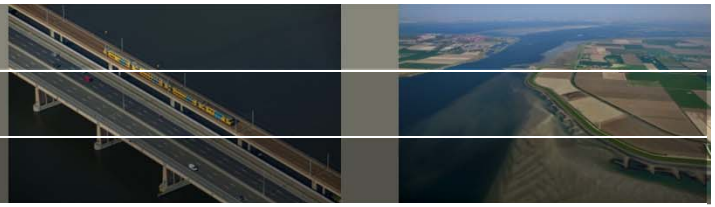
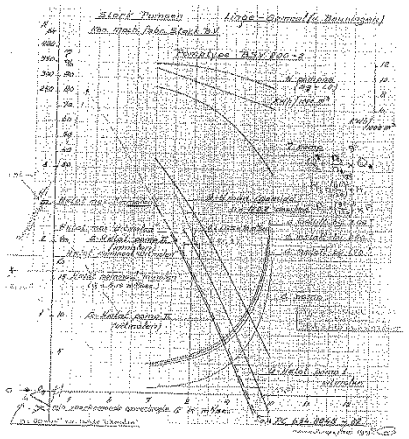
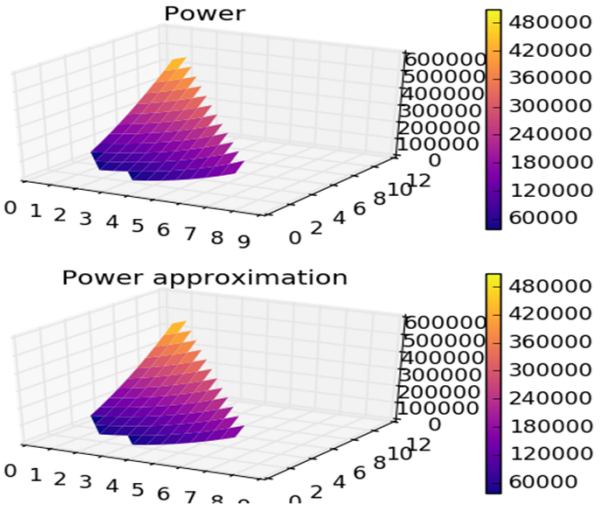
Klaudia.Horvath@deltares.nl

Convex pump modelling I

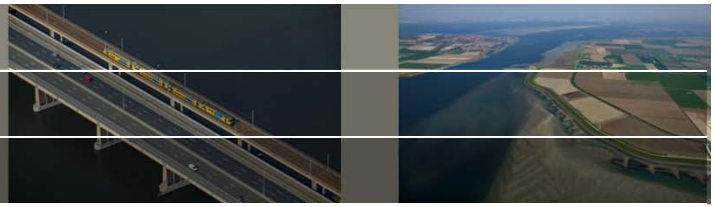


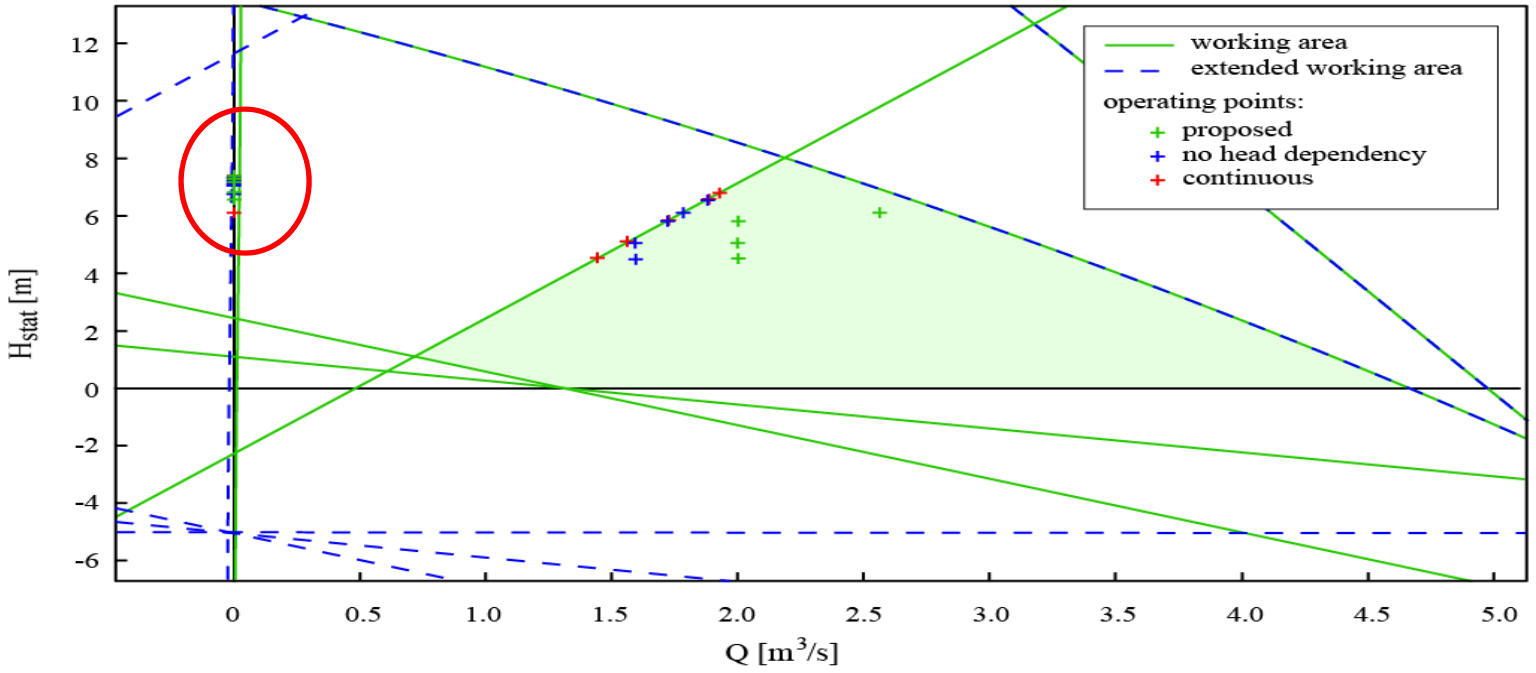




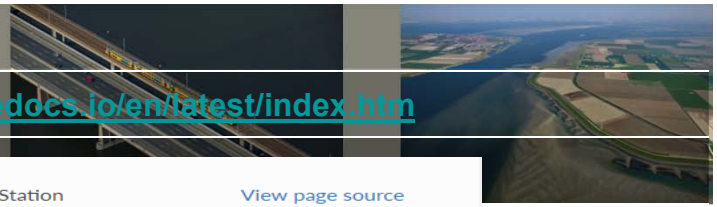
https://www.crompton.co.in/centrifugal-monoset-pumps/

Turning the pump off





Documentation http://rtc-tools.hydraulic-structures.readthedocs.io/en/latest/index.htm



RTC-Tools Hydraulic Structures
stable

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Basic Pumping Station

Note

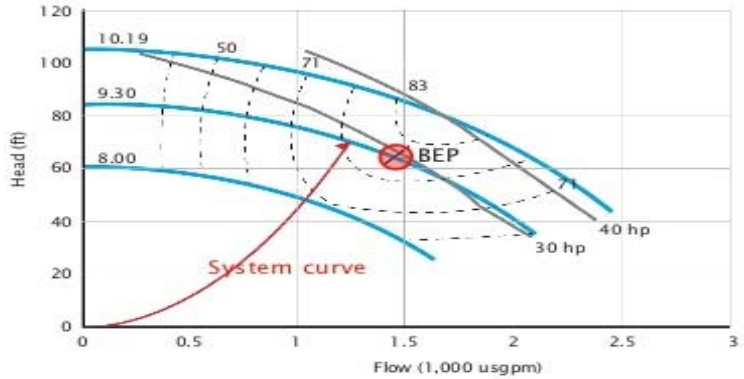
This example focuses on how to implement optimization for pumping stations in RTC-Tools using the Hydraulic Structures library. It assumes basic exposure to RTC-Tools. If you are a first-time user of RTC-Tools, please refer to the RTC-Tools documentation.

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)
10.19
50
71
83
9.30
8.00
BEP
40 hp
30 hp
System curve
0
0.5
1
1.5
2
2.5
3
Flow (1,000 usgpm)