The CP Shortcut: Solving the High-Power Pump Activation Problem without the Overkill

CP2026

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Plant setup

UCLouvain

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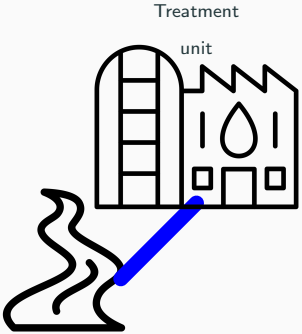

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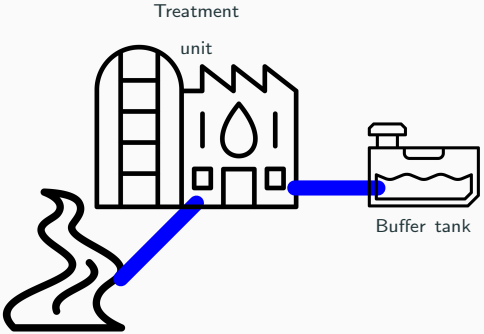

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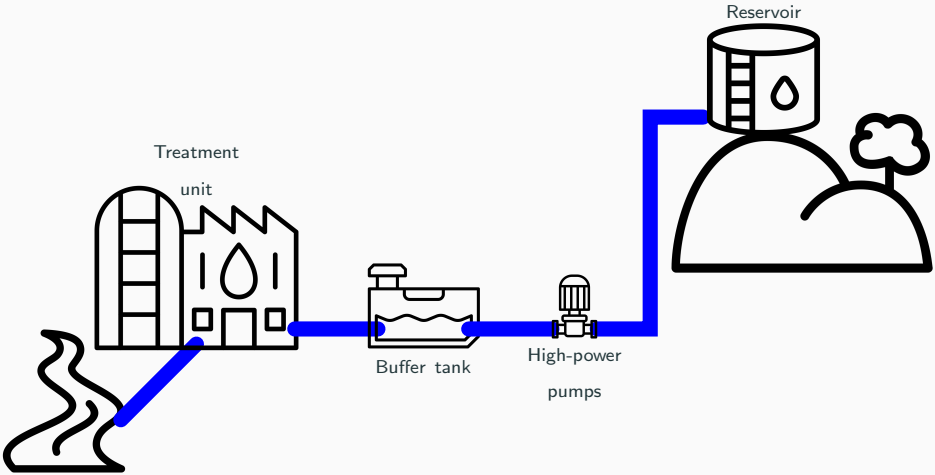

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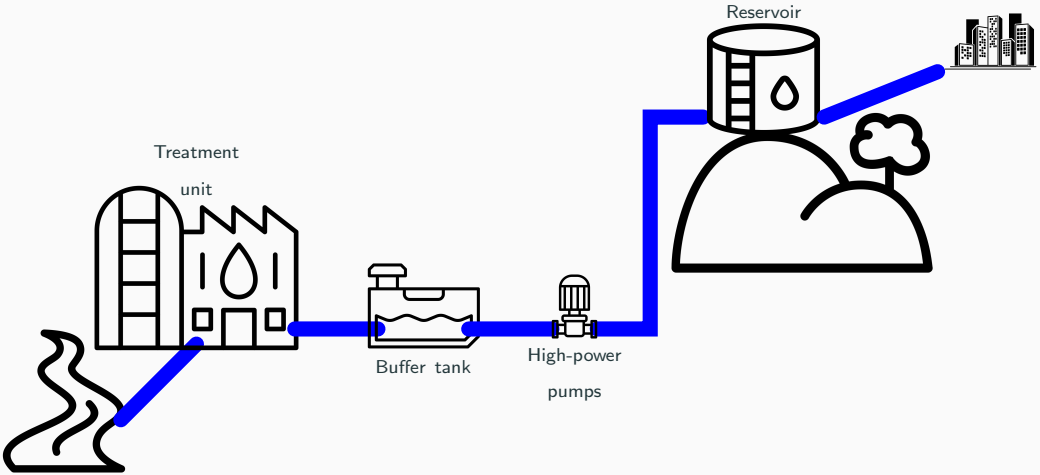

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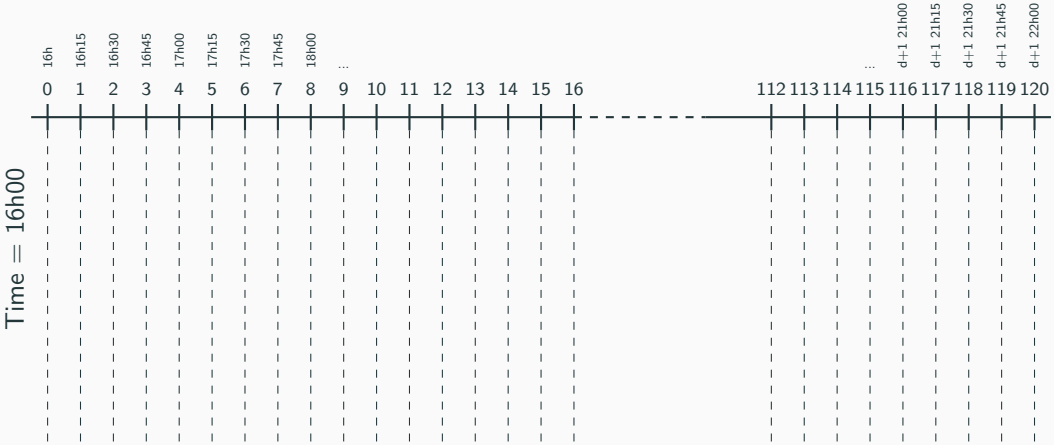

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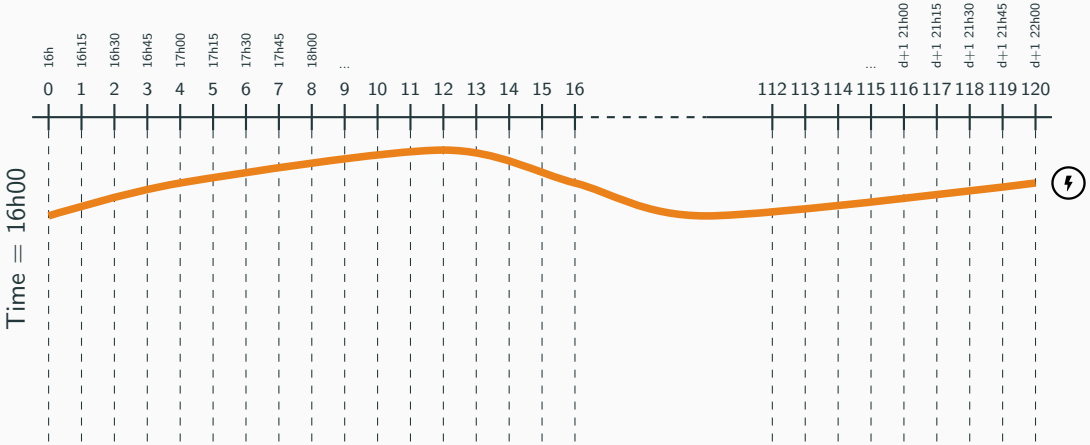

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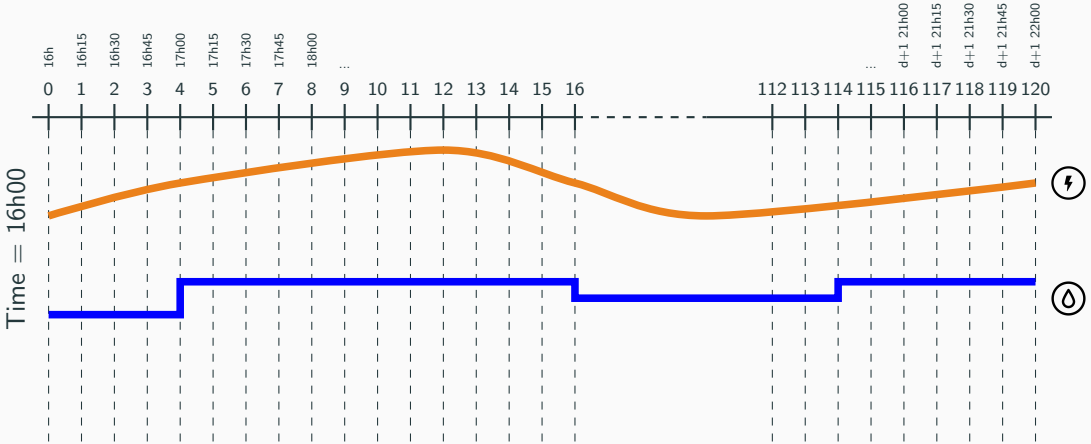

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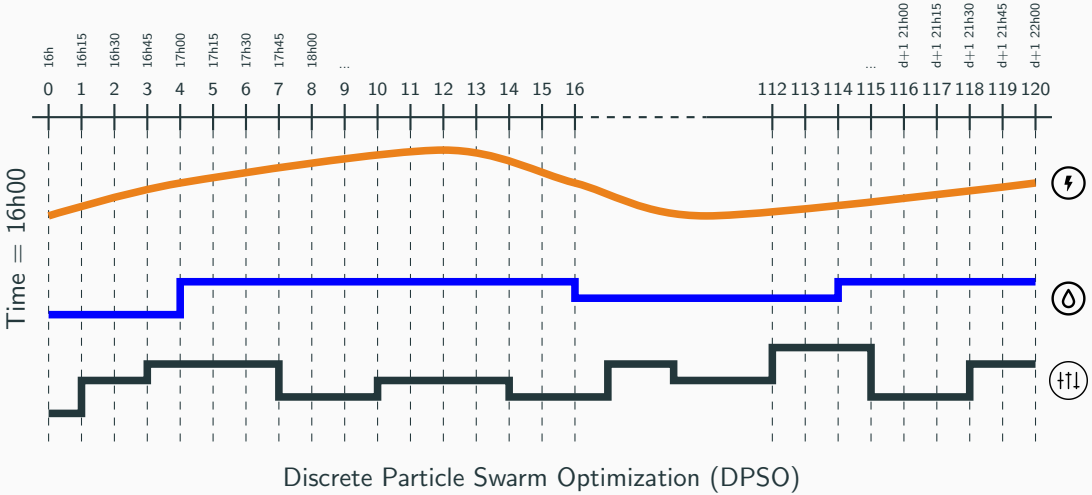

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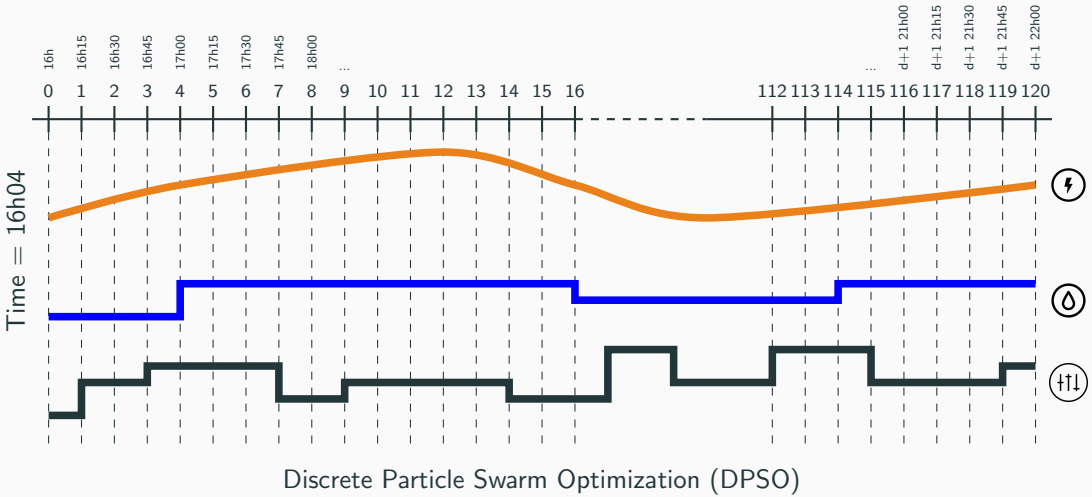

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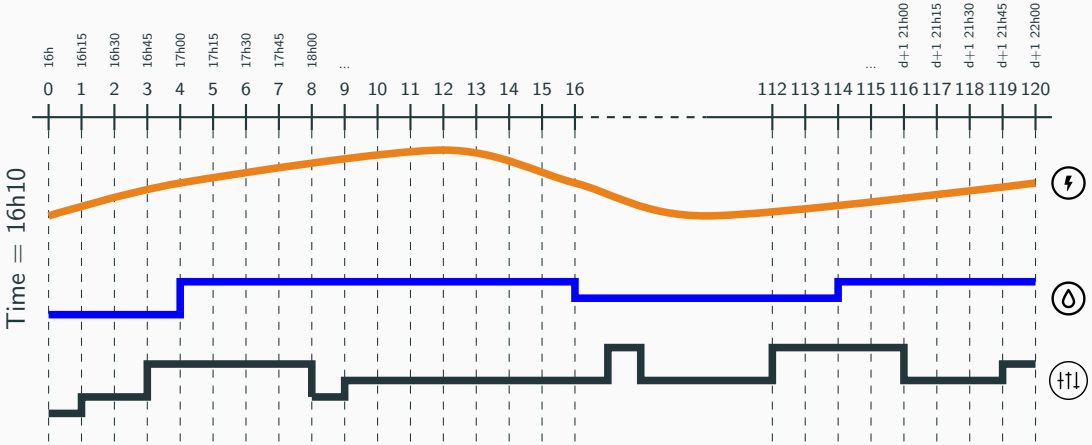

Discrete Particle Swarm Optimization (DPSO)

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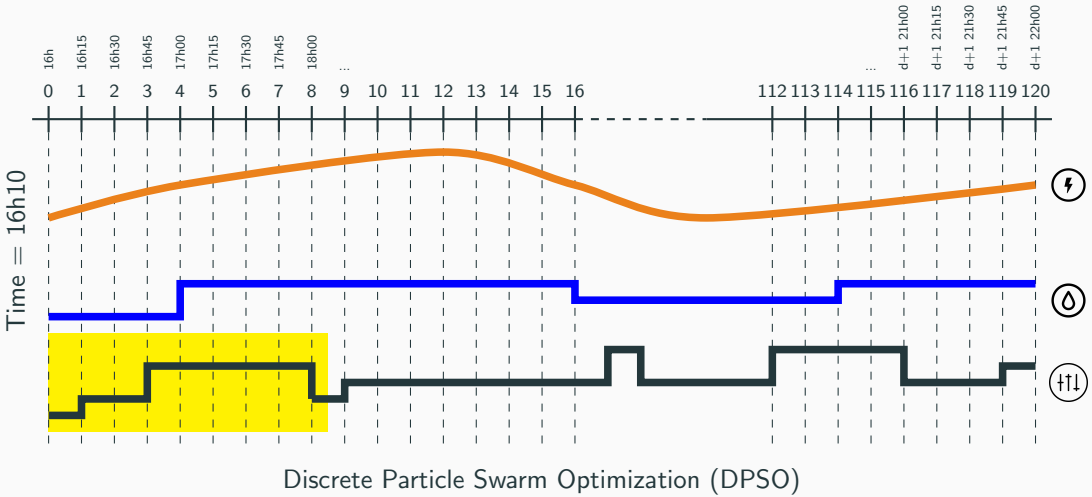

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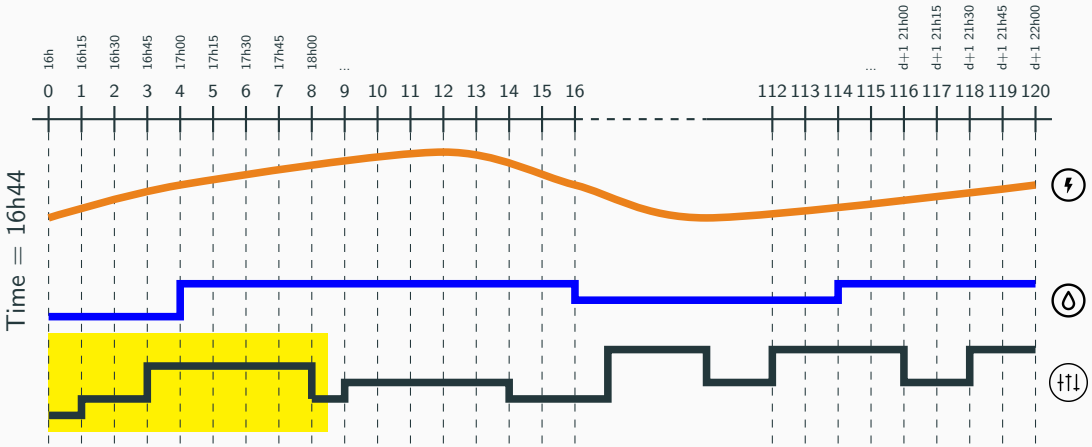

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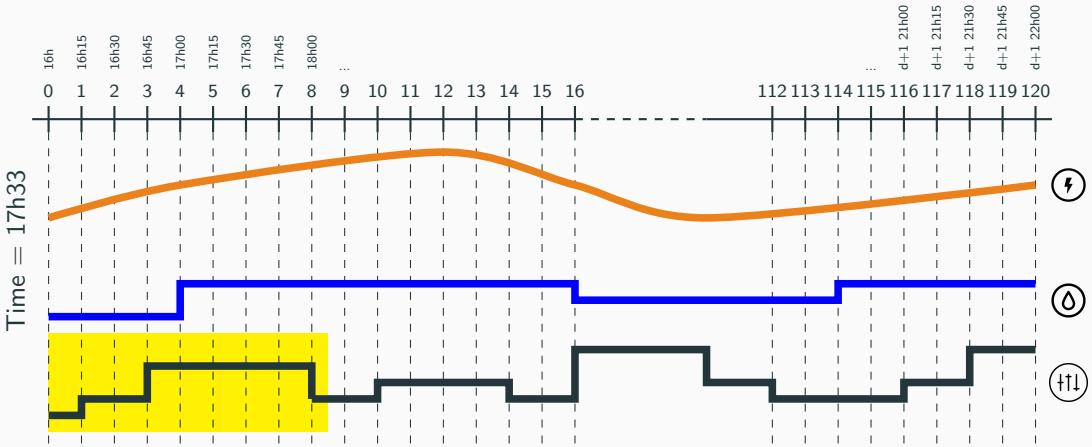

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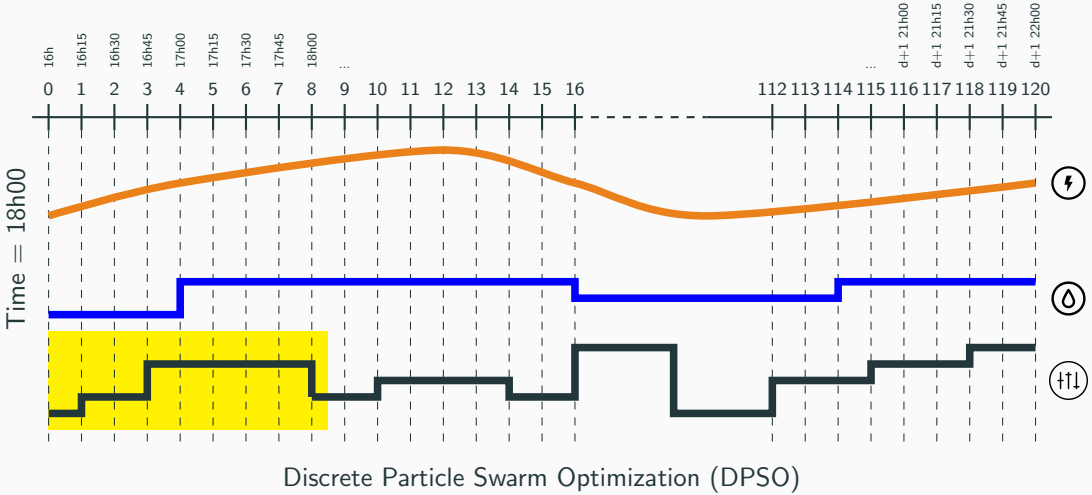

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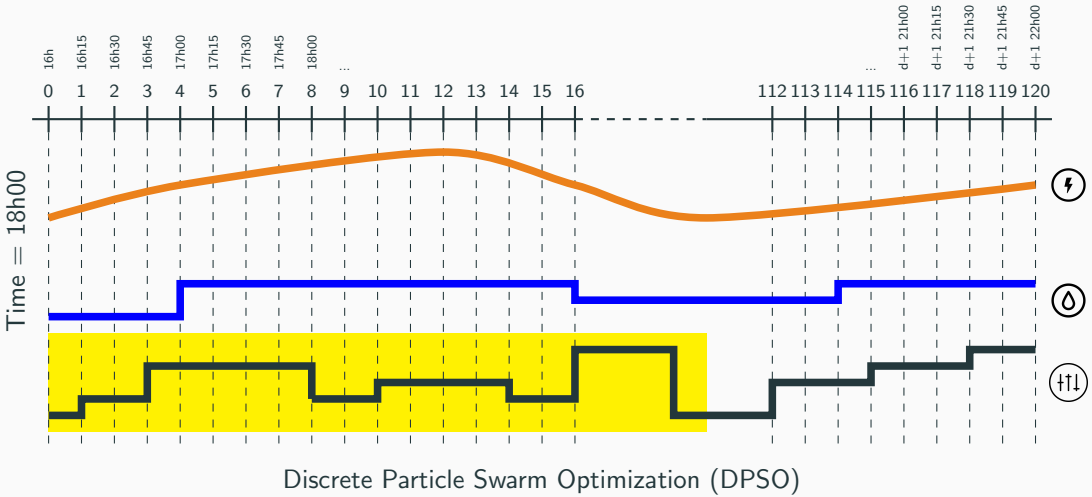

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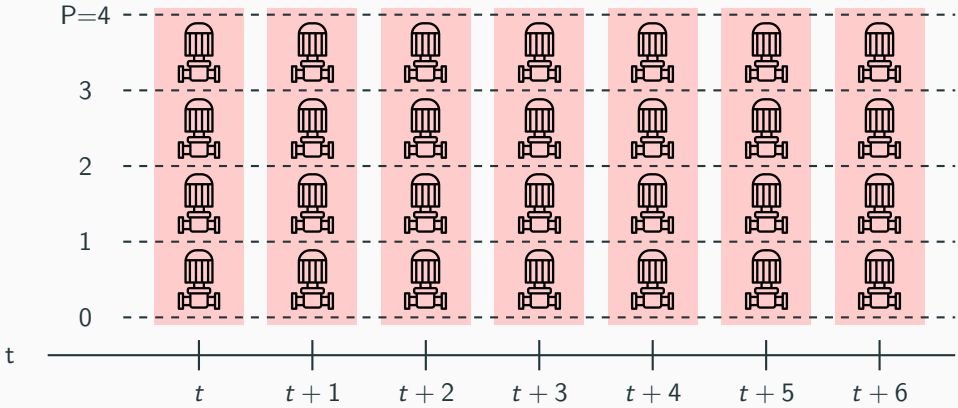
- Computation on 40h to avoid full tank effect, and take in account already trend of the next day (less precise predictions)

CP Model: Pumps



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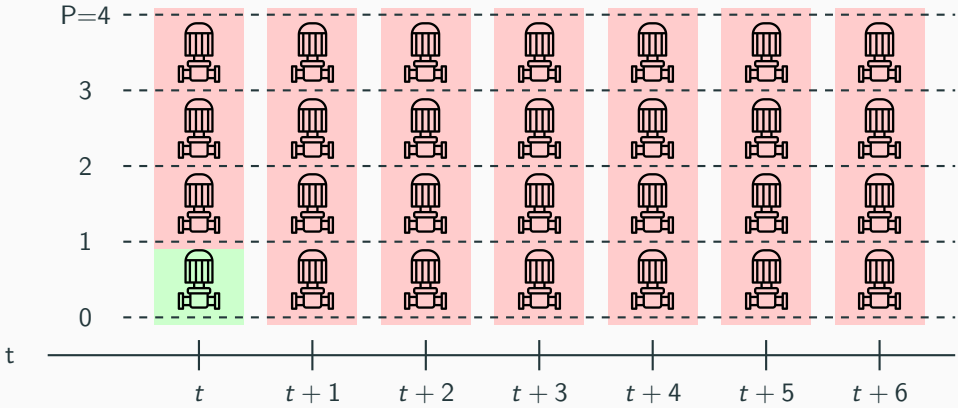

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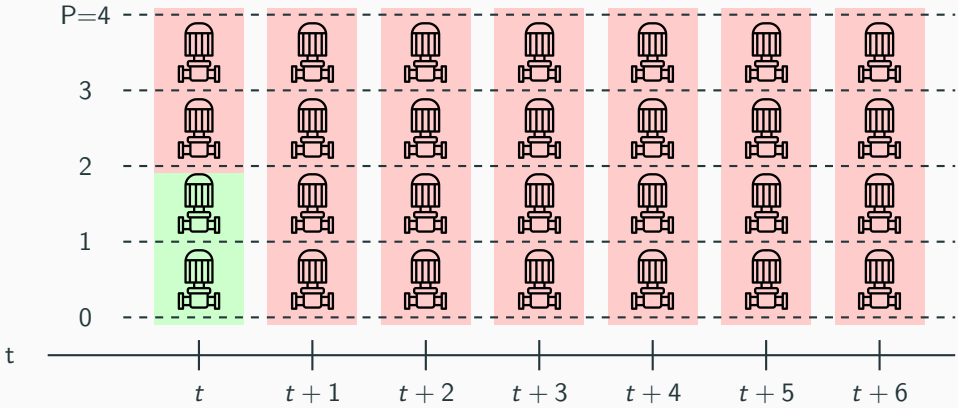

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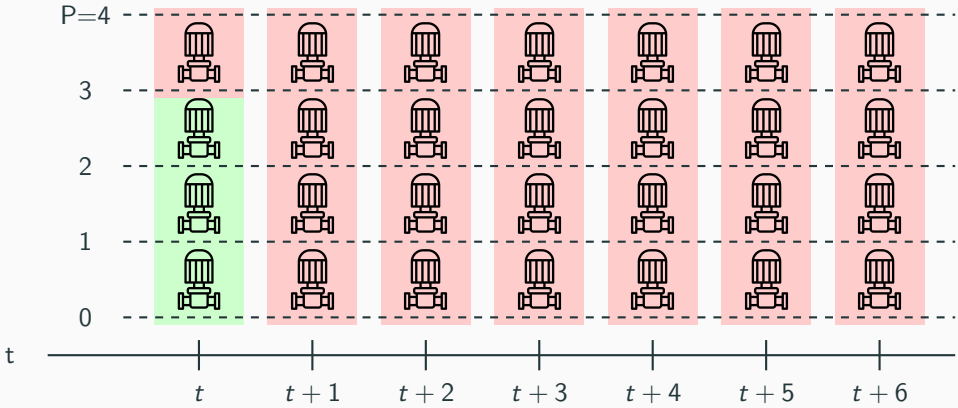

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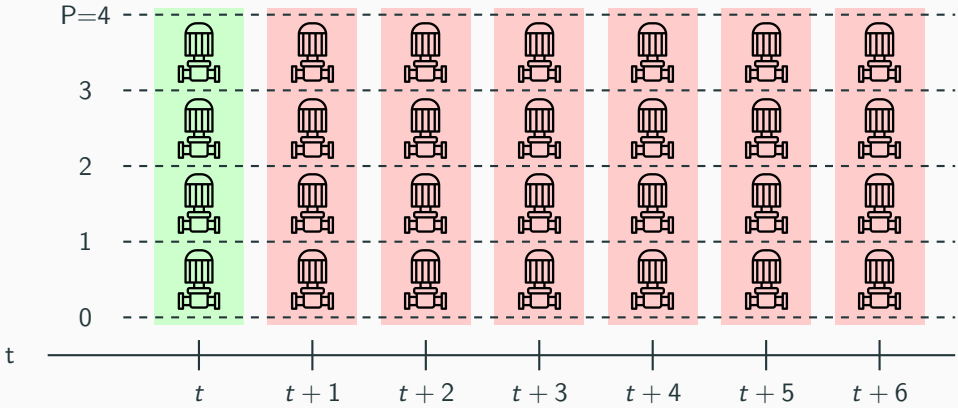

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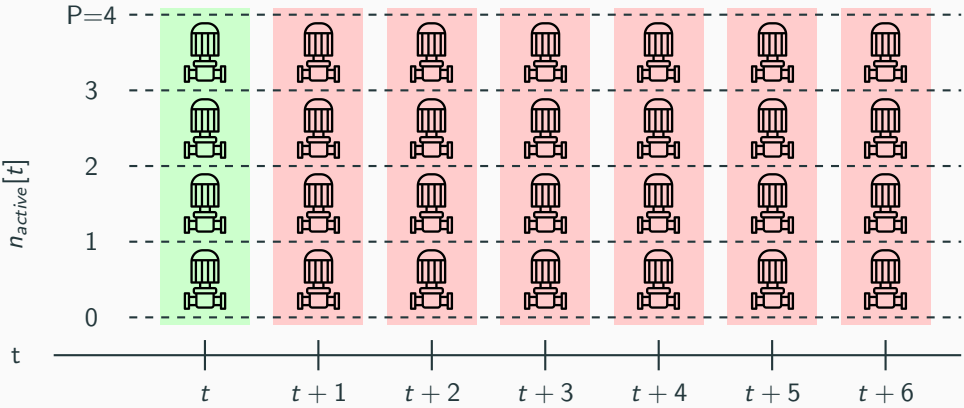

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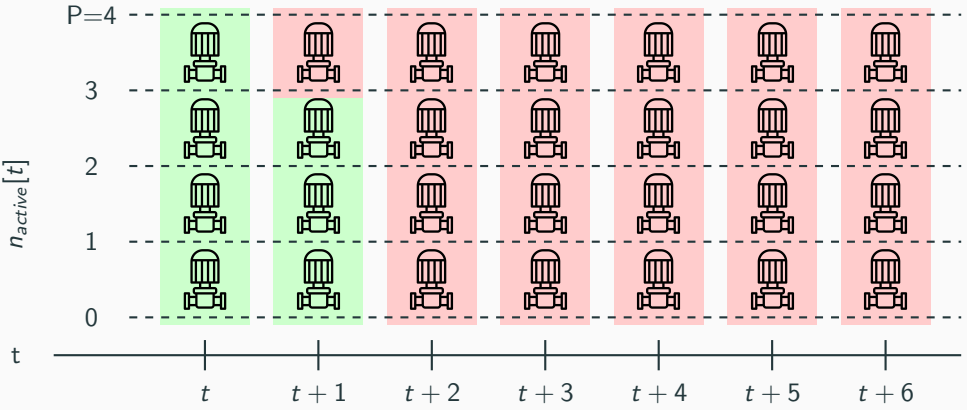

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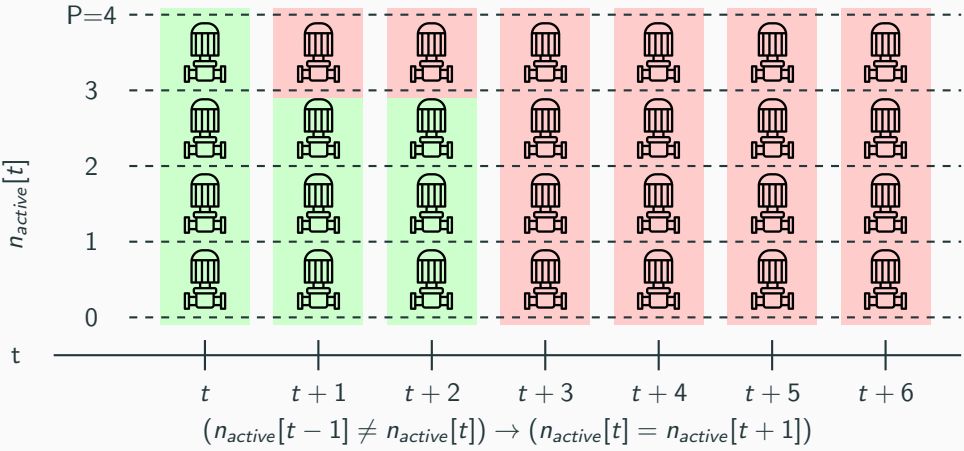

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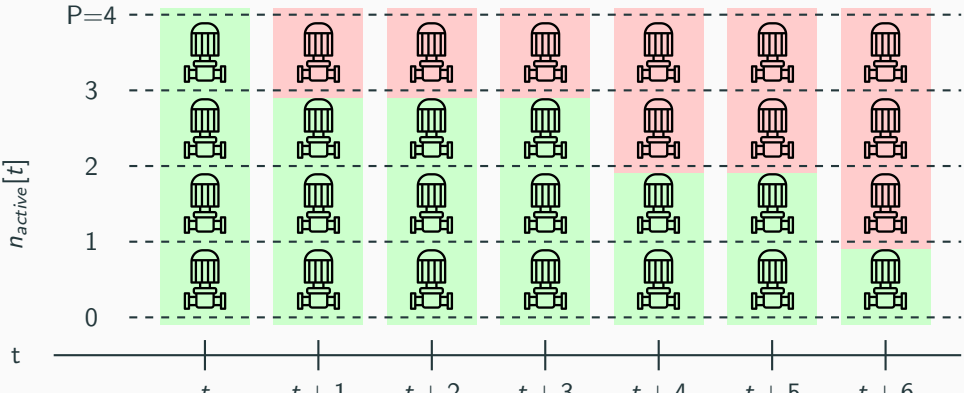

$$\sum_{i=j}^{j+24\times 4-1} |n_{active}[i] - n_{active}[i+1]| \leq M$$

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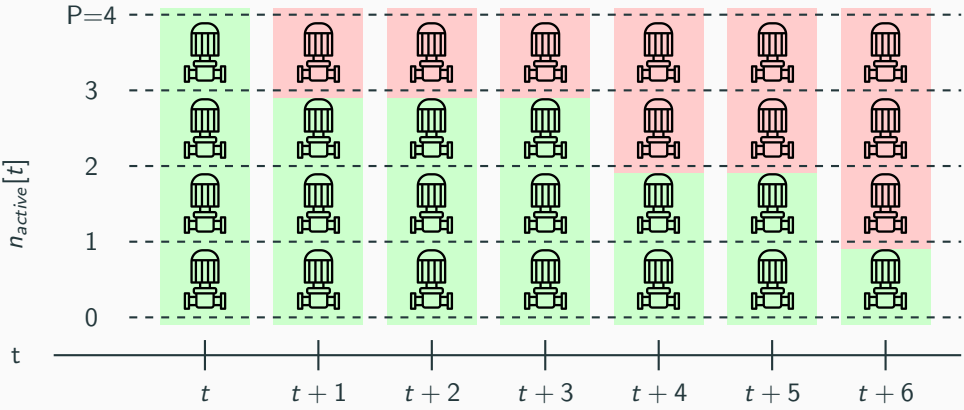
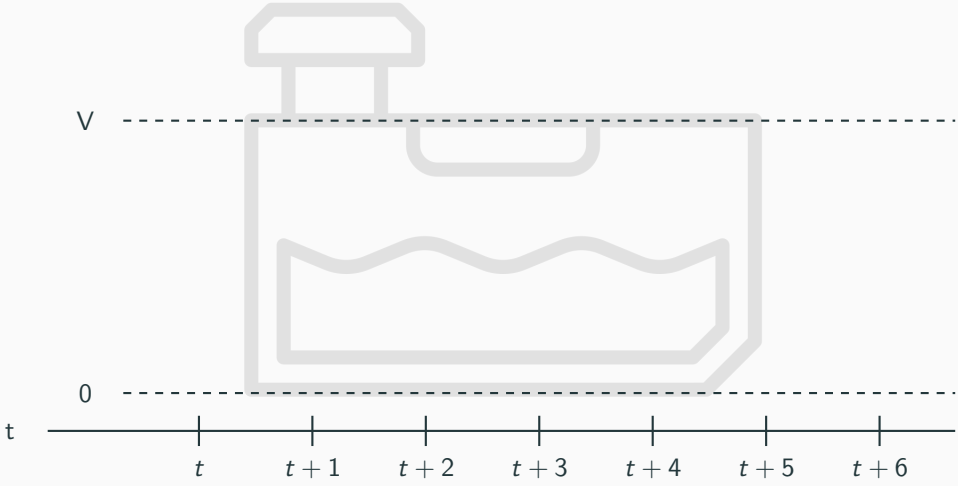


$$\min Cost = \min \sum_{t=0}^{T-1} \pi_t \times p[n_{active}[t]]$$

CP Model: Buffer Tanks



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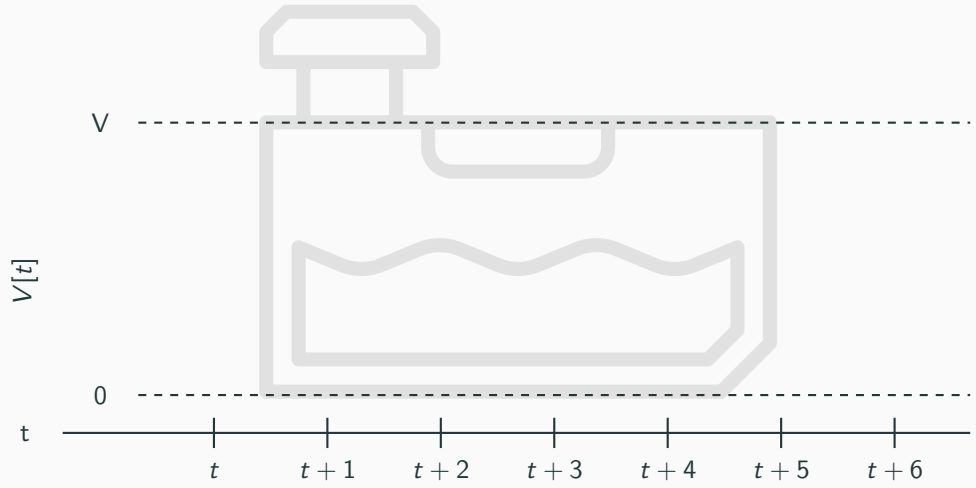

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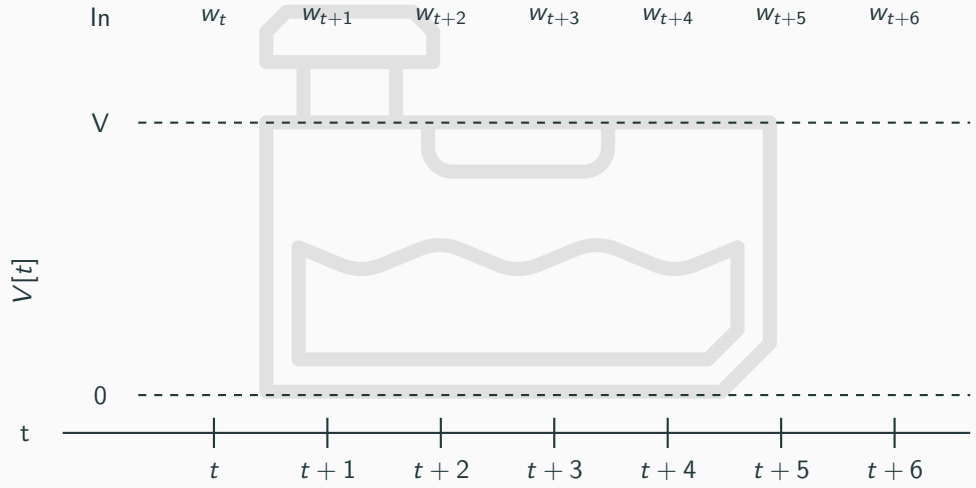

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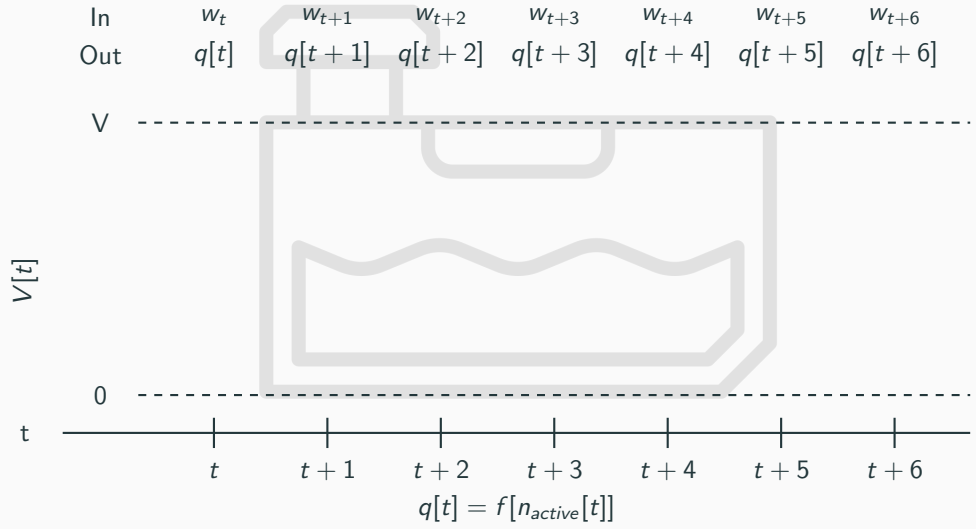

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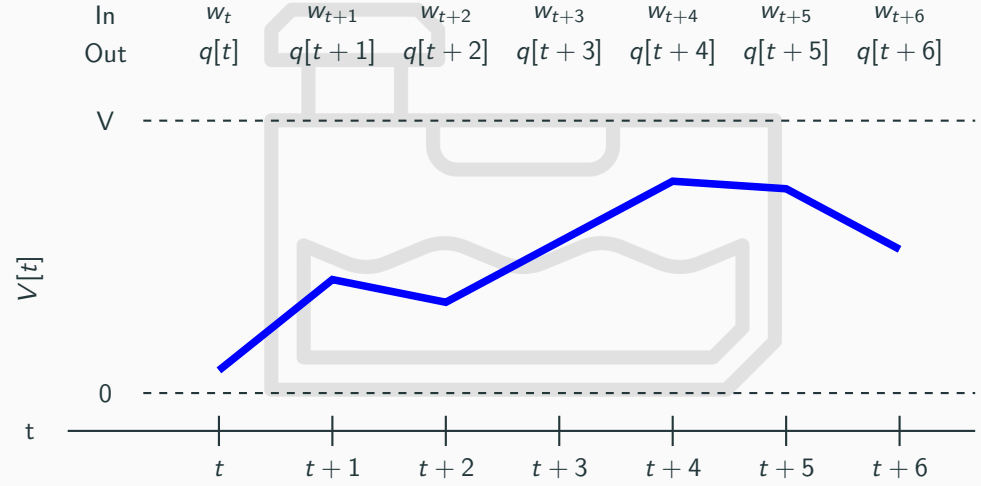

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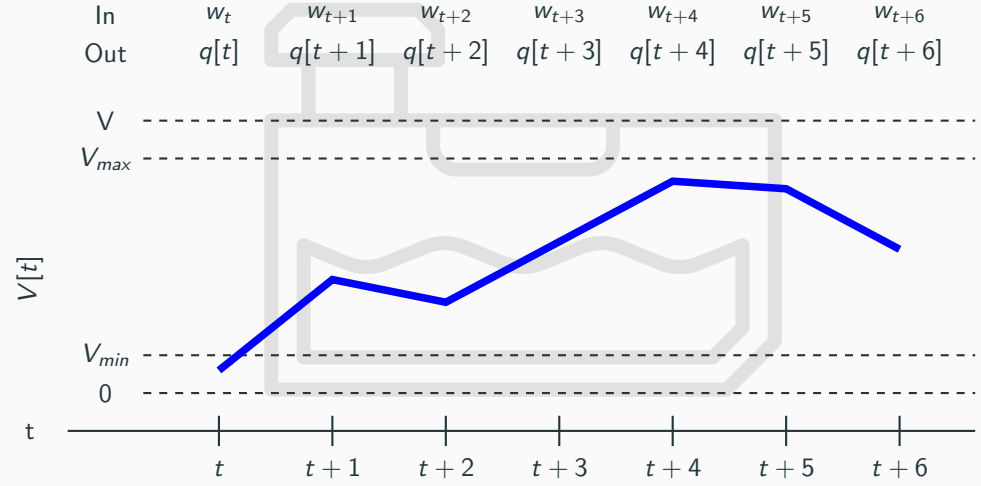

$(V[t] > V_{max}) \rightarrow (V[t] > V[t+1])$ and $(V[t] < V_{min}) \rightarrow (V[t] < V[t+1])$

Experiments

Scenarios:

Parameters:

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Parameters:

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- CP runs for 10 min (CPMpy model to Or-Tools, Gurobi and CP Optimizer)

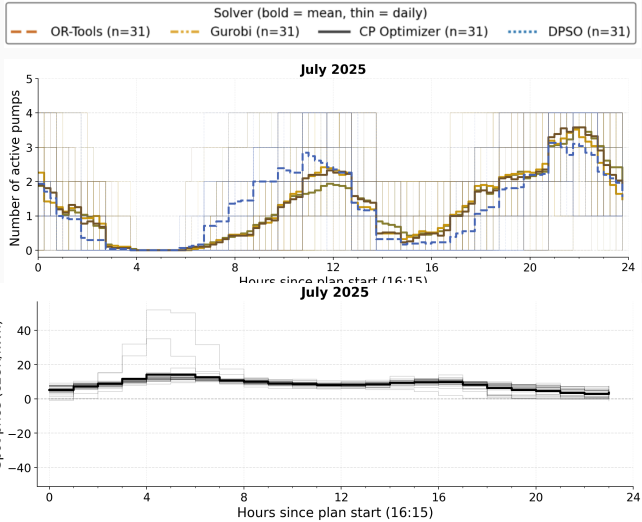
	Demands (m^3/day)			Prices (c€/kWh)			
	Min	Mean	Max	Min	Mean	Max	
May	82.000	99.258	117.000	-1,00	6,04	9,98	avg demand, low prices
July	62.000	75.290	127.000	4,06	8,39	17,72	low demand, high prices
December	127.000	143.161	157.000	6,08	8,54	11,9	high demand, avg prices

Results

		DPSO		Or-Tools		CP Optimizer		Gurobi	
		24 h	40 h	24 h	40 h	24 h	40 h	24 h	40 h
May	S1	2773	6744	2260	5681	2300	5728	**2255**	**5659**
	S2			2282	**5731**	2309	5787	**2280**	5746
	S3			2350	5898	2376	5930	**2306**	**5819**
Jul.	S1	2391	5736	2234	**5133**	2235	5138	**2226**	**5133**
	S2			2240	**5271**	2256	5284	**2233**	5278
	S3			**2281**	**5244**	2296	5271	2332	5337
Dec.	S1	6085	12232	5976	11830	6009	11874	**5970**	**11817**
	S2			**5931**	**11943**	5968	12006	5933	11947
	S3			5887	11706	5928	11747	**5884**	**11698**

(Mean cost (€/day) over the full month for each scenario and each model)

Negative Correlation



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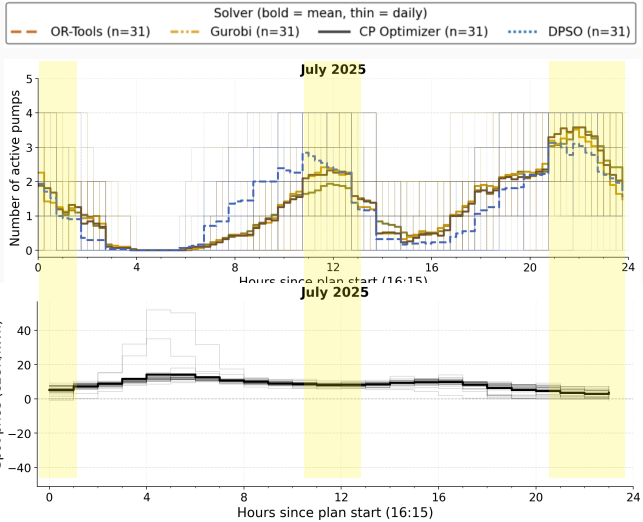

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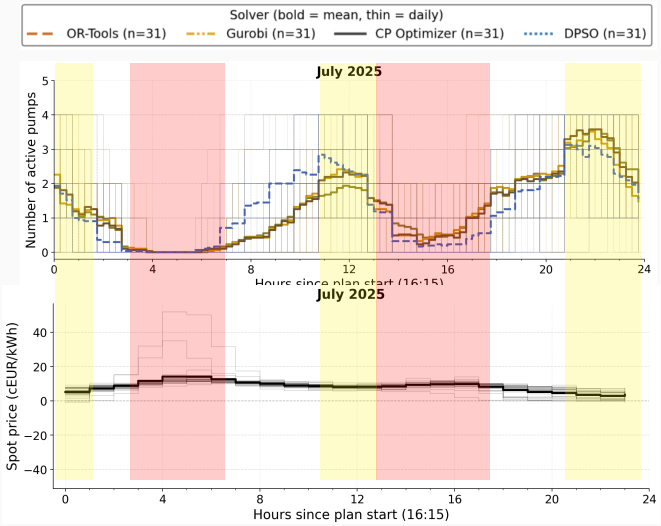

Robustness to changes

	DPSO	Or-Tools			
	Normal conditions	Normal conditions	3 pumps	18 switches	12 switches
May	2267	1843	1877	1866	1901
Jul.	3562	3475	3677	3476	3615
Dec.	7054	6762	6954	6774	6853

(Mean cost (€/day) over the first 5 days of each month (S3))

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Thank you for listening!

Any questions?

https://hverhaeghe.bitbucket.io/