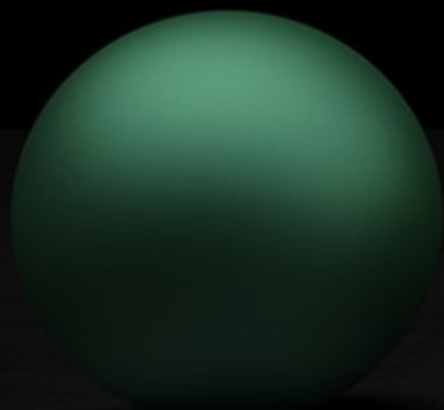




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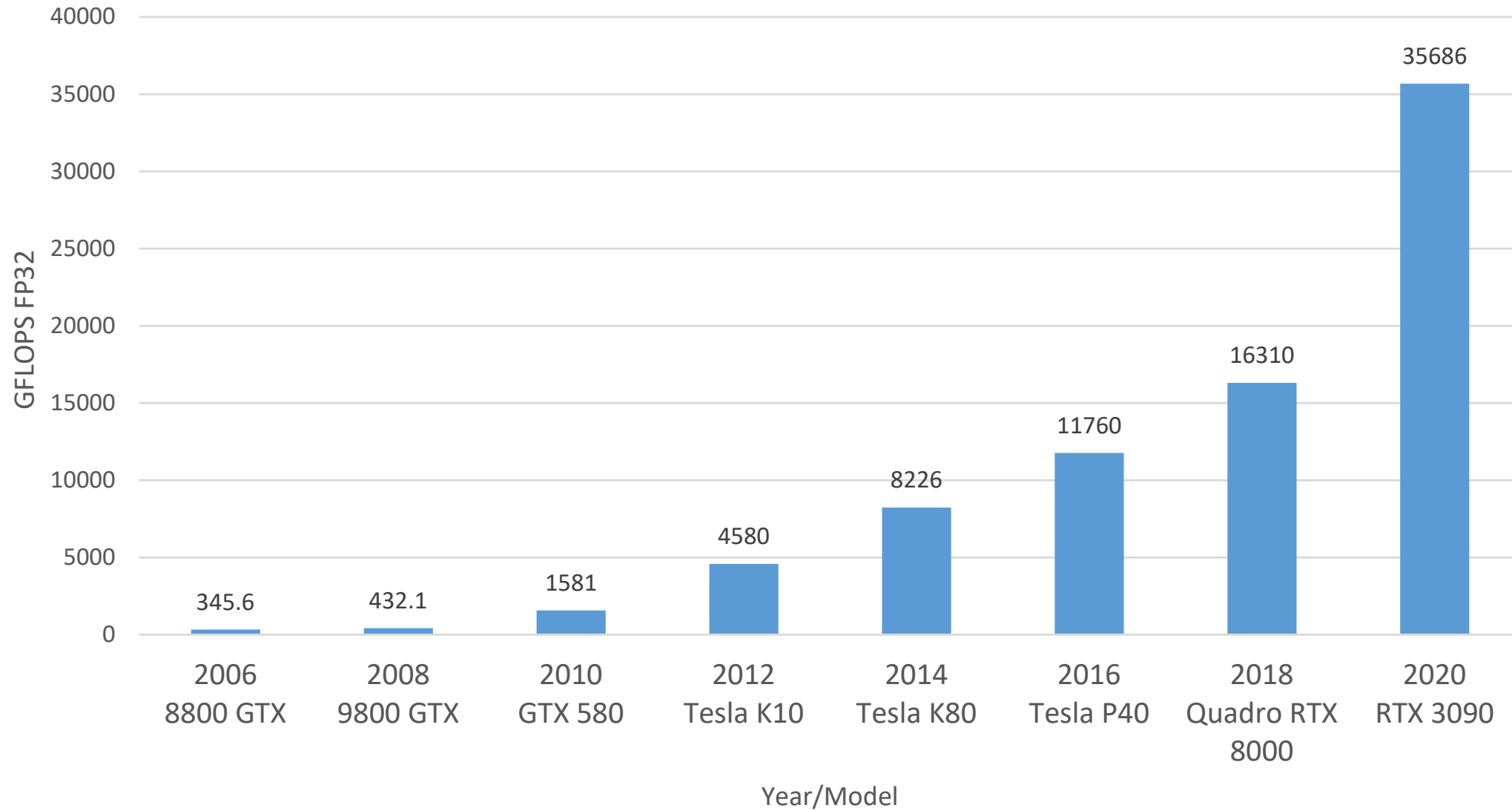


GoHydro

Hans Ivar Skjelbred, 12.09.2022
Hydropower Scheduling Conference, Oslo

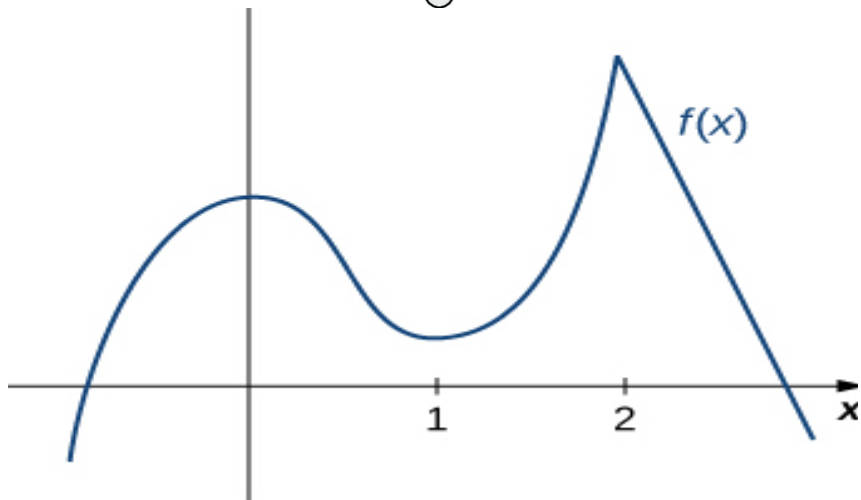
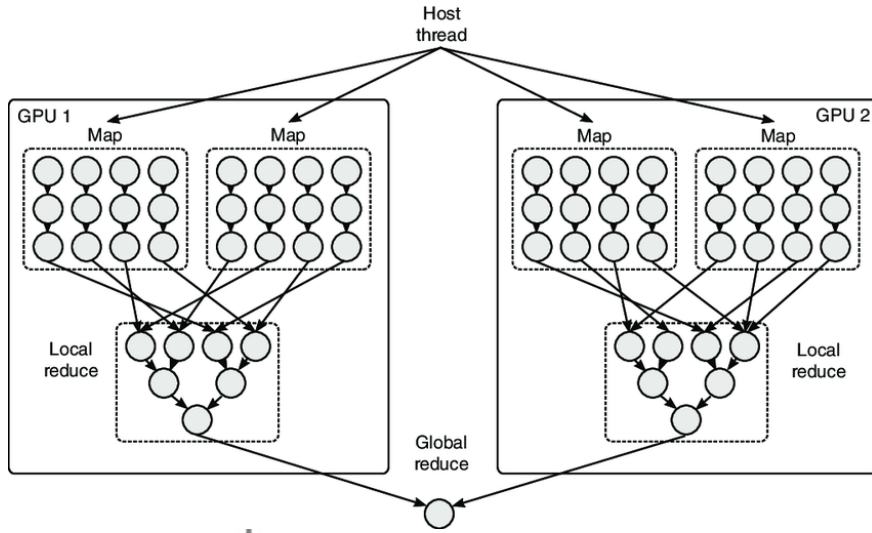
Technology for a better society

GPU performance development

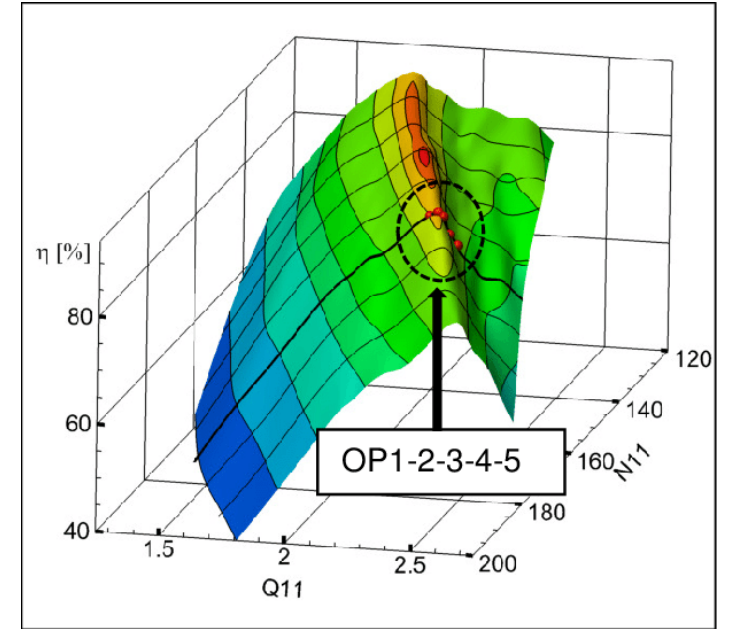
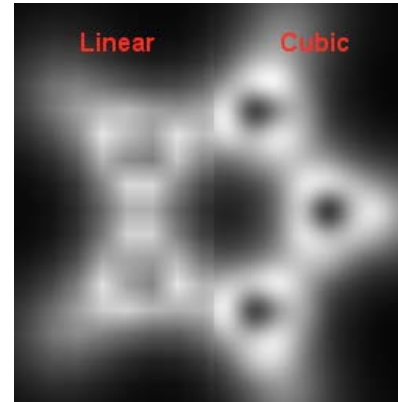


GPU functions

- Maximization



- Interpolation



- Sum product

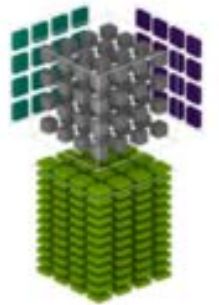
$$D = \begin{pmatrix} A_{0,0} & A_{0,1} & A_{0,2} & A_{0,3} \\ A_{1,0} & A_{1,1} & A_{1,2} & A_{1,3} \\ A_{2,0} & A_{2,1} & A_{2,2} & A_{2,3} \\ A_{3,0} & A_{3,1} & A_{3,2} & A_{3,3} \end{pmatrix} + \begin{pmatrix} B_{0,0} & B_{0,1} & B_{0,2} & B_{0,3} \\ B_{1,0} & B_{1,1} & B_{1,2} & B_{1,3} \\ B_{2,0} & B_{2,1} & B_{2,2} & B_{2,3} \\ B_{3,0} & B_{3,1} & B_{3,2} & B_{3,3} \end{pmatrix} + \begin{pmatrix} C_{0,0} & C_{0,1} & C_{0,2} & C_{0,3} \\ C_{1,0} & C_{1,1} & C_{1,2} & C_{1,3} \\ C_{2,0} & C_{2,1} & C_{2,2} & C_{2,3} \\ C_{3,0} & C_{3,1} & C_{3,2} & C_{3,3} \end{pmatrix}$$

HMMA FP16 or FP32
IMMA INT32

FP16
INT8 or UINT8

FP16
INT8 or UINT8

FP16 or FP32
INT32



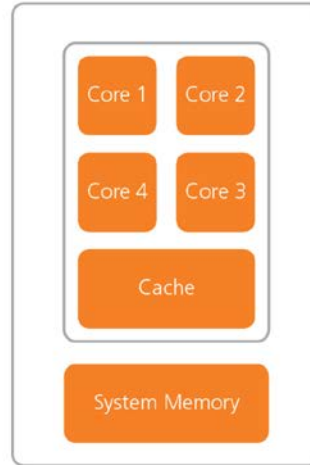


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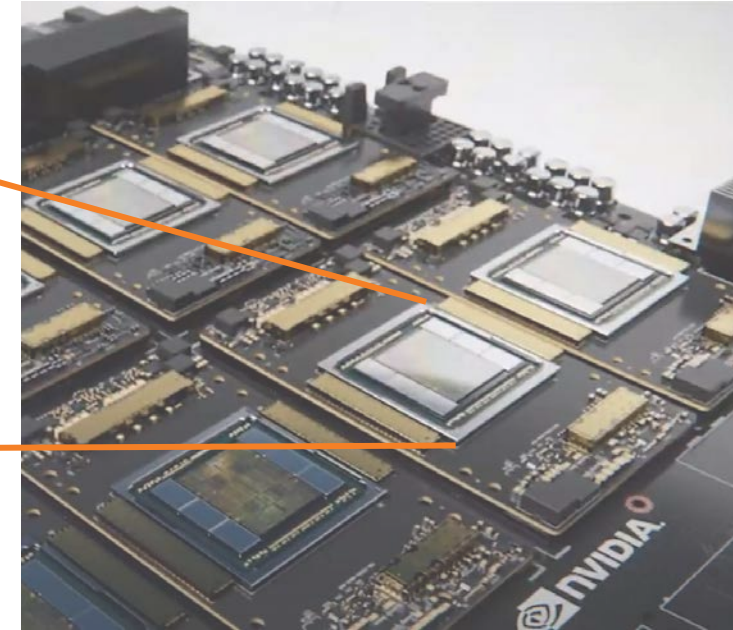
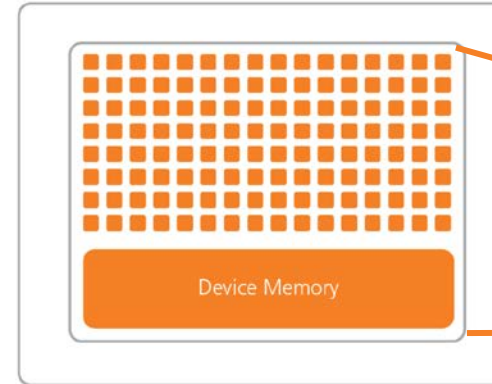
GoHydro

- >100 000 identical tasks that can be solved in parallel
- Efficient memory addressing

CPU (Multiple Cores)



GPU (Hundreds of Cores)



Parallelize the search for optimum

Maximize the parallelization of the optimization problem

Scalable algorithm for non-linear large-scale optimization problems



SINTEF

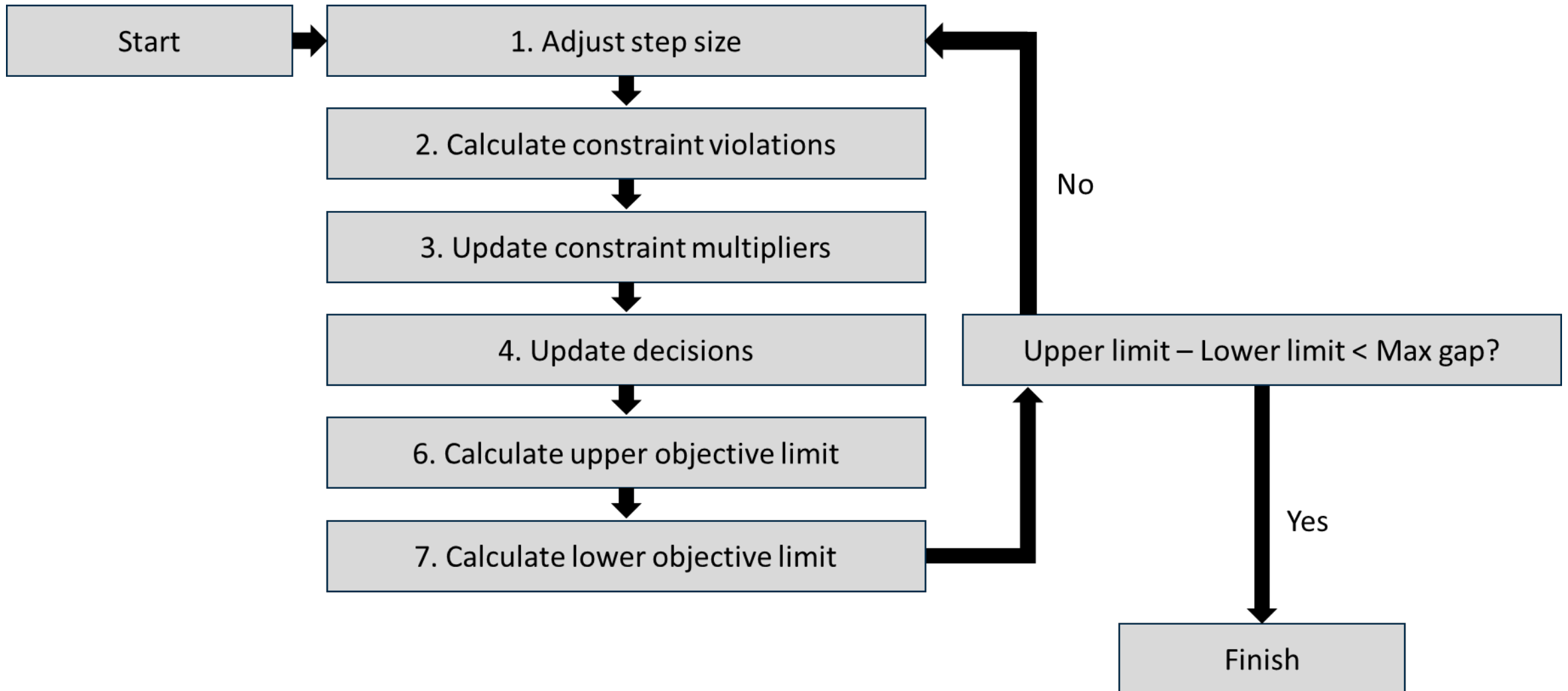
GoHydro problem formulation

- Sum production = demand
 - => couples all watercourses and all thermal production
 - => decompose by energy price
- => All decisions can be made independently in parallel
- => Need to search for optimal multipliers for relaxed restrictions



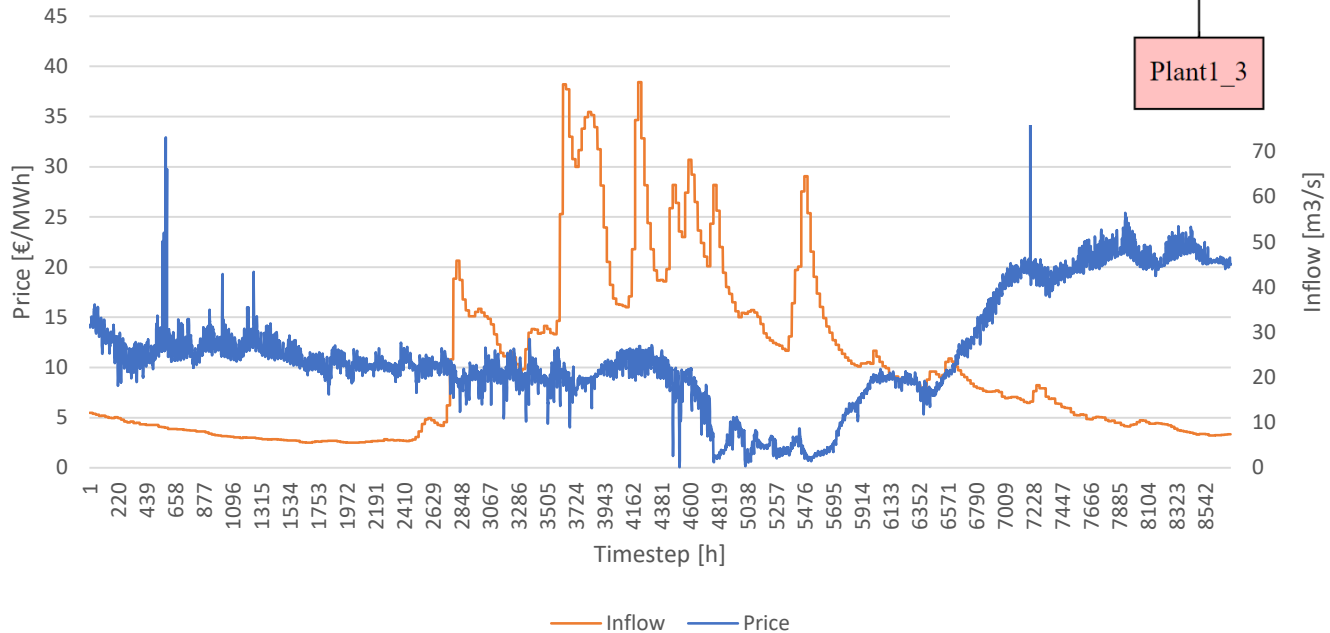
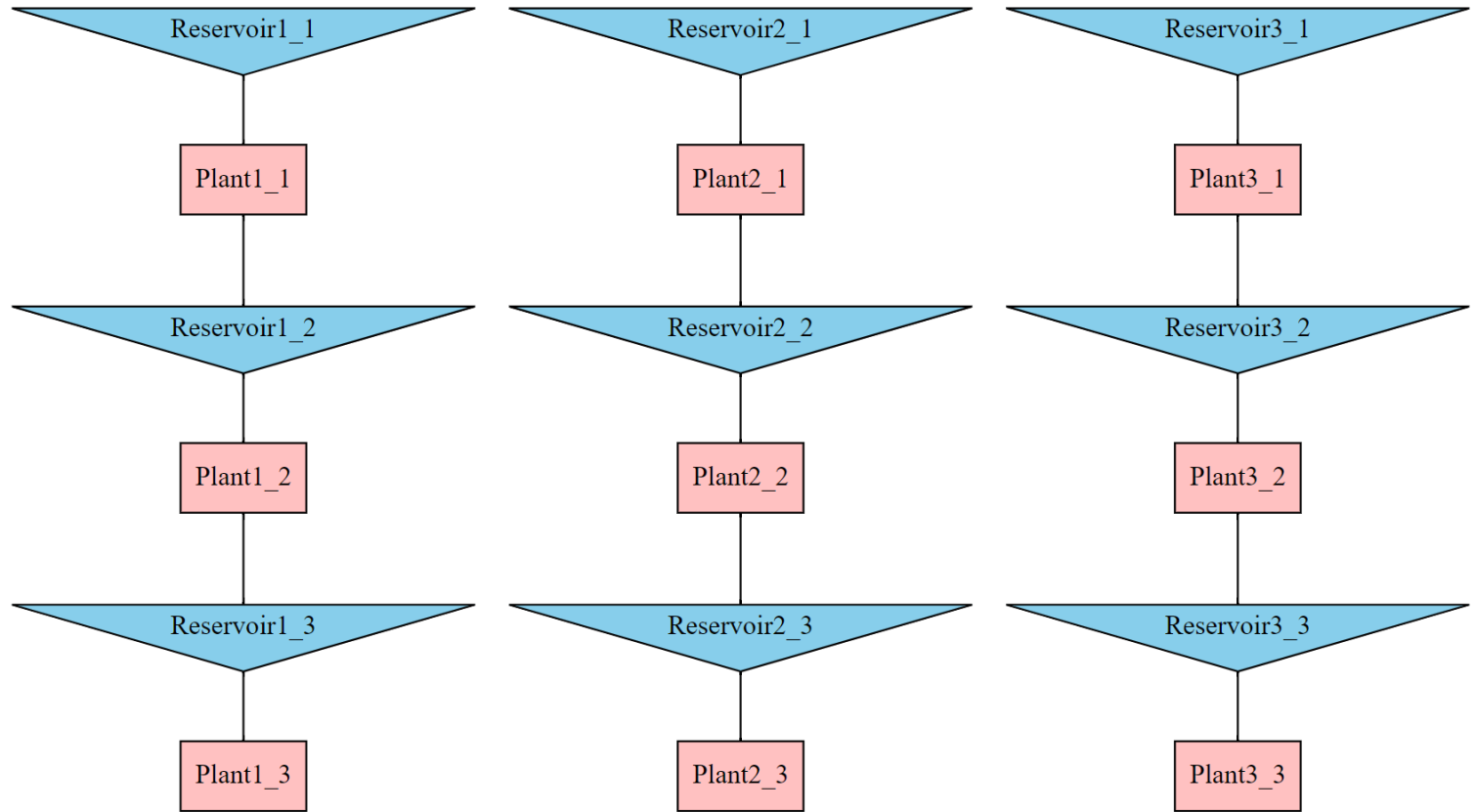
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GoHydro-algorithm





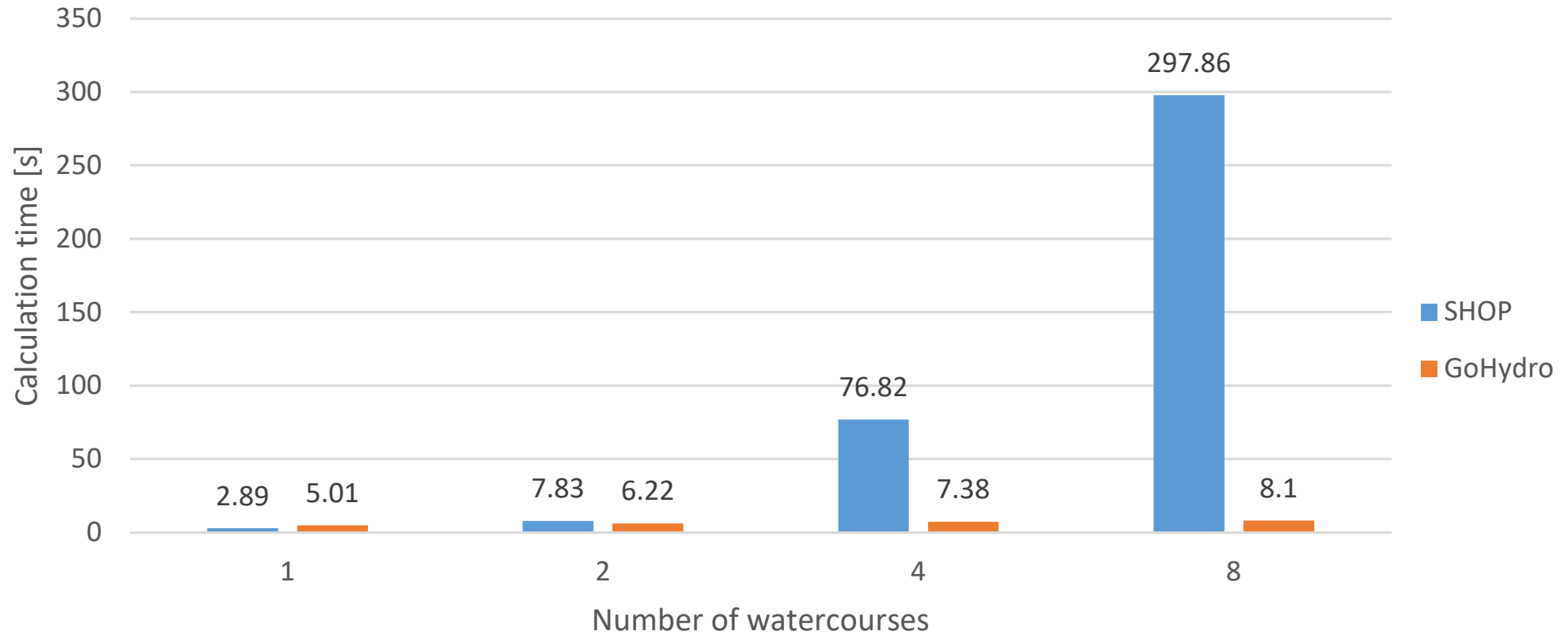
Test setup





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Scaling properties

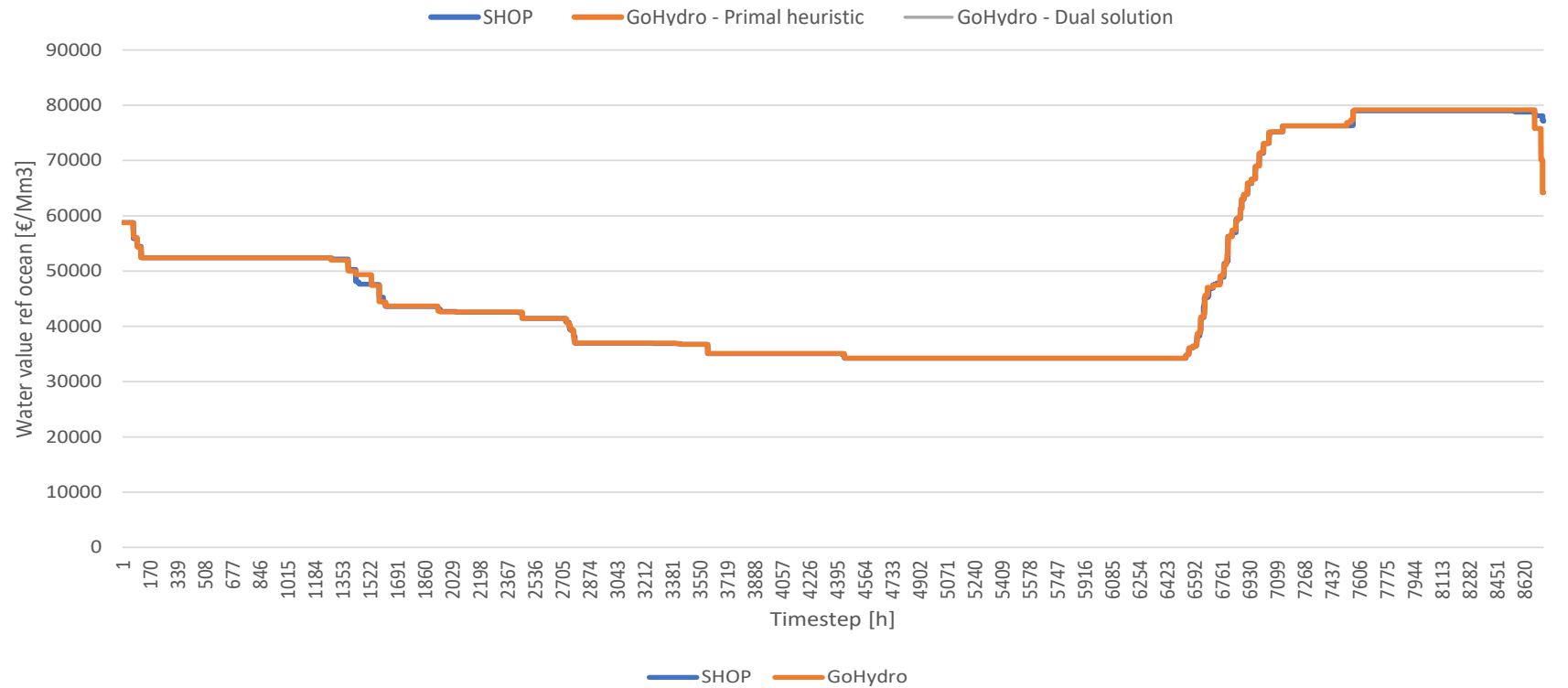
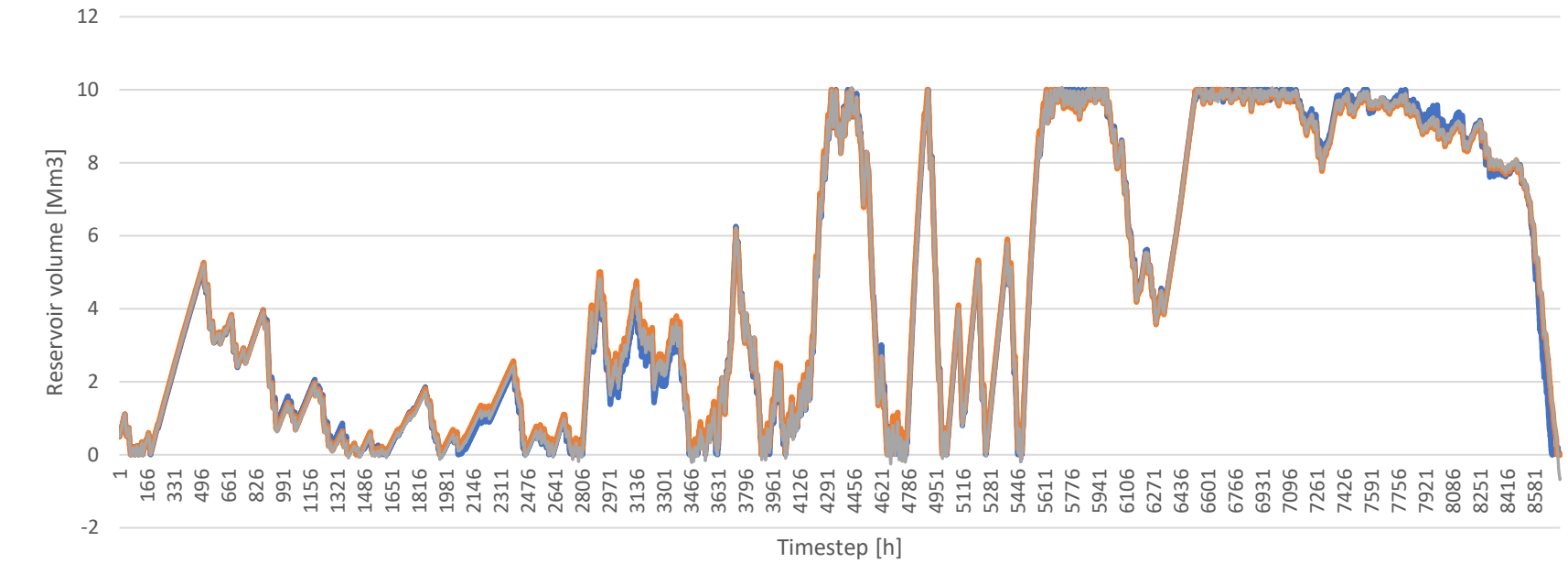


	SHOP		GoHydro				
Size	Time [s]	Objective	Time [s]	Upper bound	Lower bound	Absolute gap	Relative gap
1	2.89	24445209	5.01	24506526	24409086	97440	0.003992
2	7.83	49333248	6.22	49434980	49238424	196556	0.0039919
4	76.82	100389556	7.38	100608464	100210640	397824	0.0039699
8	297.86	207324174	8.1	207688976	207106144	582832	0.0028142



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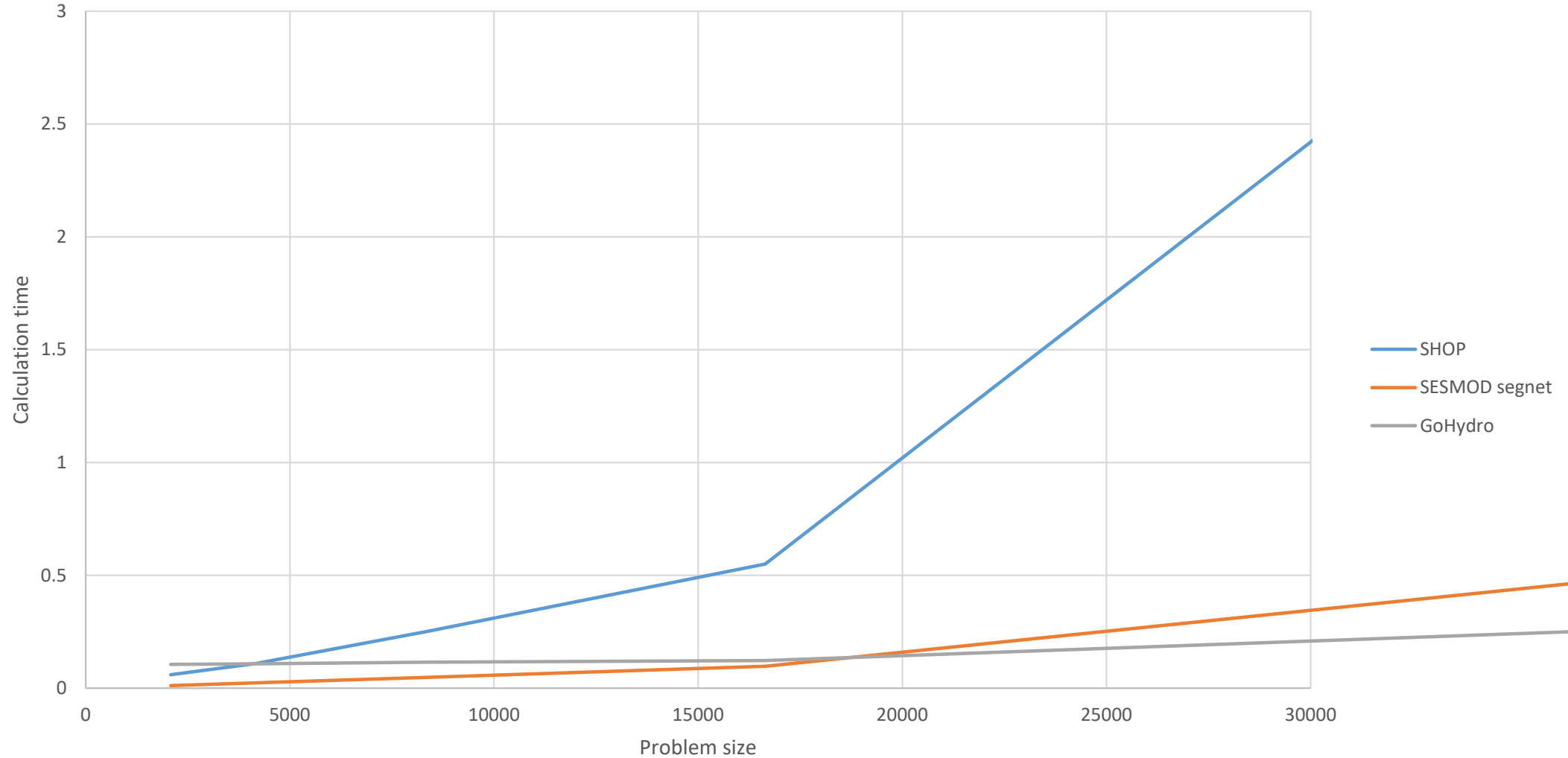
Reservoir trajectories and water values





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Calculation time - scaling with case size

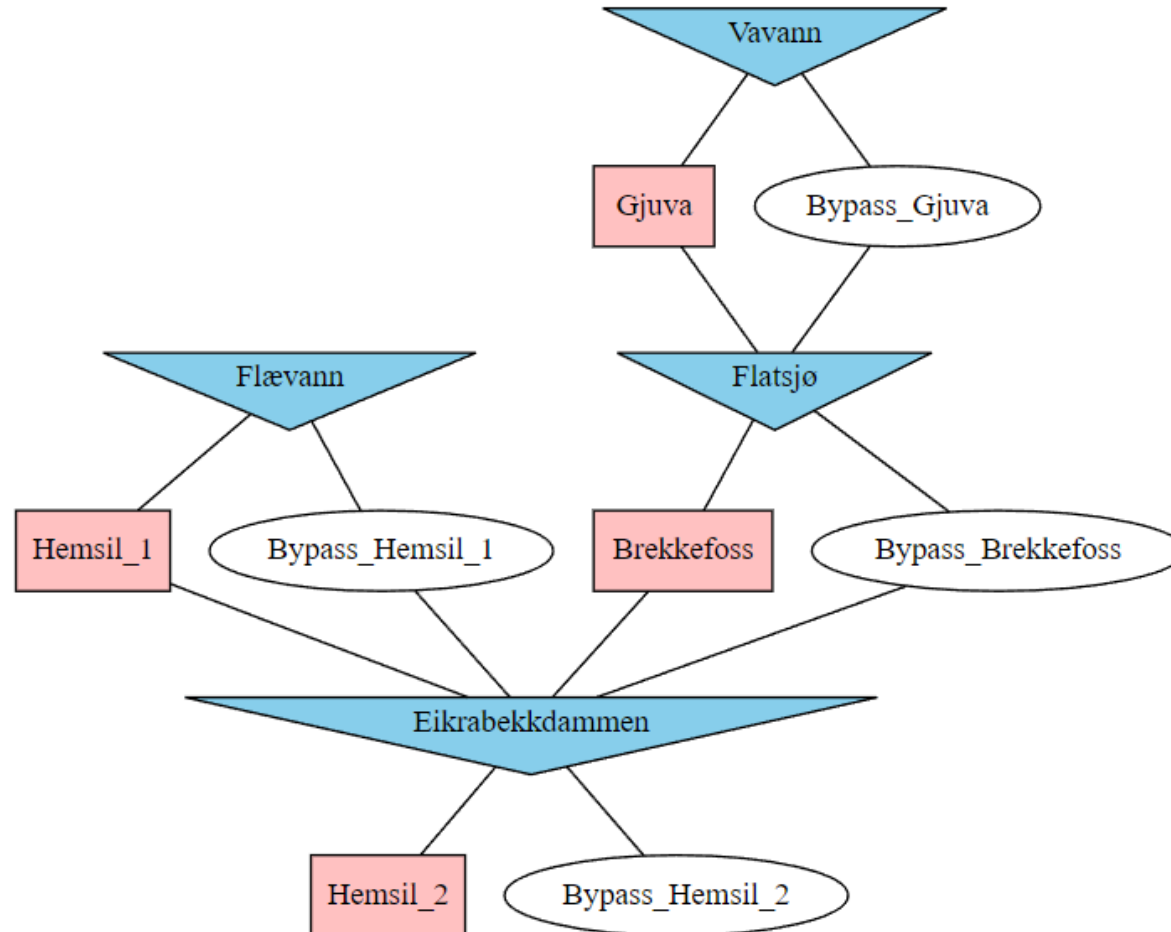




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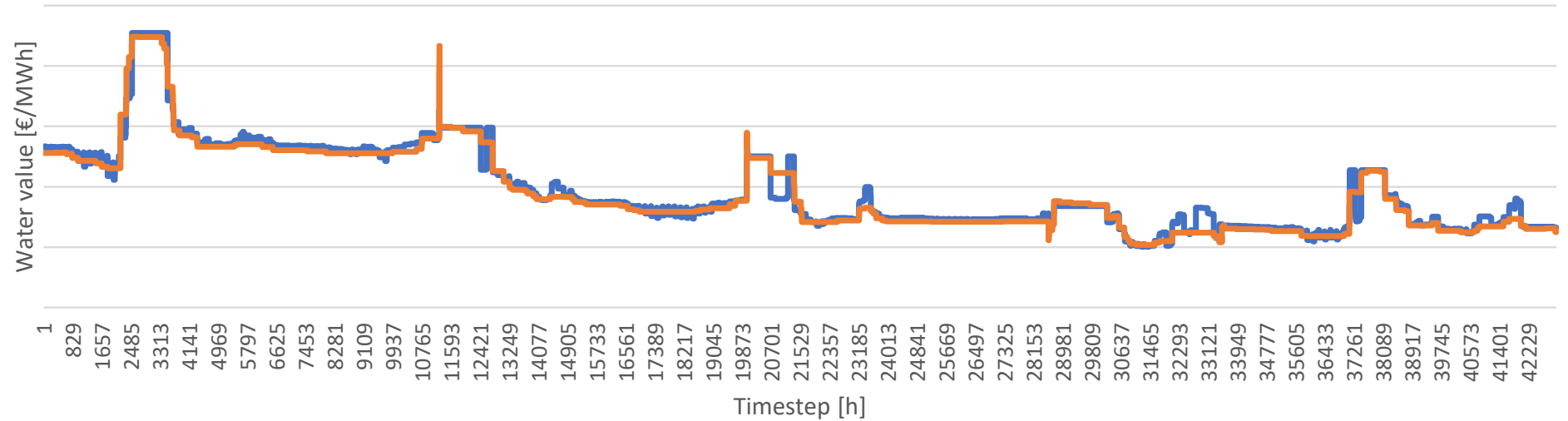
Operational case – Hemsil (Hafslund Eco)

5 years time horizon
36 price/inflow scenarios
Hourly time resolution

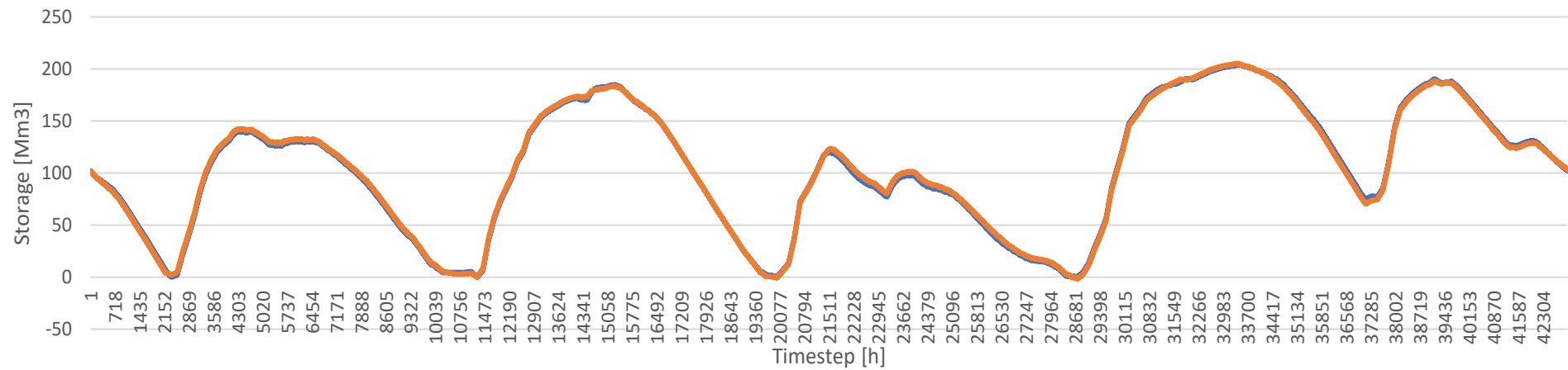
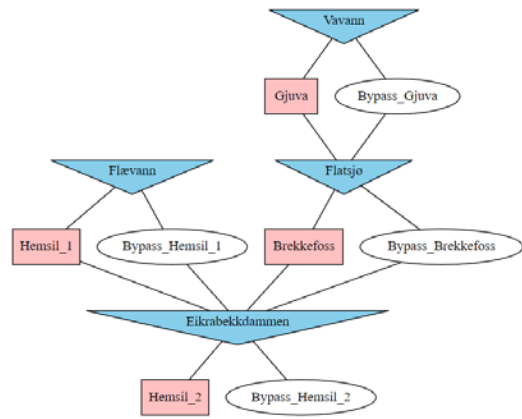




Water value and reservoir trajectory Flævann



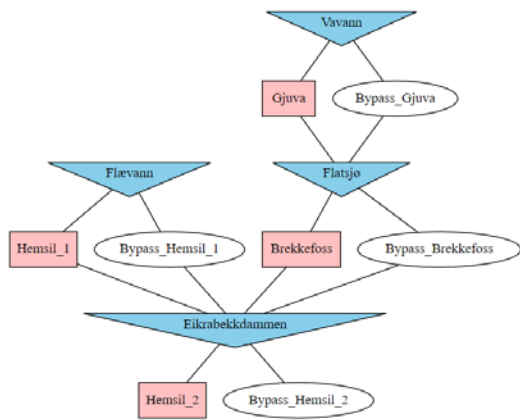
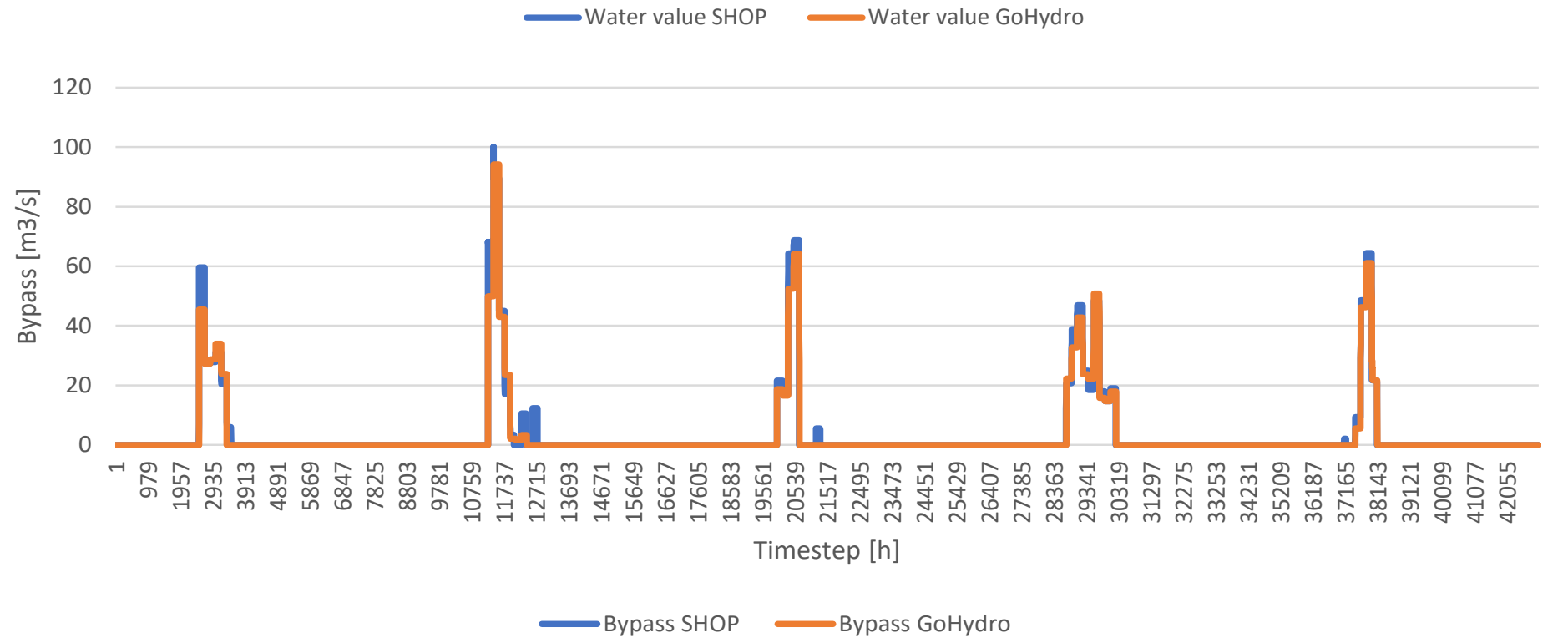
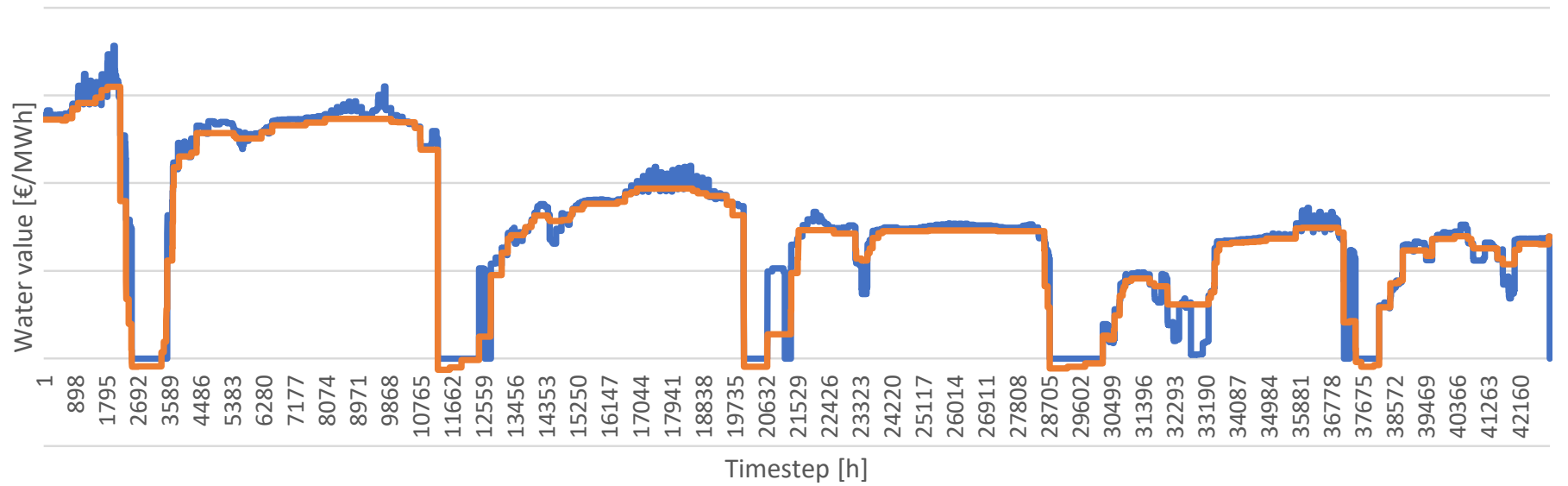
— SHOP water value — GoHydro water value



— SHOP_storage — GoHydro_storage



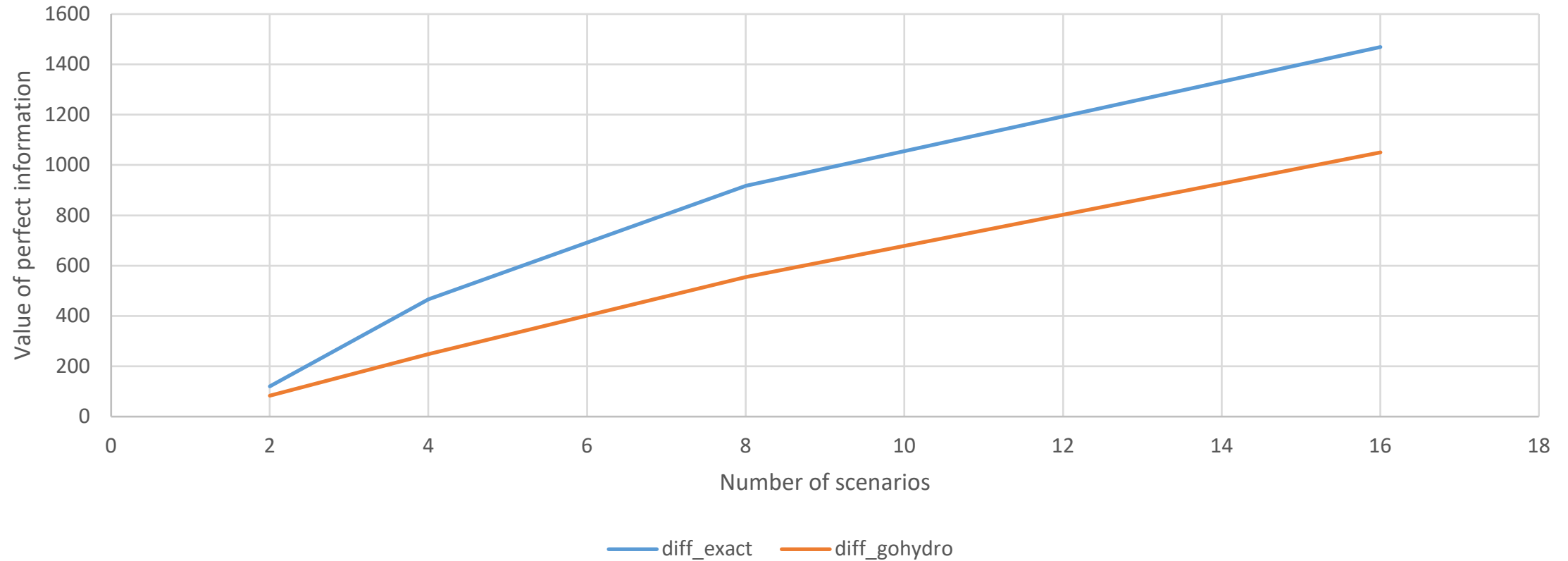
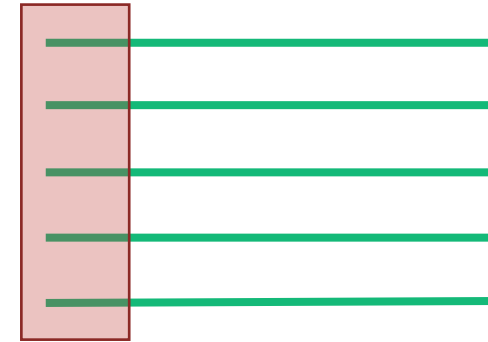
Water value and bypass Eikrabbekdammen





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Stochastic optimization - work in progress





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Further work

- Double the resources for working on this next six months
- Increase problem size and model complexity
- Compare with state-of-the-art tools
- Common goal with industry to reach a Minimum Viable Product (MVP)



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Teknologi for et
bedre samfunn