Statkraft

GoHydro

Accelerating Hydropower optimization

Tellef Juell Larsen, Statkraft Energi AS
Hans Ivar Skjelbred, SINTEF Energi AS

SINTEF user meeting, May 6, 2025

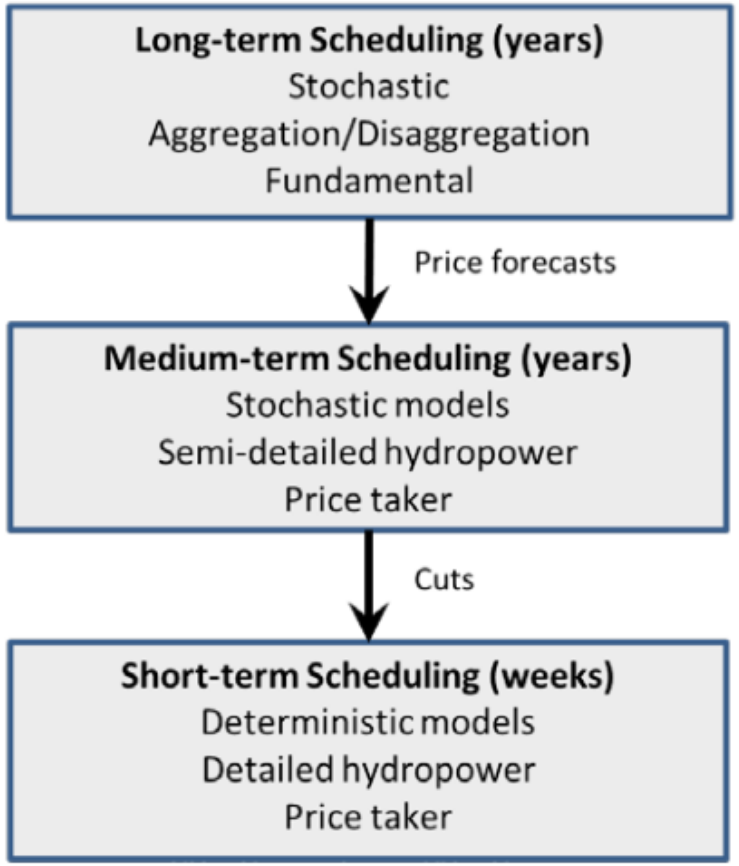
Calculation time is a challenge

- Finer time resolution
- Shorter deadlines
- More market obligations
- More hydropower details

- Longer time horizons
- Stochastic optimization
- Multi-market modelling
- Grid modelling

Statkraft

The model setup is a challenge



- Several models involved
  - Creates inconsistencies
  - Expensive to develop and operate
  - Hinders cooperation across units/processes
- Many models are old with legacy code

Statkraft

R&D journey

Several attempts to reduce calculation time and to reduce the gap towards LTM
- but without success

2017 (Alpha Zero)

- PROMISE, proposal to use ML to update models
- Agder Energi & UIA starts project on ML for hydropower

2018

- Powel initiates ML project (with NFR support)
- SENSATION, proposal using sensor-based optimization (BigData)

2019

- SHOP-ZERO, mass simulation & meta-heuristics with GPU's (2 x NFR)
- iSCHEDULING, ML for SHOP command parameters

2020

- SOFT-LINKING, proposal to link ProdRisk and SHOP
- INCOME, proposal to combine operation and maintenance planning
- DYNAMO, dynamic modelling in SHOP to handle longer horizons
- SHORTCUTS, calculating cuts with SHOP

2021

- GoHydro, GPU-accelerated optimization of hydropower
  - 4 years, rejected by NFR

Statkraft

GoHydro journey

GoHydro IV
Goal POC production planning
Start Q1 2024
Duration 2 years

GoHydro V?

GoHydro III
Goal POC market analysis
Start Q1 2023
Duration 1 year

GoHydro II
Goal POC water value calculation
Start Q3 2022
Duration 0,5 year

GoHydro I
Goal Proof of concept
Start Q1 2021
Duration 1,5 year

Statkraft

Still a long way to go!

- On schedule when comparing with the SHOP journey
- GoHydro is still an R&D prototype
- No inhouse operative testing yet
- No decision whether to make GoHydro an operative or a commercial product

Statkraft

Statkraft

Thank you

GoHydro

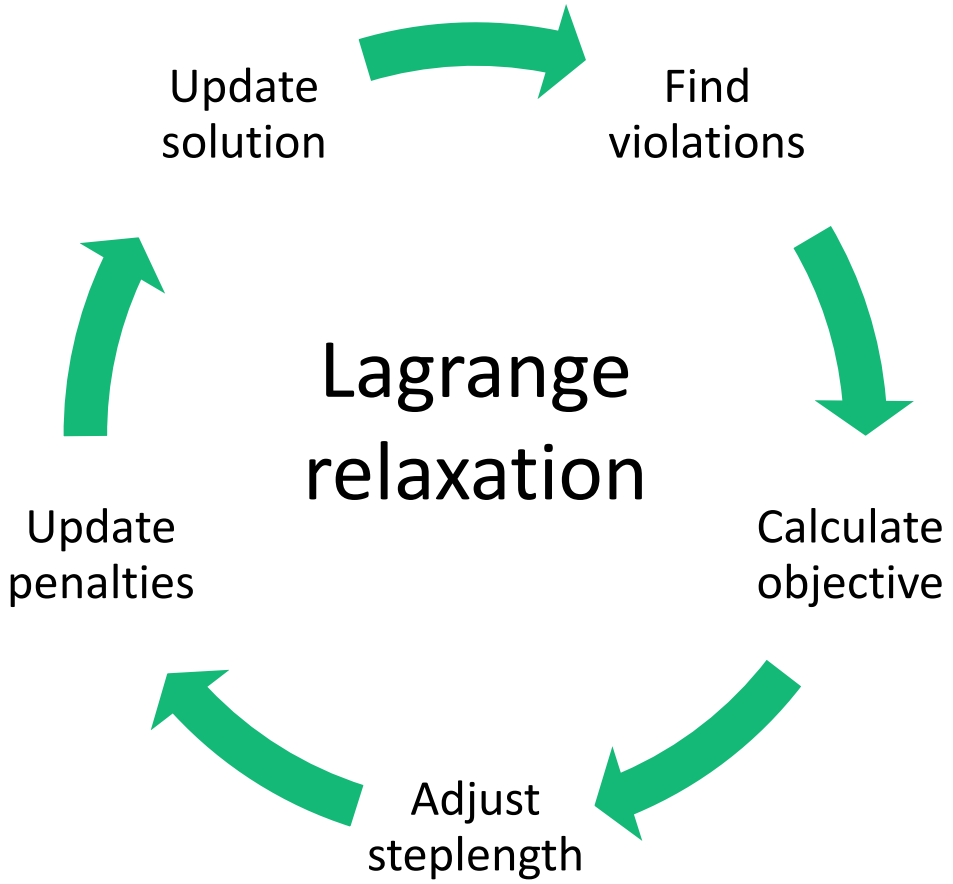
Accelerating Hydropower optimization

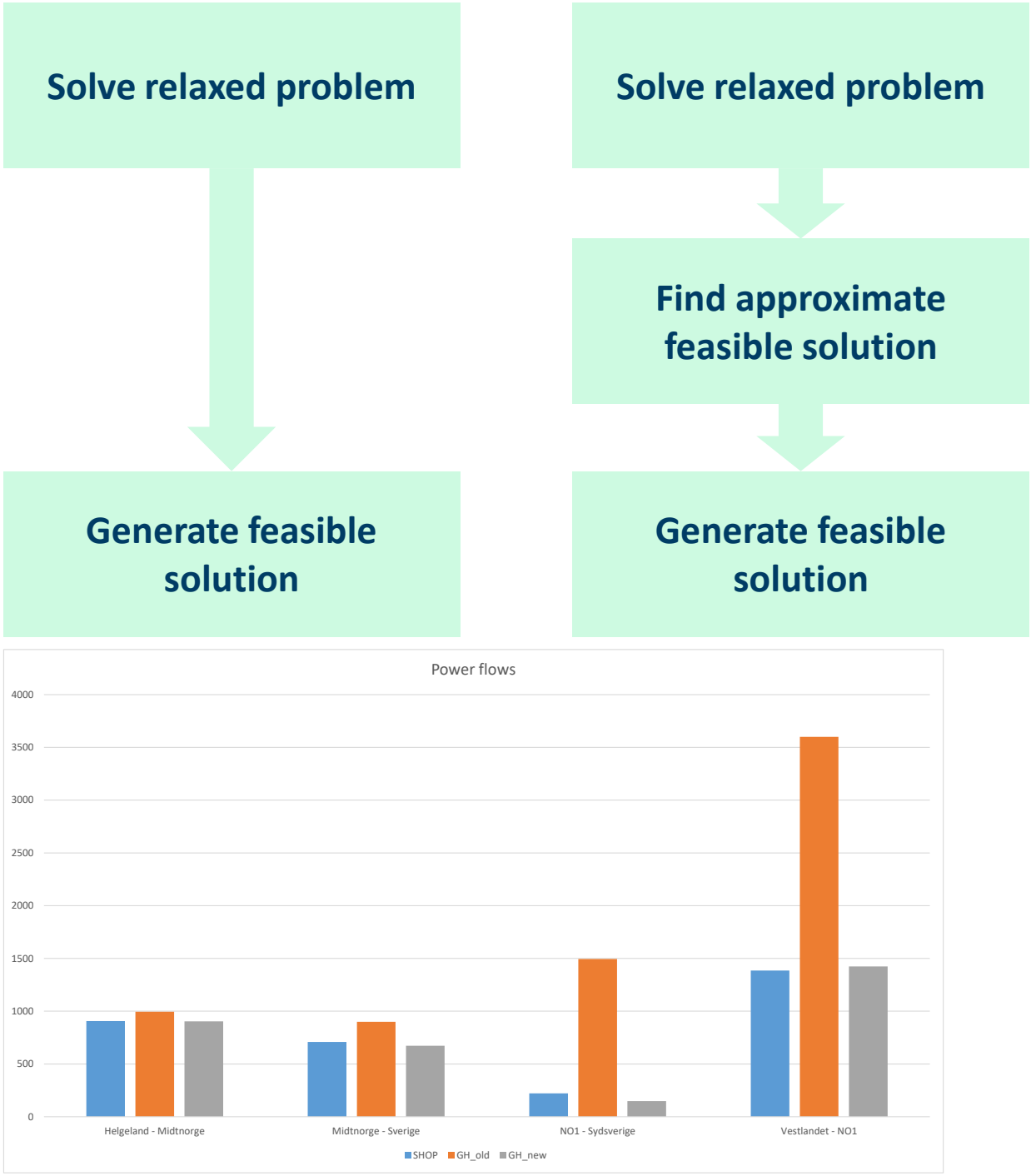
Hans Ivar Skjelbred

SINTEF Energy User Meeting

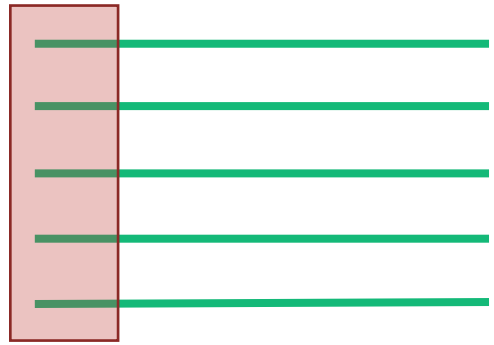
Oslo, May 6th 2025

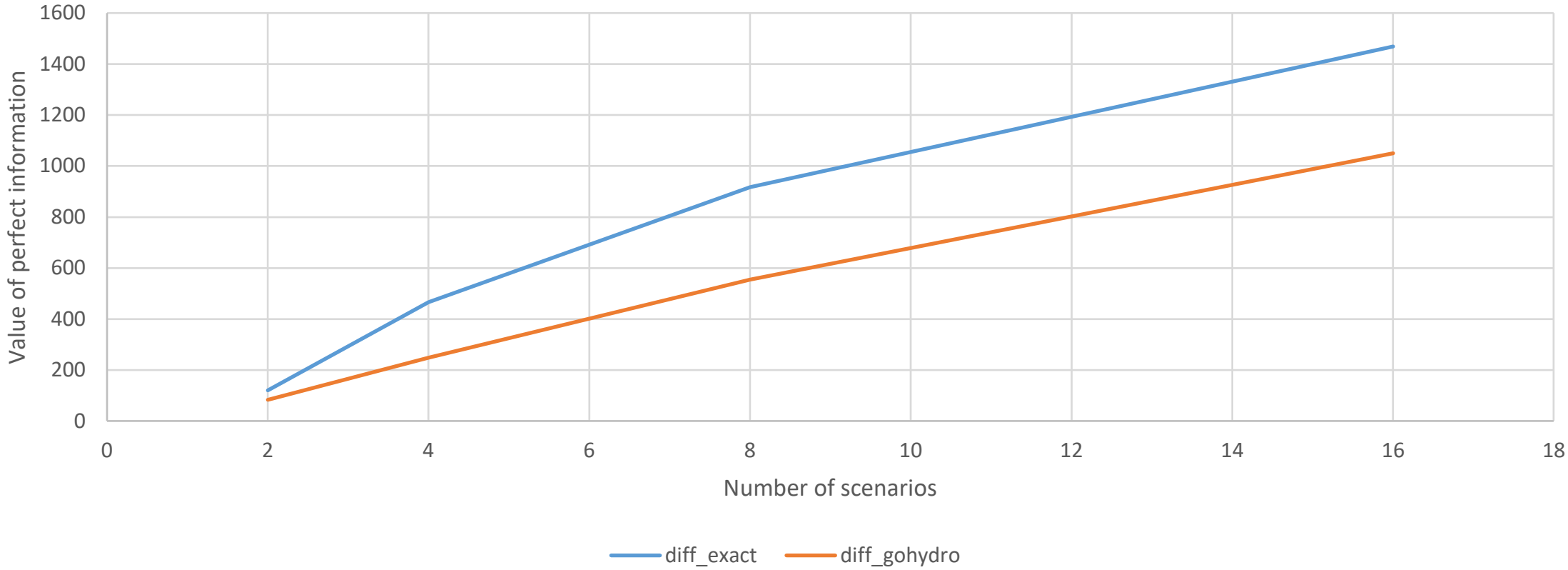
Basic concepts



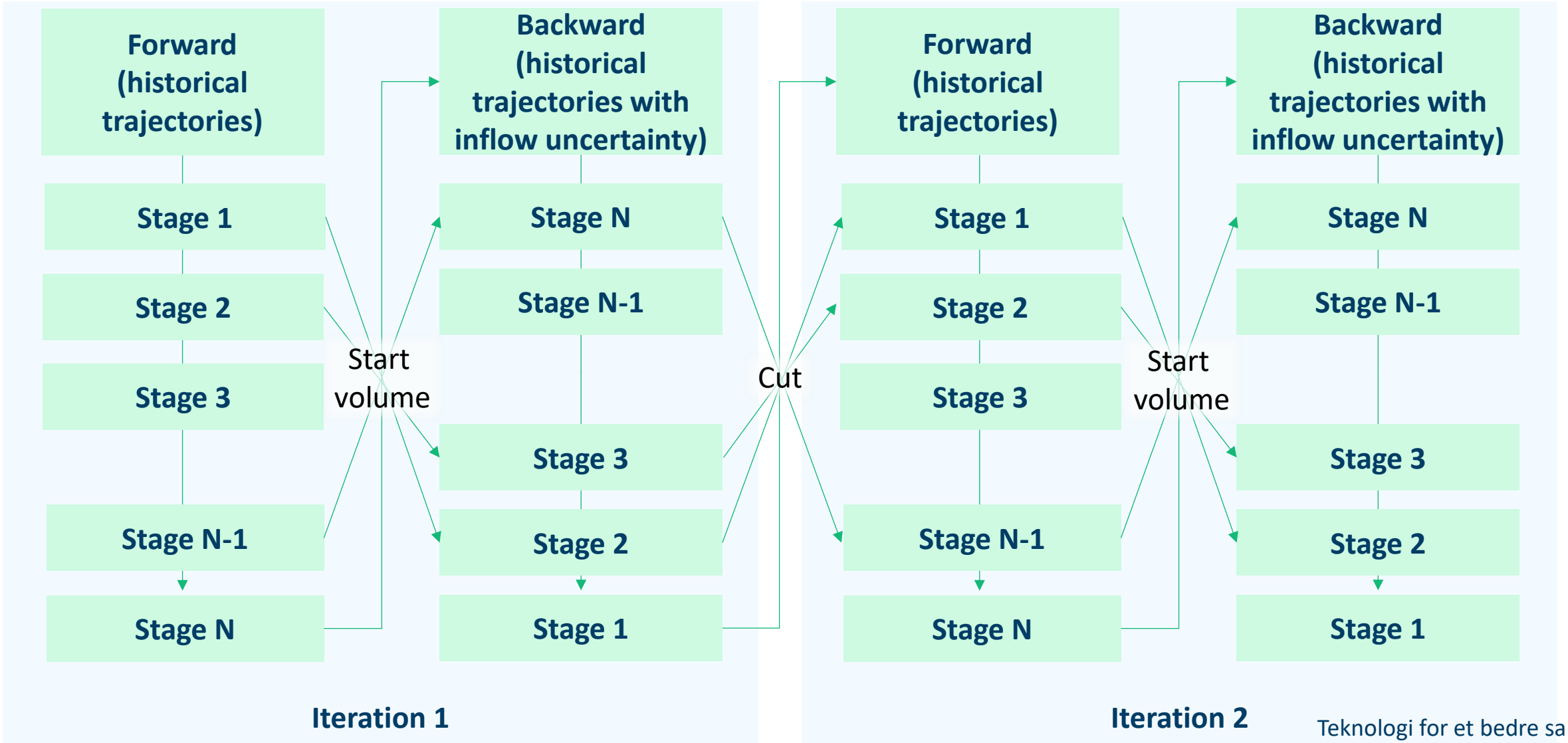


Stochastic optimization strategies

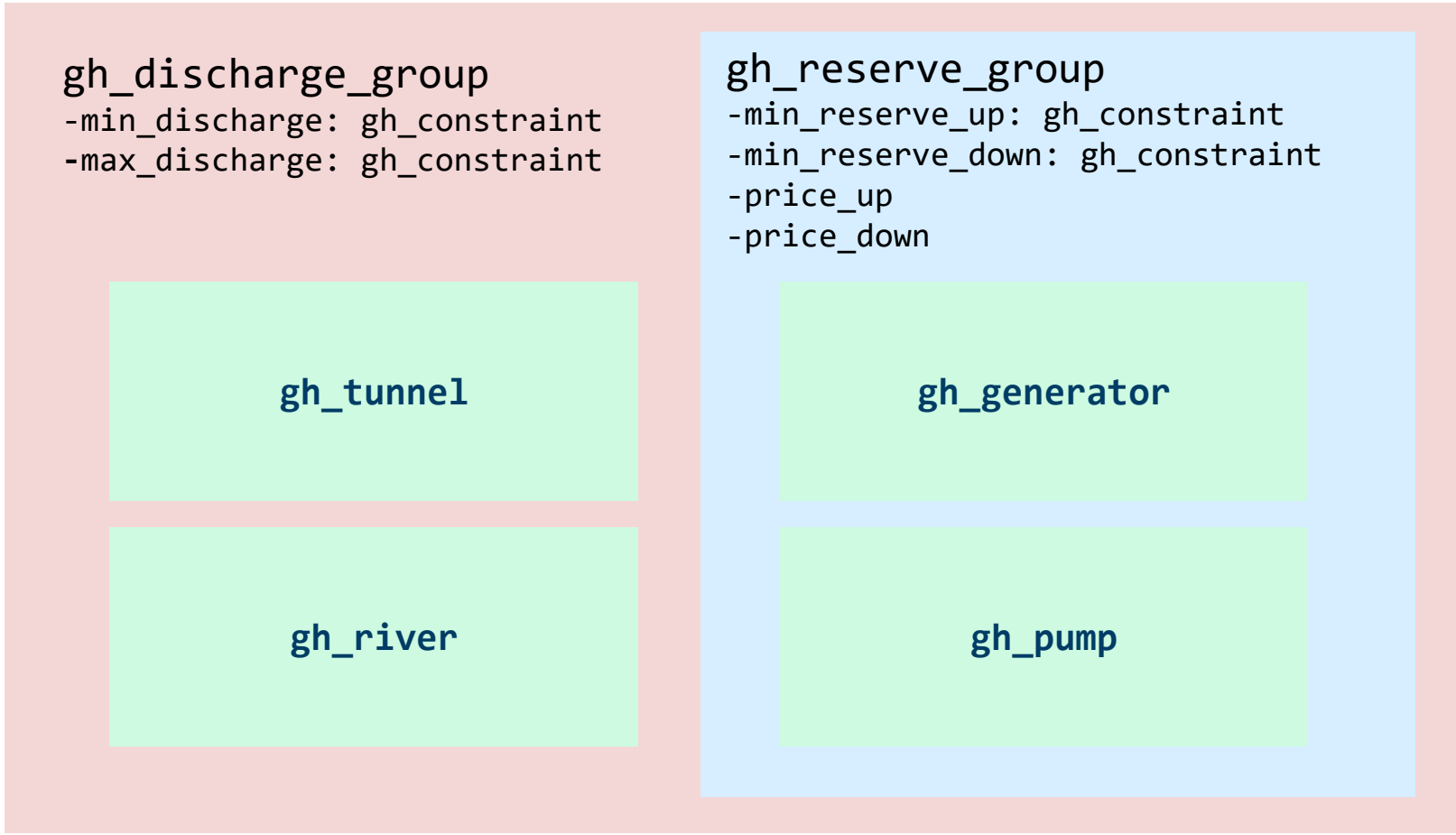




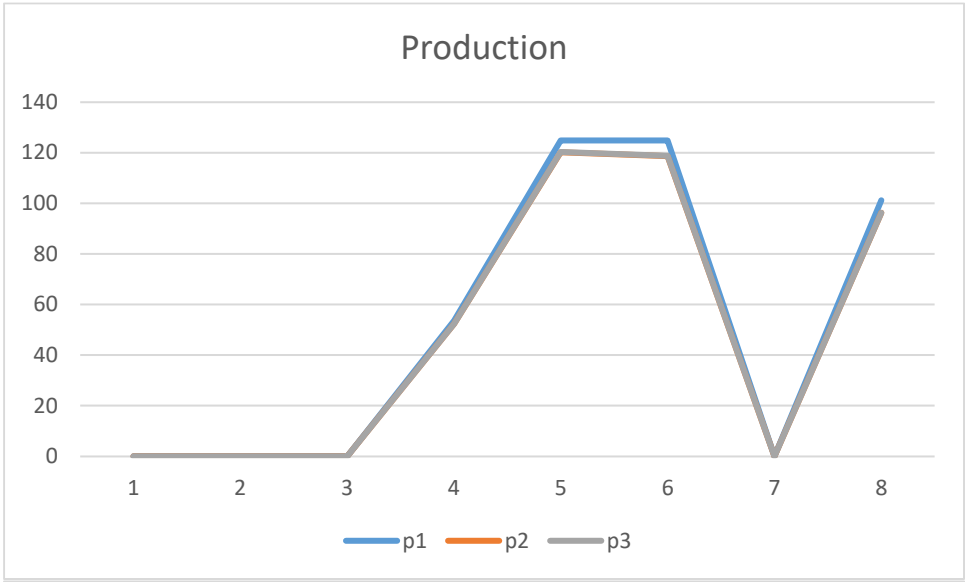
GoHydro SDDP script

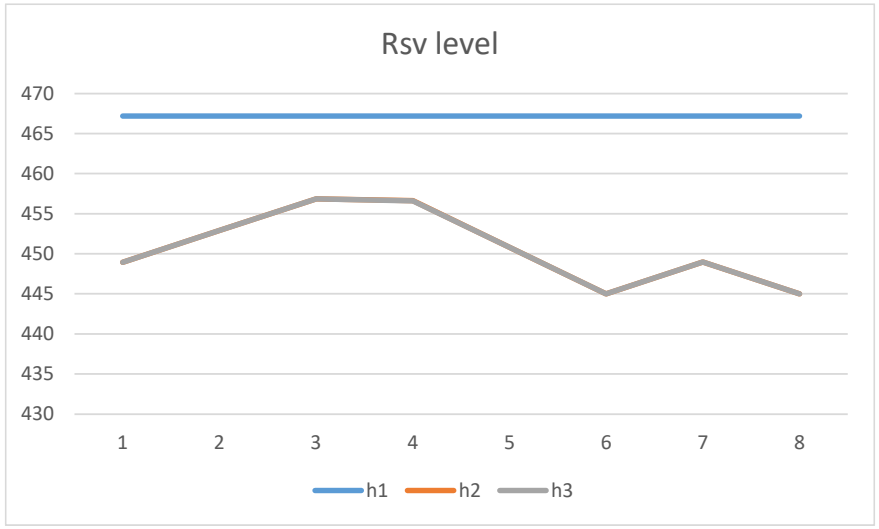


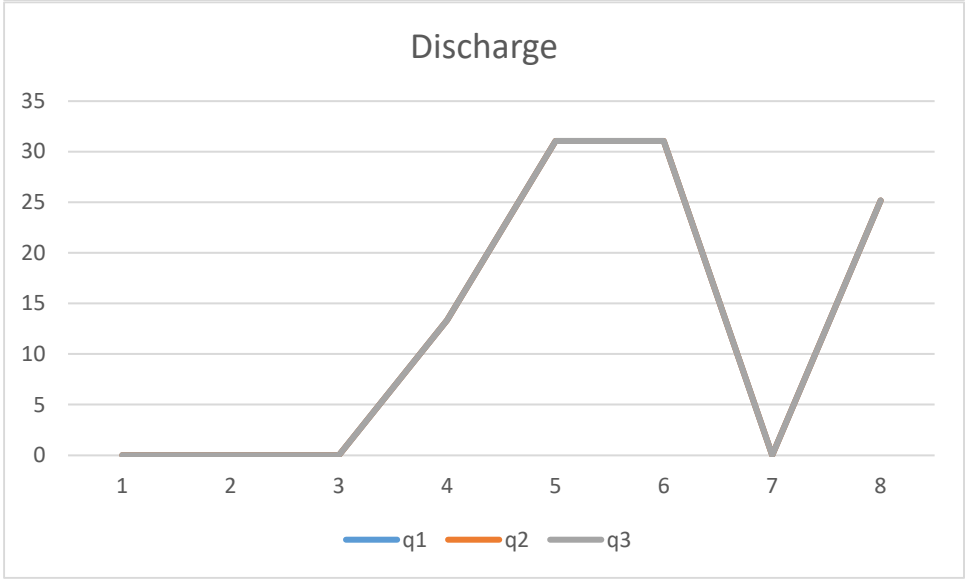
GoHydro – Modelling sum constraints



GoHydro – Iterative head coefficients

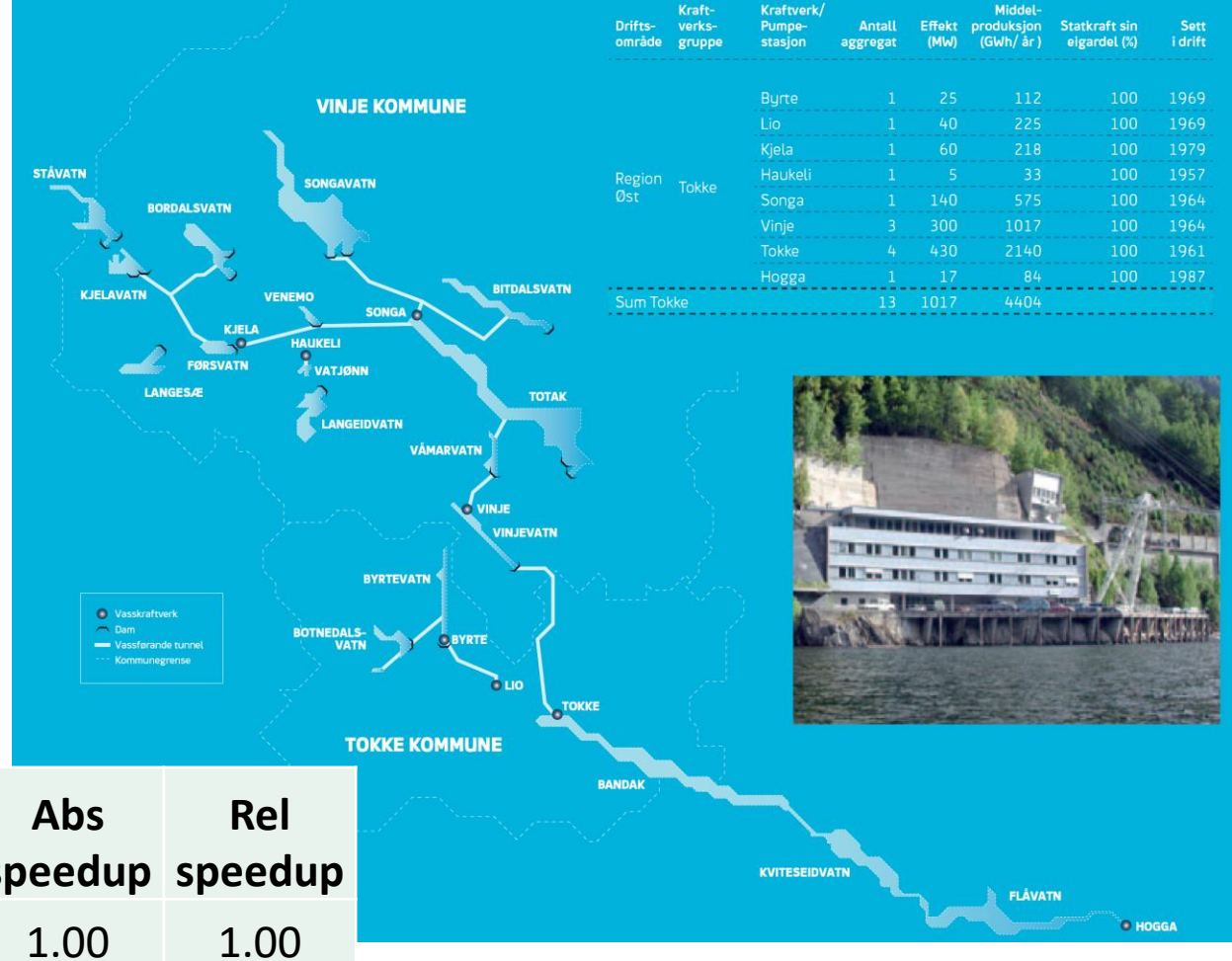






GoHydro – Scaling capabilities

sigma2



Drifts-område	Kraft-verks-gruppe	Kraftverk/ Pumpe-stasjon	Antall aggregat	Effekt (MW)	Middel-produksjon (GWh/ år)	Statkraft sin eigardel (%)	Sett i drift
Region Øst	Tokke	Byrte	1	25	112	100	1969
		Lio	1	40	225	100	1969
		Kjela	1	60	218	100	1979
		Haukeli	1	5	33	100	1957
		Songa	1	140	575	100	1964
		Vinje	3	300	1017	100	1964
		Tokke	4	430	2140	100	1961
		Hogga	1	17	84	100	1987
Sum Tokke			13	1017	4404		

nGPUs	Time (s)	Abs speedup	Rel speedup
1	172.73	1.00	1.00
2	87.26	1.98	0.99
4	45.14	3.83	0.96
8	23.28	7.42	0.93
11	17.51	9.86	0.90
22	10.15	17.02	0.77

88 scenarios, 5 years, 3-hour resolution

nGPUs	Time (s)	Abs speedup	Rel speedup
1	480.39	1.00	1.00
2	241.52	1.99	0.99
4	124.31	3.86	0.97
8	61.67	7.79	0.97
11	45.70	10.51	0.96
22	25.13	19.12	0.87

88 scenarios, 5 years, 1-hour resolution

GPU Model	Theoretical	Measured
P100	1.00	1.00
A100	2.05	1.83
H200	6.35	?

SINTEF

75 years

1950 – 2025
Technology for a better society

sintef.no/75