Brukermøtet 2013

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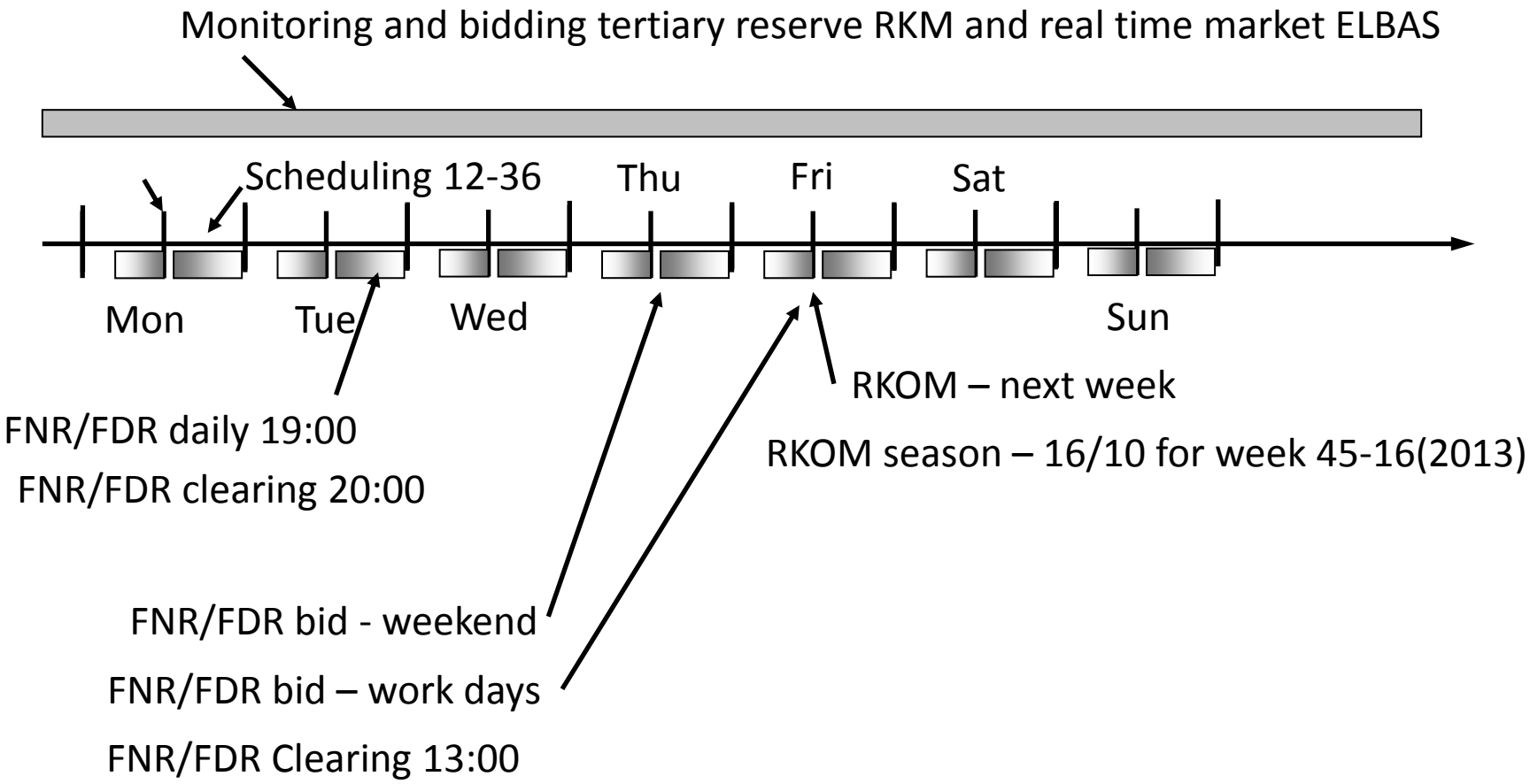
Short-time scheduling

- New functionalities available in SHOP
- Further developments in SHOP

System services in SHOP

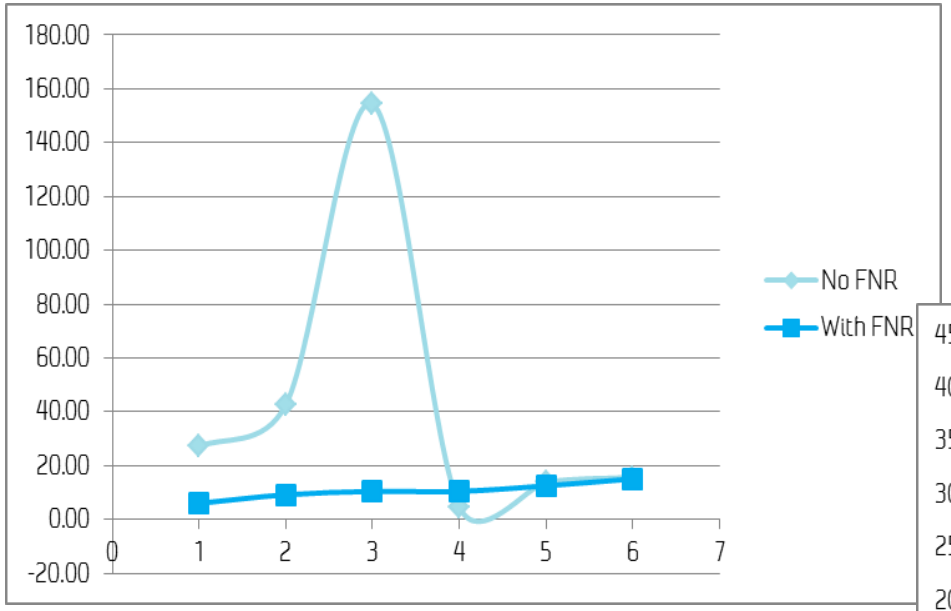
Potential applications of SHOP



Primary reserve

- FNR and FDR
  - Sum restrictions for each market
  - Respecting the minimum requirement of 2%
  - Includes adjustment of production limits
  - Includes extra wear and tear costs
- Usage of FNR functionality
  - Respecting FNR requirement in other markets
  - Optimizes distribution of droop on rotating units
    - Consequence: more units in operation and lower volumes in the day ahead market
    - Given weekly price forecast one can evaluate reserve bids

Impact on computation time

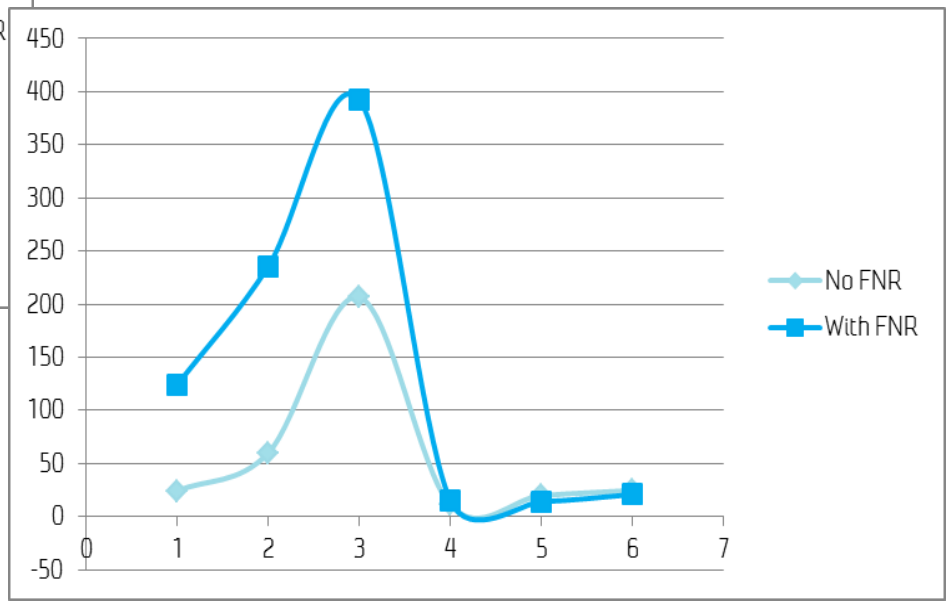


High FNR demand

~2800 binaries (1500)
~23500 constraints (16500)

Moderate FNR demand

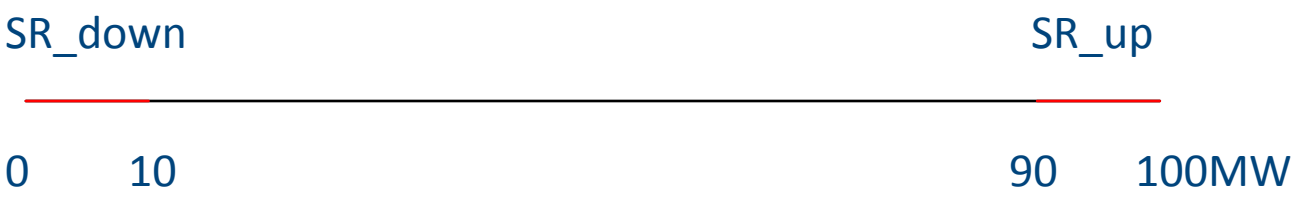
~4400 binaries (2300)
~34500 constraints (19500)



Purpose of rotating reserve schedule

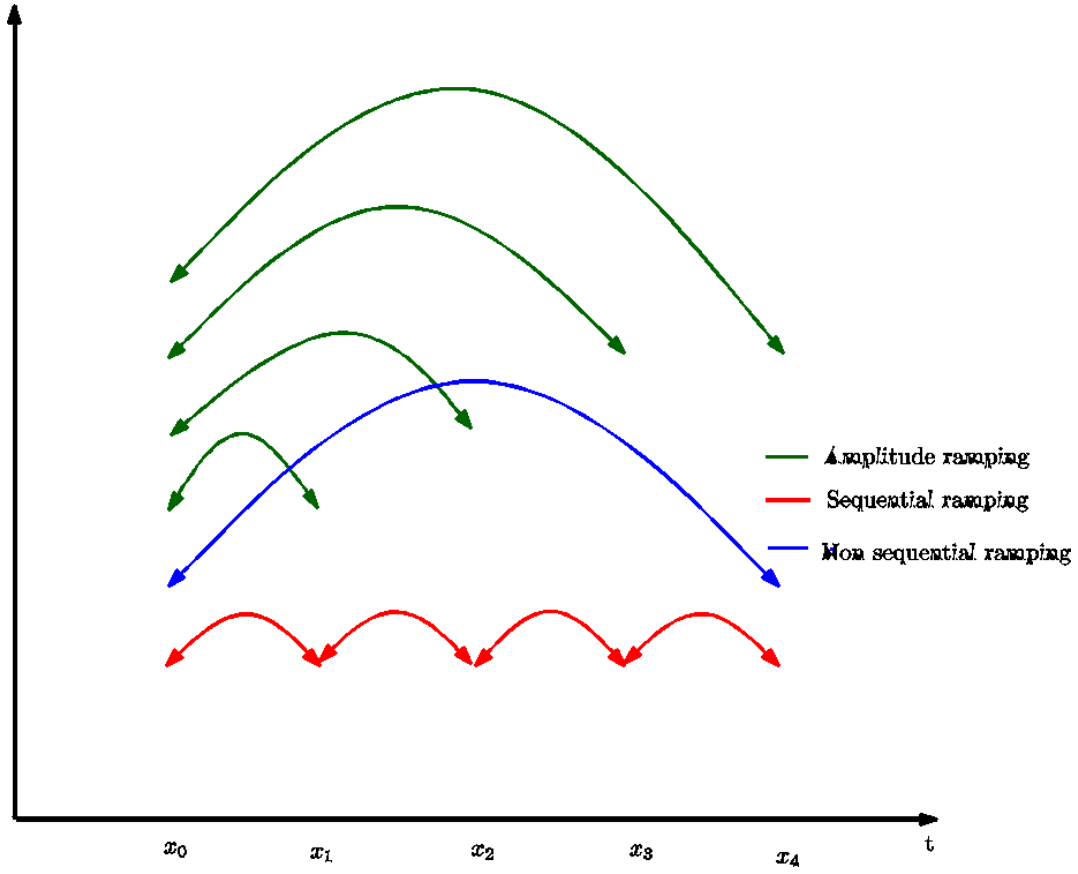
- Secondary reserves – new market since 2012

- Regulation of System Responsibility (FoS), Statnett, 2012: Reserve capacity reserved in one market may not be included in the calculation of reserve capacity to other markets
- Assuming that the user has a schedule on generator level for LFC obligations
- This should be taken into account by reducing the free capacity on the relevant units in the SHOP

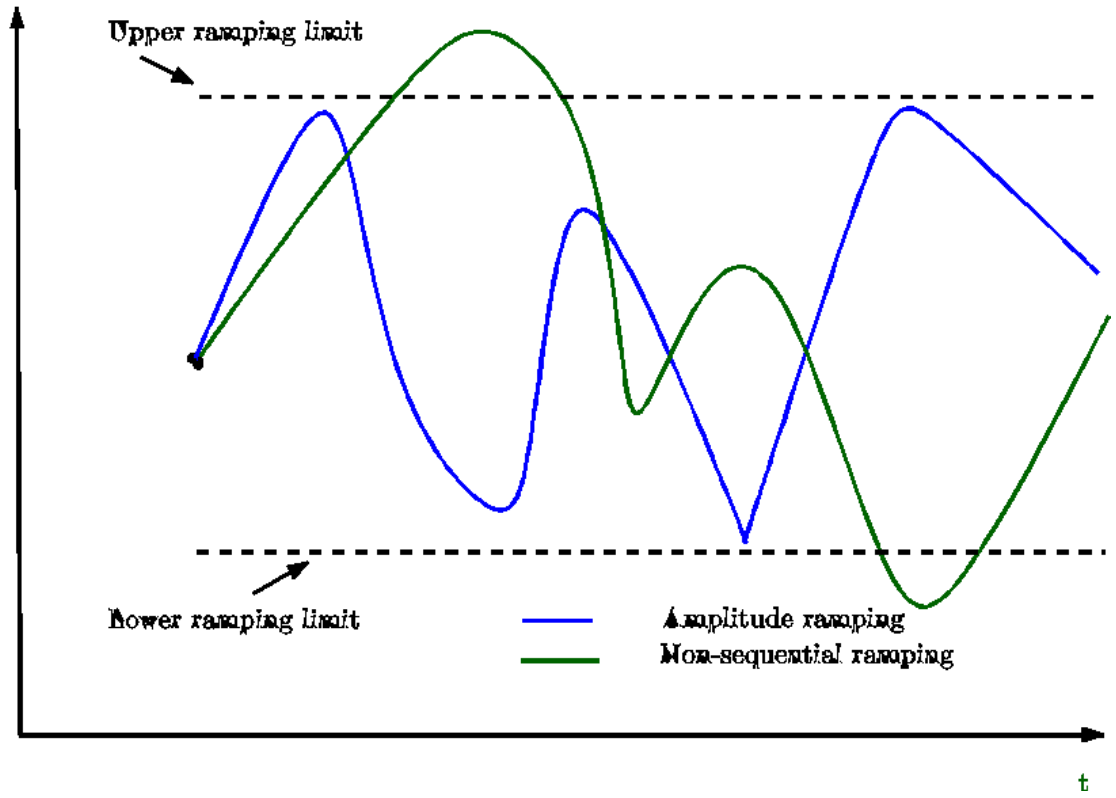


Reservoir ramping constraints over multiple time steps

Amplitude and non-sequential ramping



Amplitude and non-sequential ramping



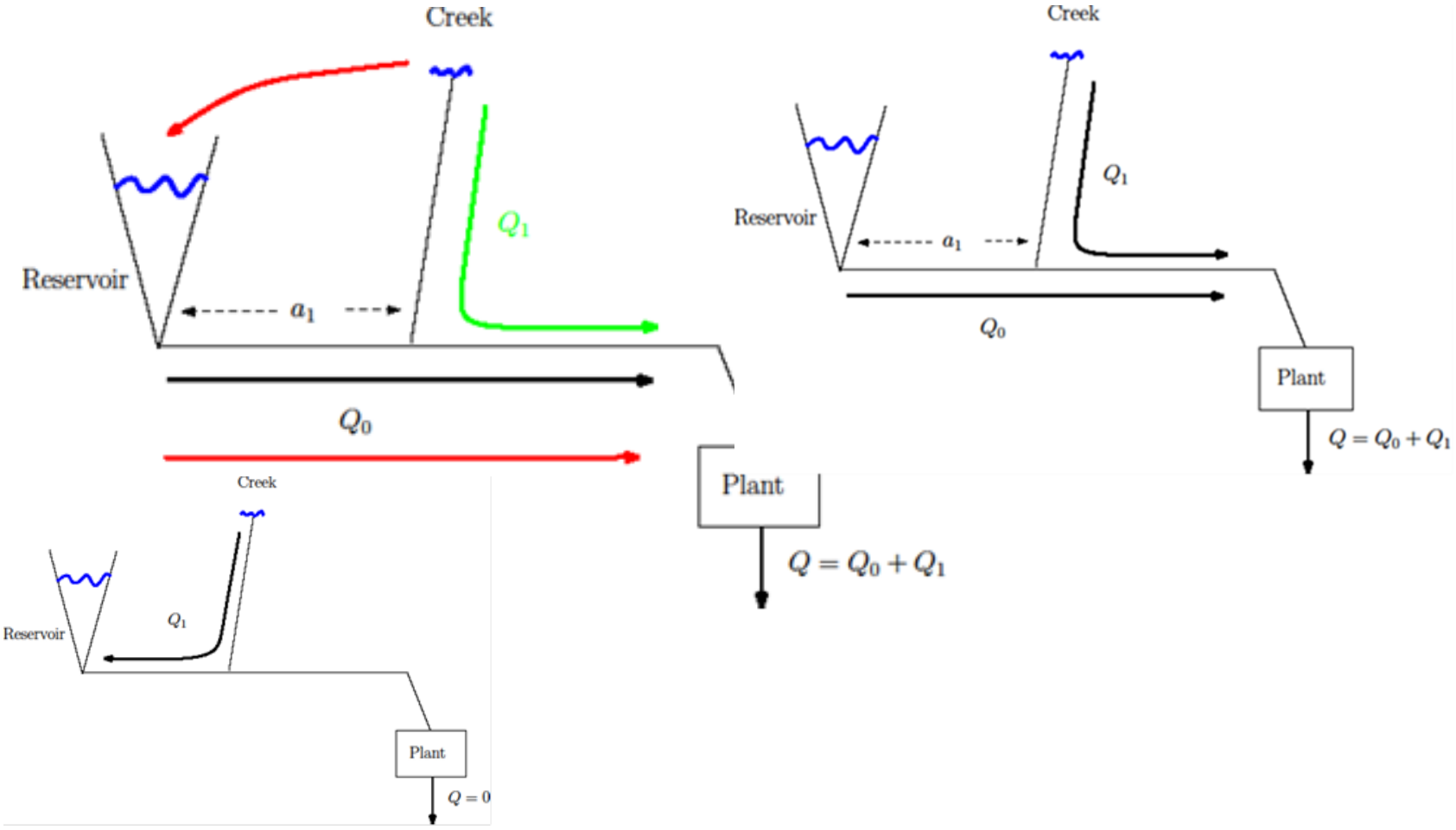
Amplitude and non-sequential ramping

- An amplitude ramping constraint will give a restriction on max change of reservoir volume for all time steps the constraint yields.
- A non sequential ramping constraint will give a restriction on max change of reservoir volume for two arbitrary time steps.
- Input data in new TTXY format:

- *RESERVOIR amplitude_ramping my_rsv*
- *0 0 20130120000000000 MINUTE 14400 -1 MM3 2*
- *20130120000000000 20130120200000000 2*
- *20130120200000000 20130130000000000 3*

New Creek Intake model

Restrictions in the previous model

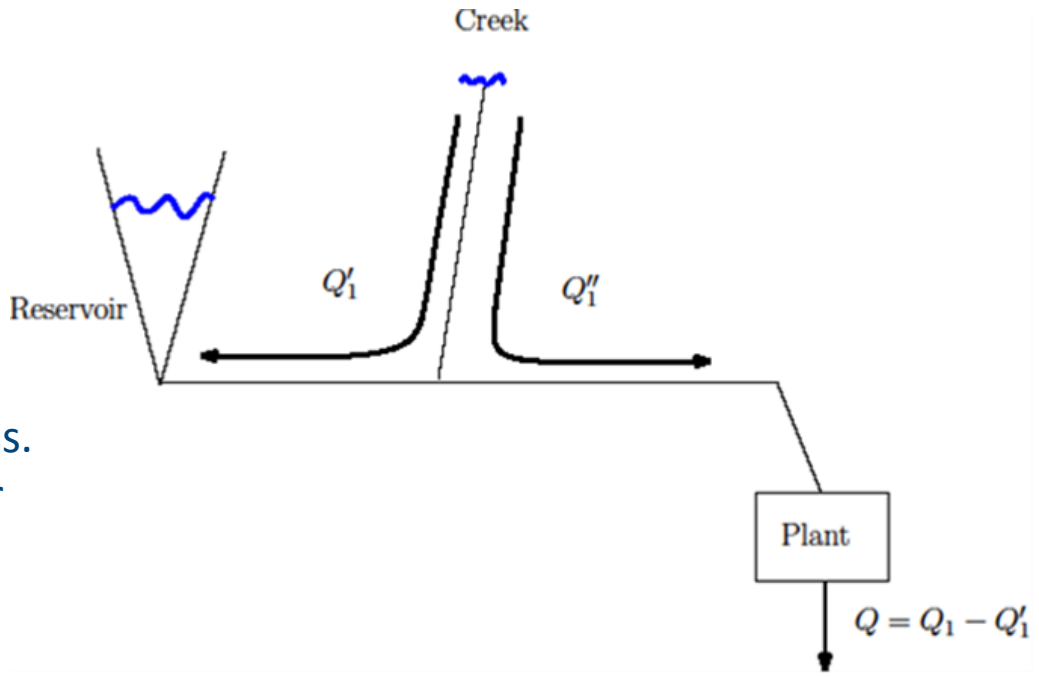


Restrictions in the previous model

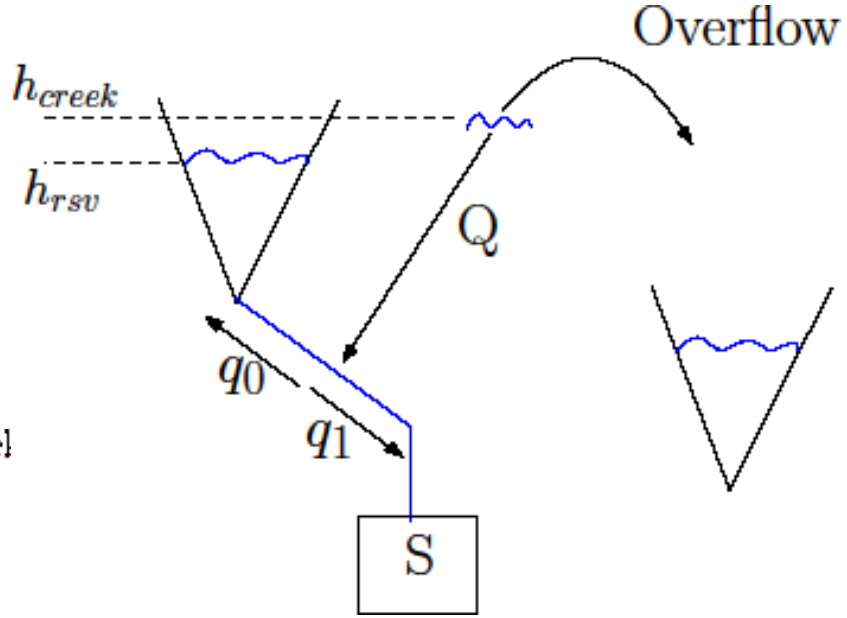
- It is not possible to have several creek intakes in series.
- When inflow is larger than the capacity of the intake, one has to extract the overflow manually.
- When the plant is running , the plant discharge has to exceed the inflow to the creek intake. This means that one cannot have simultaneous inflow to the plant and the reservoir.

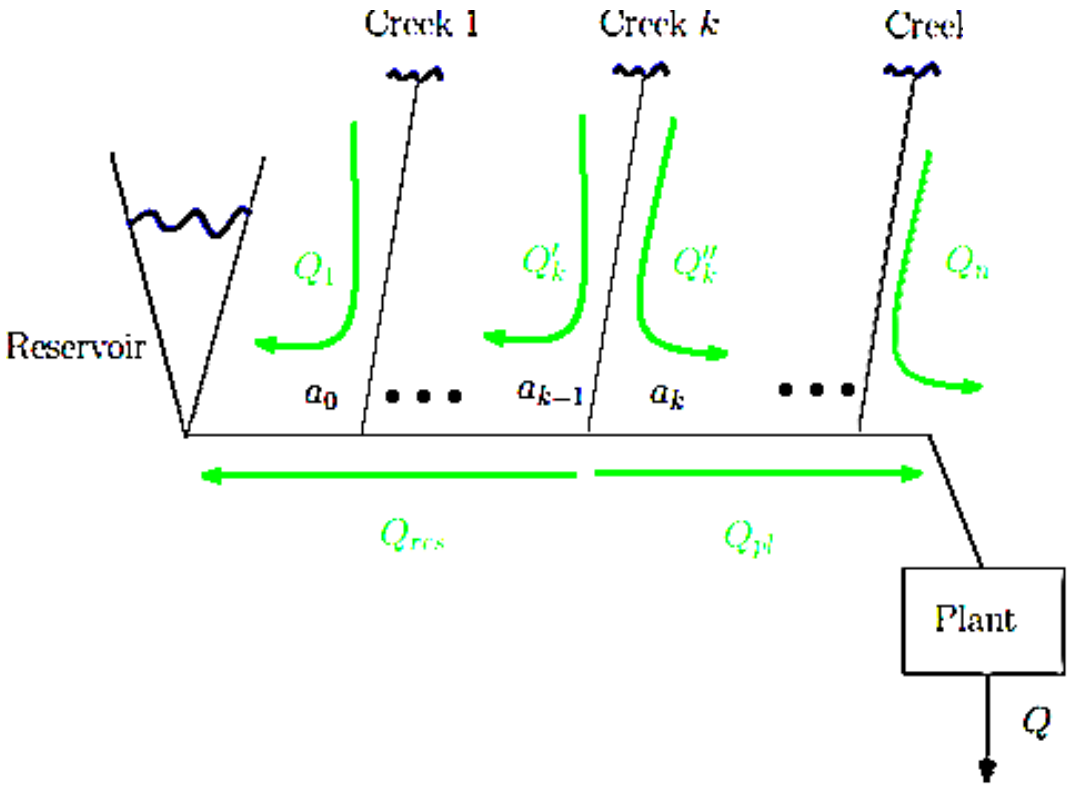
The new creek intake model

- Modeling correct inflow in the right place in the watercourse
- Reducing the head loss in the PQ-model of the plant when there is inflow in the creek intake
- Model can handle negative head loss. and further increase the impulse for running the plant



Description of the new model





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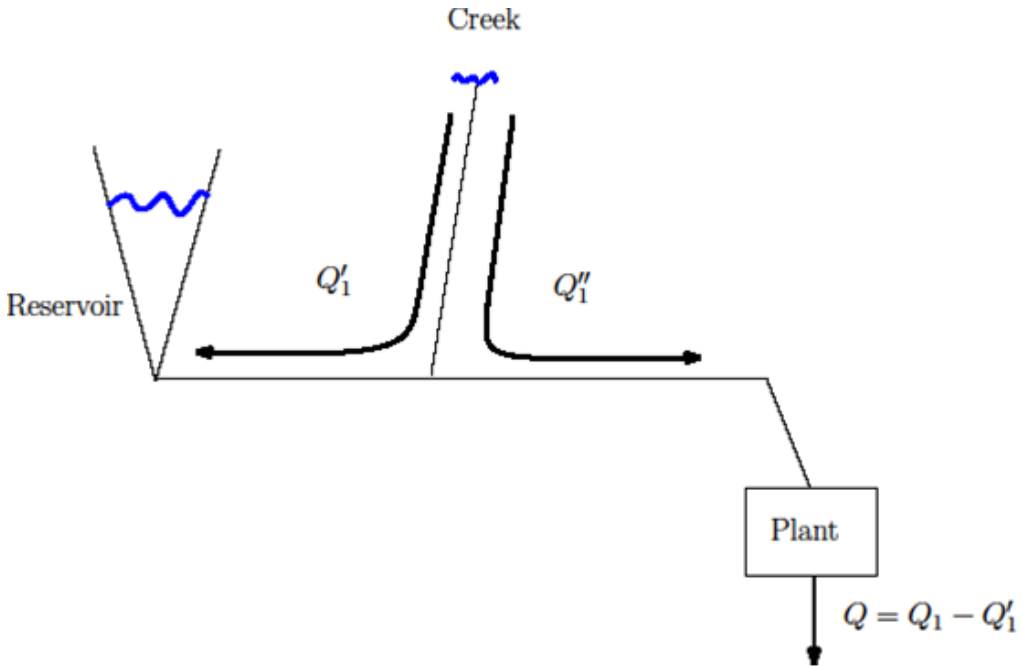

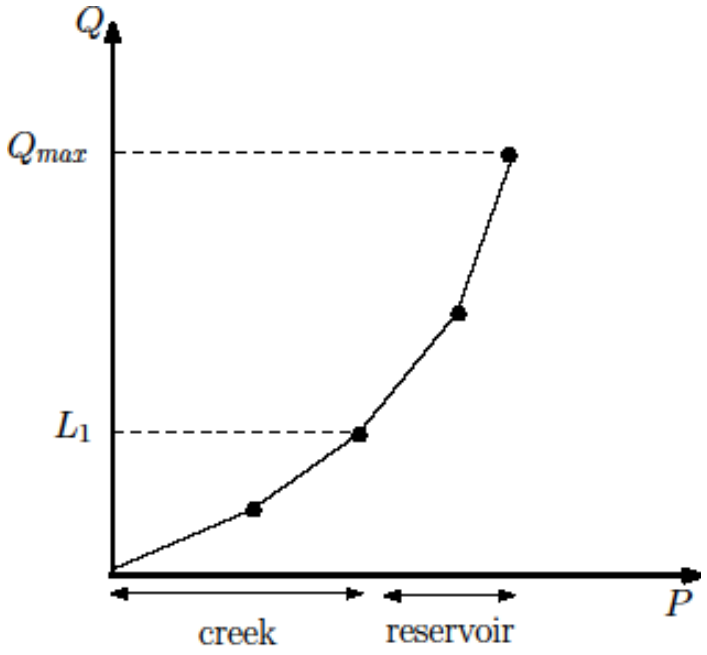

$$L_1 = \min\{Q_1, CAP_{on}\}$$

$$Q \leq Q_{max}$$

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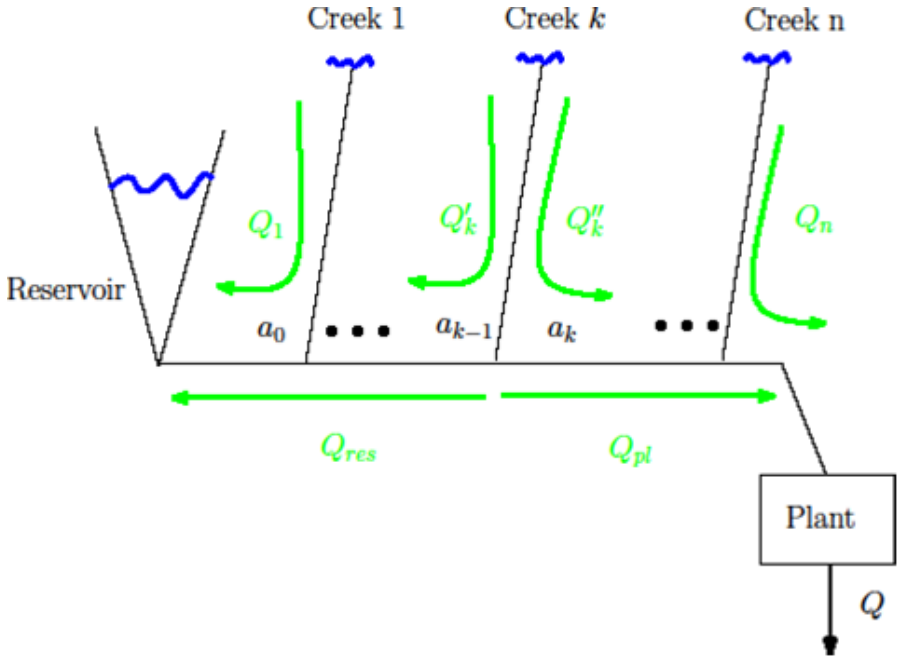
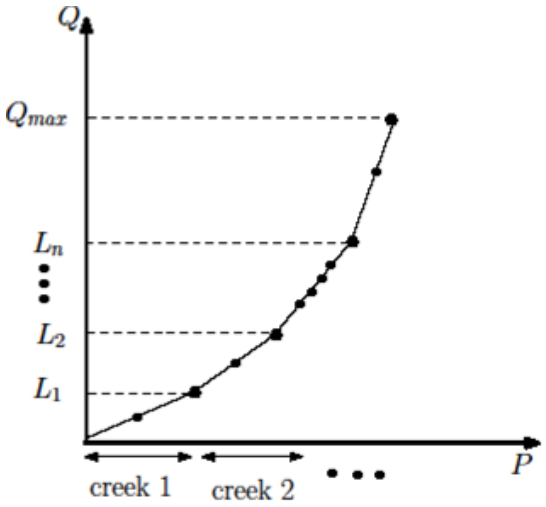
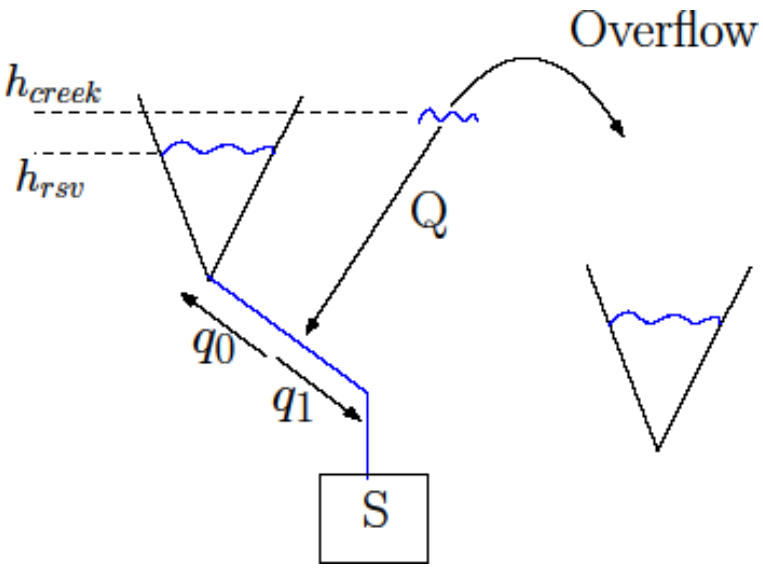
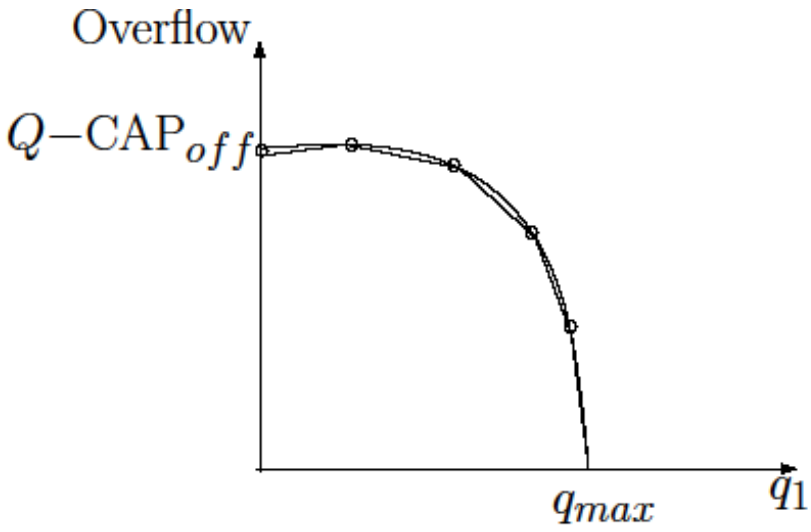




$$L_1 = \min\{Q_n, CAP^n_{on}\}$$
$$L_2 = \min\{Q_n, CAP^n_{on}\} + \min\{Q_{n-1}, CAP^{n-1}_{on}\}$$
$$\vdots$$
$$L_n = \min\{Q_n, CAP^n_{on}\} + \min\{Q_{n-1}, CAP^{n-1}_{on}\} + \ldots + \min\{Q_1, CAP^1_{on}\}$$
$$Q \leq Q_{max}$$

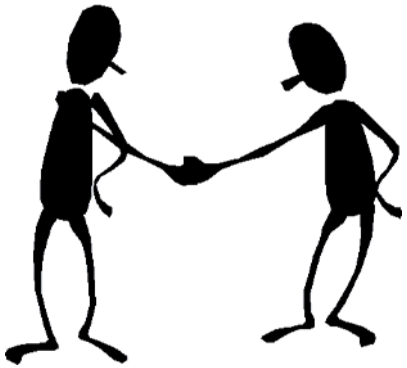
Overflow modelling





$$\text{Overflow} = Q-\mathrm{CAP}_{off} + \Sigma_{i=1}^{k}\left(\frac{\overline{q}_0^{i-1}-\overline{q}_0^{i}}{q_{max}} - 1\right)\cdot q_1^i$$

Other SHOP activities



- Reduce the computation time whilst improve the quality of results
  - Efficiency curves as polynomials
  - Combining cuts and water values
- Improved coupling between models
  - Using dependent and independent water values in the same model
- Get new functionality into operational use
  - Adjustments and follow-up

Other SHOP activities

- Internal priority list on maintenance
  - 64-bit version of SHOP v9…….
  - Upgrading documentation
  - Improved test systems
  - Specific upgrades on gates, maximum, state dependent gates, user defined penalty values on hydraulic slack
  - Profiling and fixing memory leaks
  - More detailed diagnose testing and user support

Future work

- New EnergiNorge project is on the planning stage (Workshop in September)
  - Combining optimization and simulation
  - Parallel processing
  - Time resolution and calculation time
  - Flexible modeling, user over longer time horizons
  - Decision aid towards new markets
  - Optimal segmentation of all non-linear curves
- Algorithm improvements especially regarding MIP problems
- Reserve handling – combining existing and new functions regarding reserve handling

The SHOP -team

- Michael Belsnes
- Frederic Dorn
- Hans Ivar Skjelbred
- Jiehong 'Kiki' Kong

Takk for meg!

(Turbine) efficiency curves as polynomials

Efficiency curves as polynomials

- Currently efficiency curves are given as tables with discrete points.
- We can obtain a good description of the curve using many points:
  - BUT: point description restricts accuracy
  - Increased calculation time when using too many points.
- Improved description can be achieved by polynomial description of the efficiency curve.
- Challenge: How to interpolate between curves specified for different pressure heights?
- Implemented as an alternative to the current table description.

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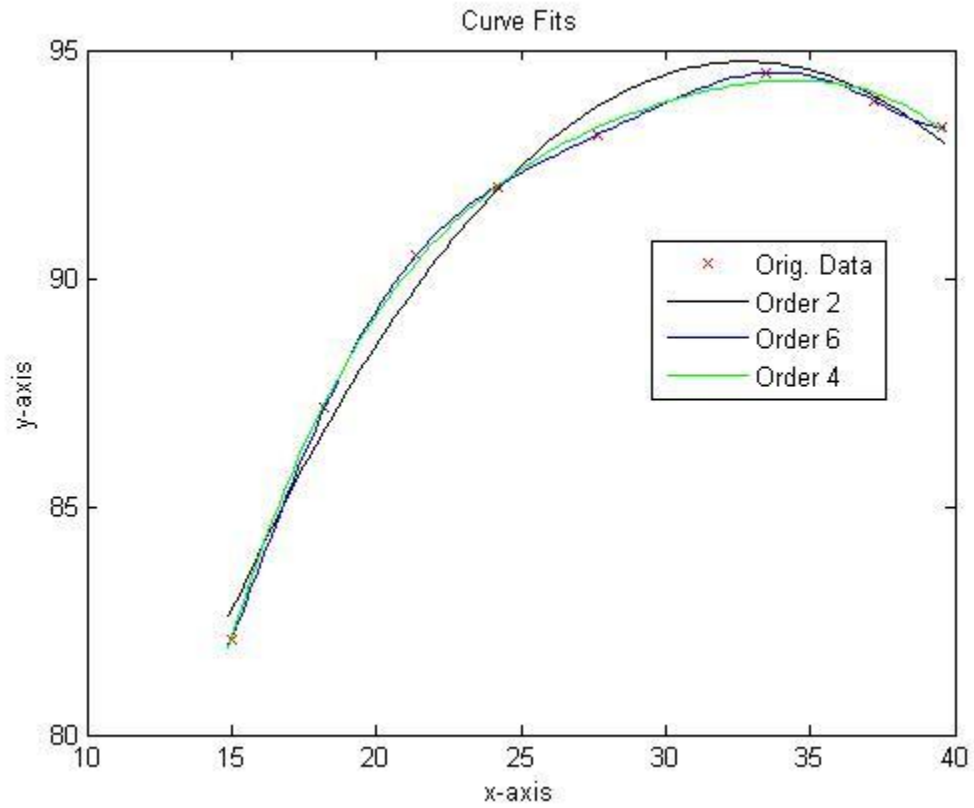
Polynomial vs. discrete curve



Polynomial vs. discrete curve

Polynomial approximation of curve with few discrete points is equivalent to the use of curves with many points.

- Will result in better running time compared to the model with many points on curves.
- More accurate than discrete curve with few points around working points.

Technology for a better society