CHAIN

Smart Water Networks

Concept and distribution network

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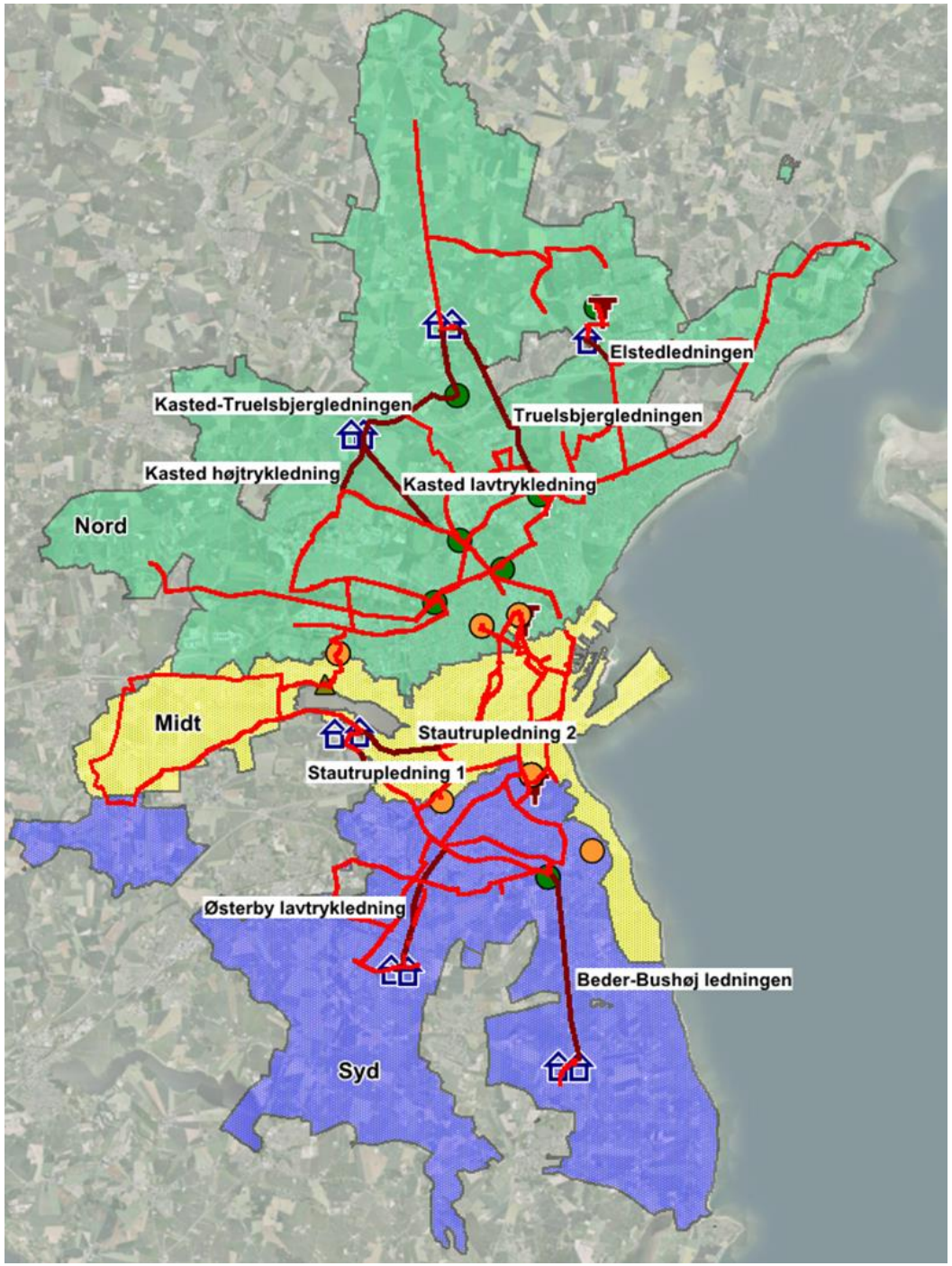
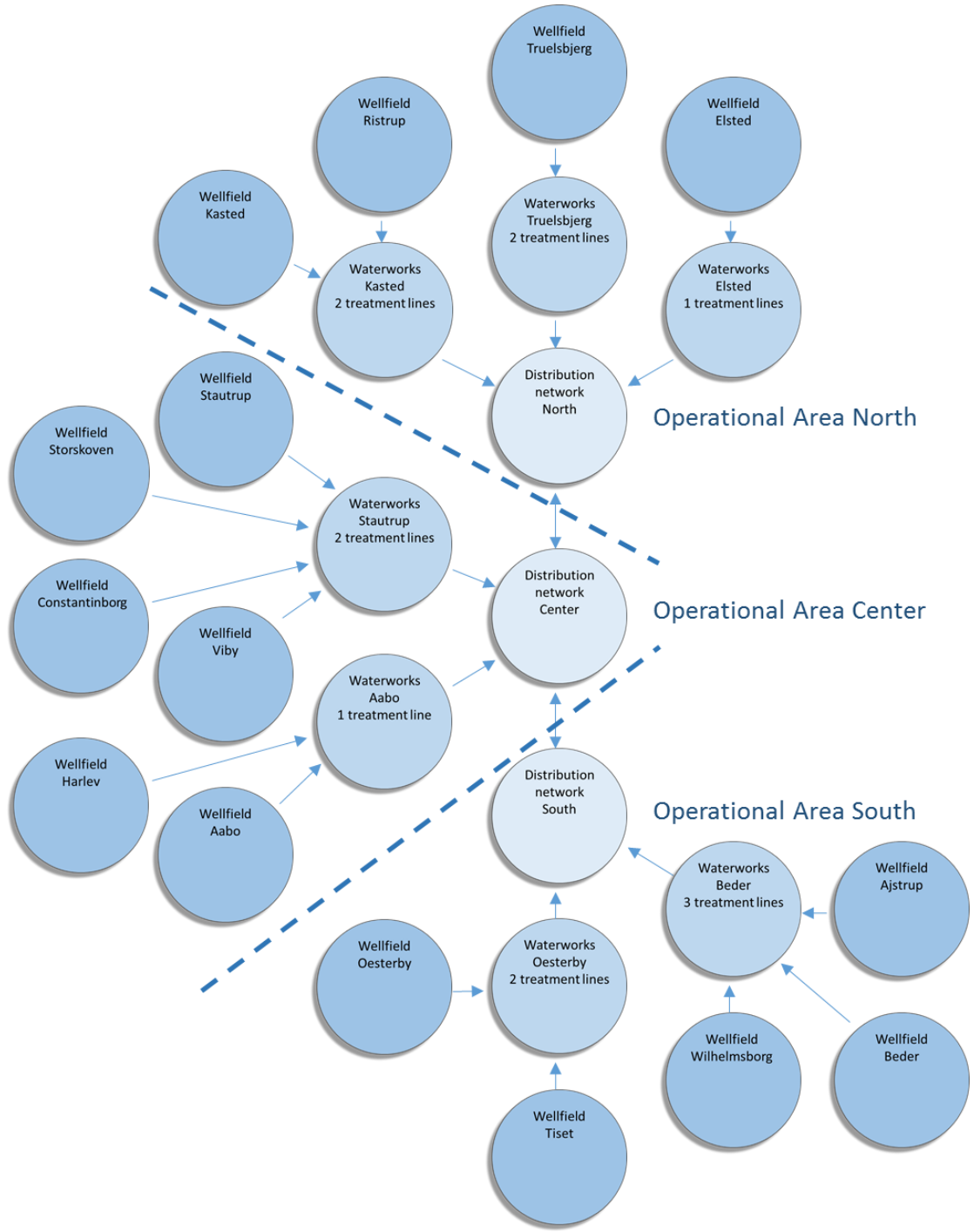
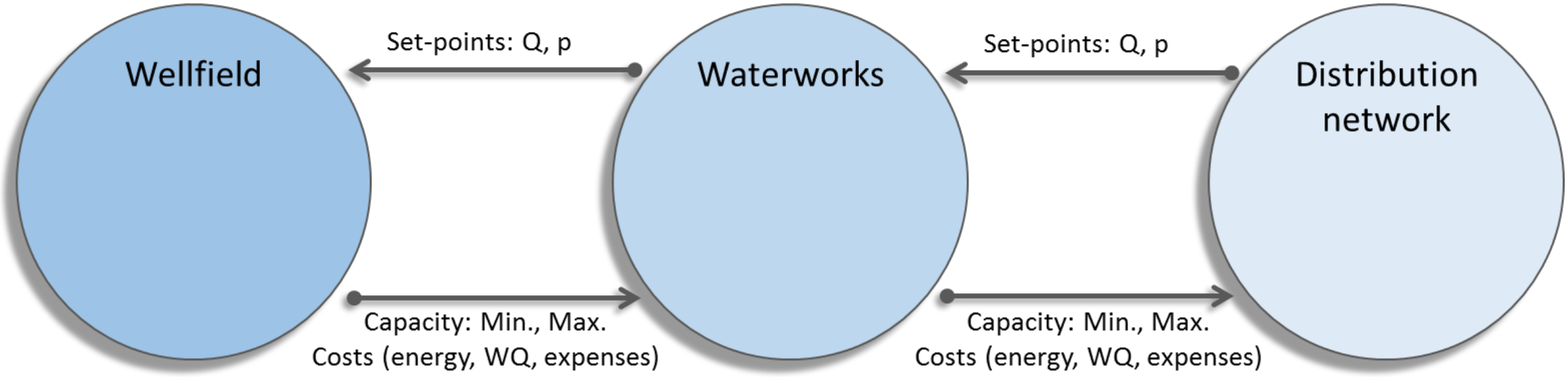
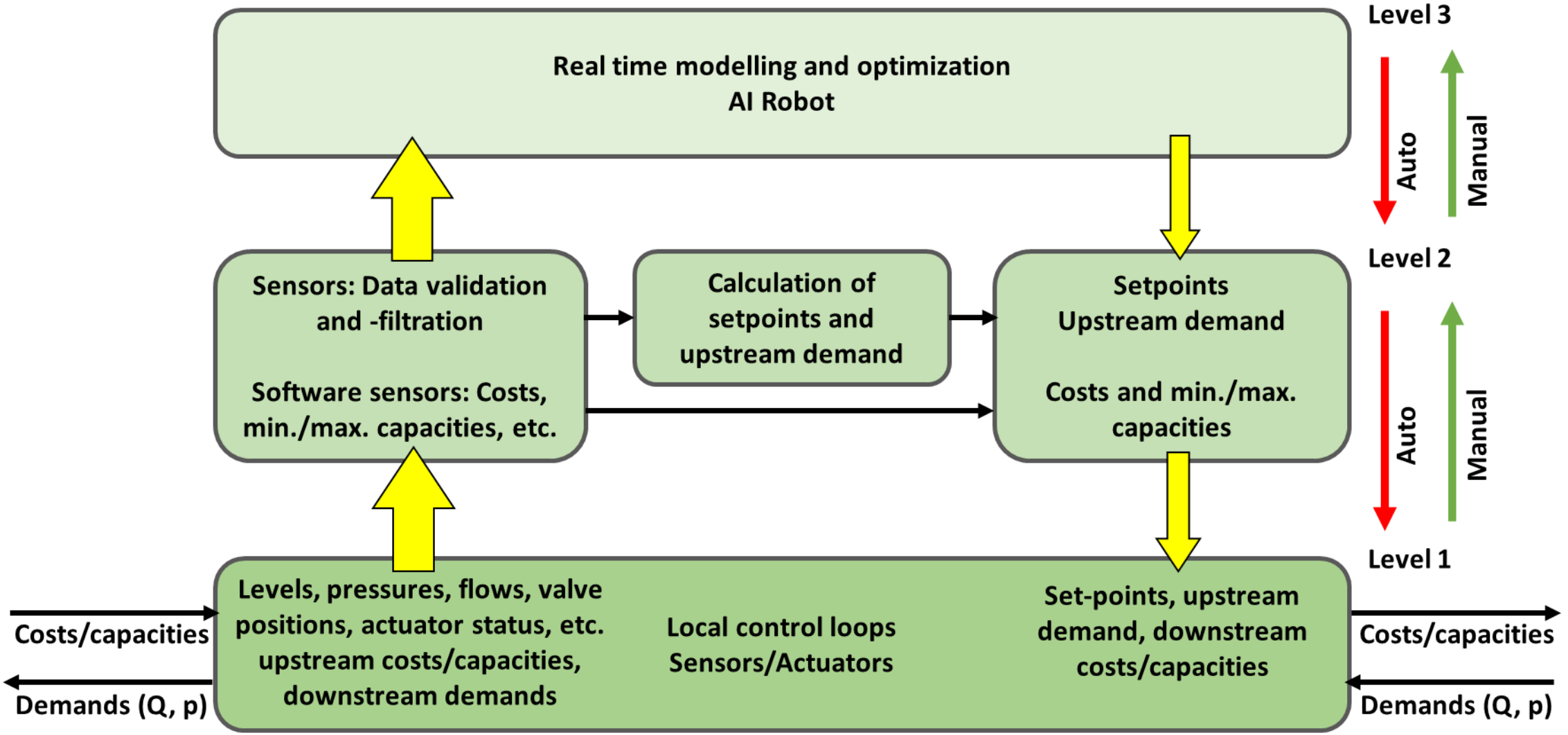

Elstedledningen
Kasted-Truelsbjergledningen
Truelsbjergledningen
Kasted højtrykledning
Kasted lavtrykledning
Nord
Midt
Stautrupledning 2
Stautrupledning 1
Østerby lavtrykledning
Beder-Bushøj ledningen
Syd


Wellfield Truelsbjerg
Wellfield Ristrup
Wellfield Elsted
Wellfield Kasted
Waterworks Truelsbjerg 2 treatment lines
Waterworks Kasted 2 treatment lines
Waterworks Elsted 1 treatment lines
Wellfield Stautrup
Distribution network North
Operational Area North
Wellfield Storskoven
Waterworks Stautrup 2 treatment lines
Wellfield Constantinborg
Distribution network Center
Operational Area Center
Wellfield Viby
Waterworks Aabo 1 treatment line
Wellfield Harlev
Distribution network South
Operational Area South
Wellfield Aabo
Waterworks Beder 3 treatment lines
Wellfield Ajstrup
Wellfield Oesterby
Waterworks Oesterby 2 treatment lines
Wellfield Wilhelmsborg
Wellfield Beder
Wellfield Tiset

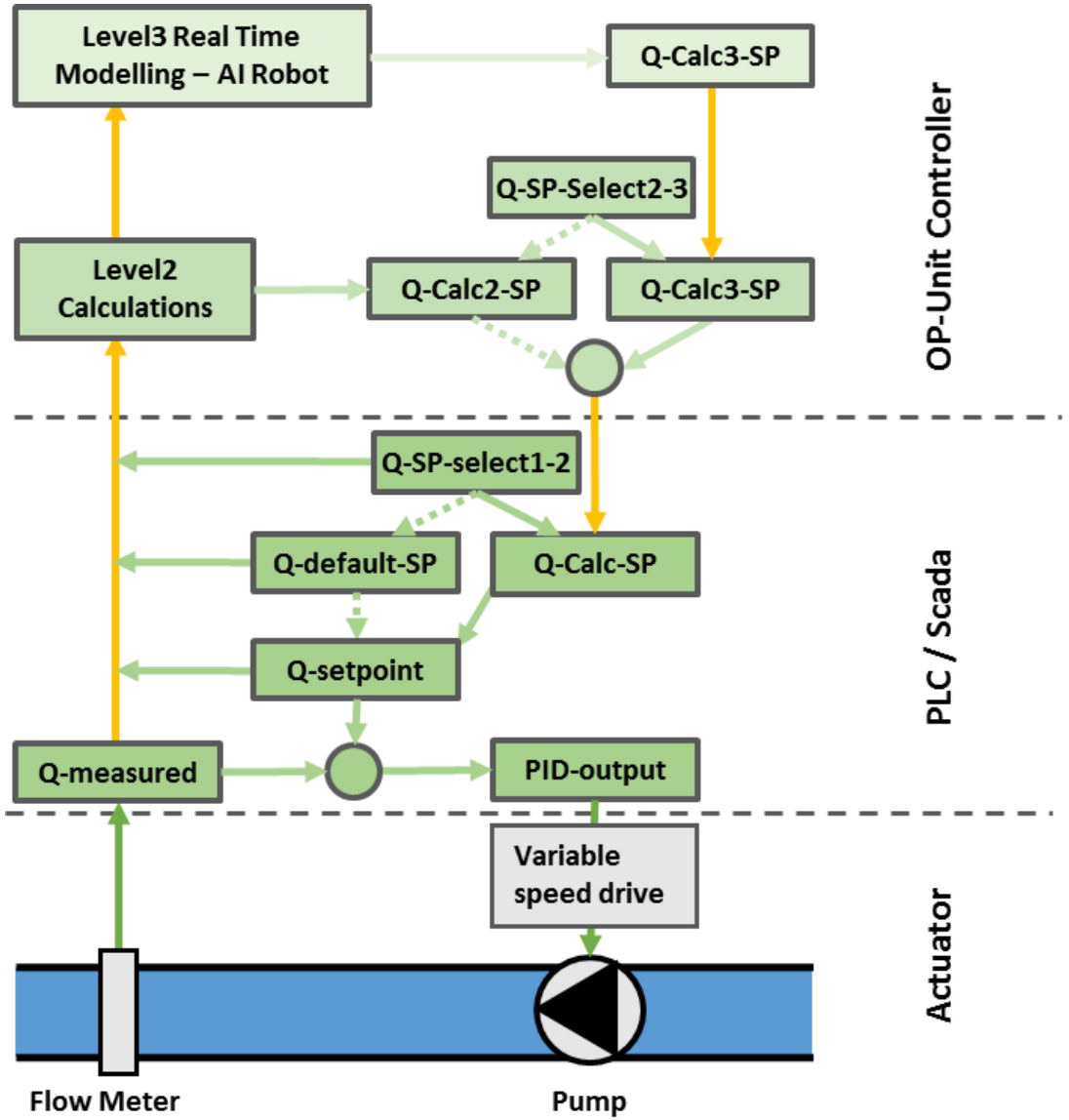
Concept: Demand Driven Water Supply

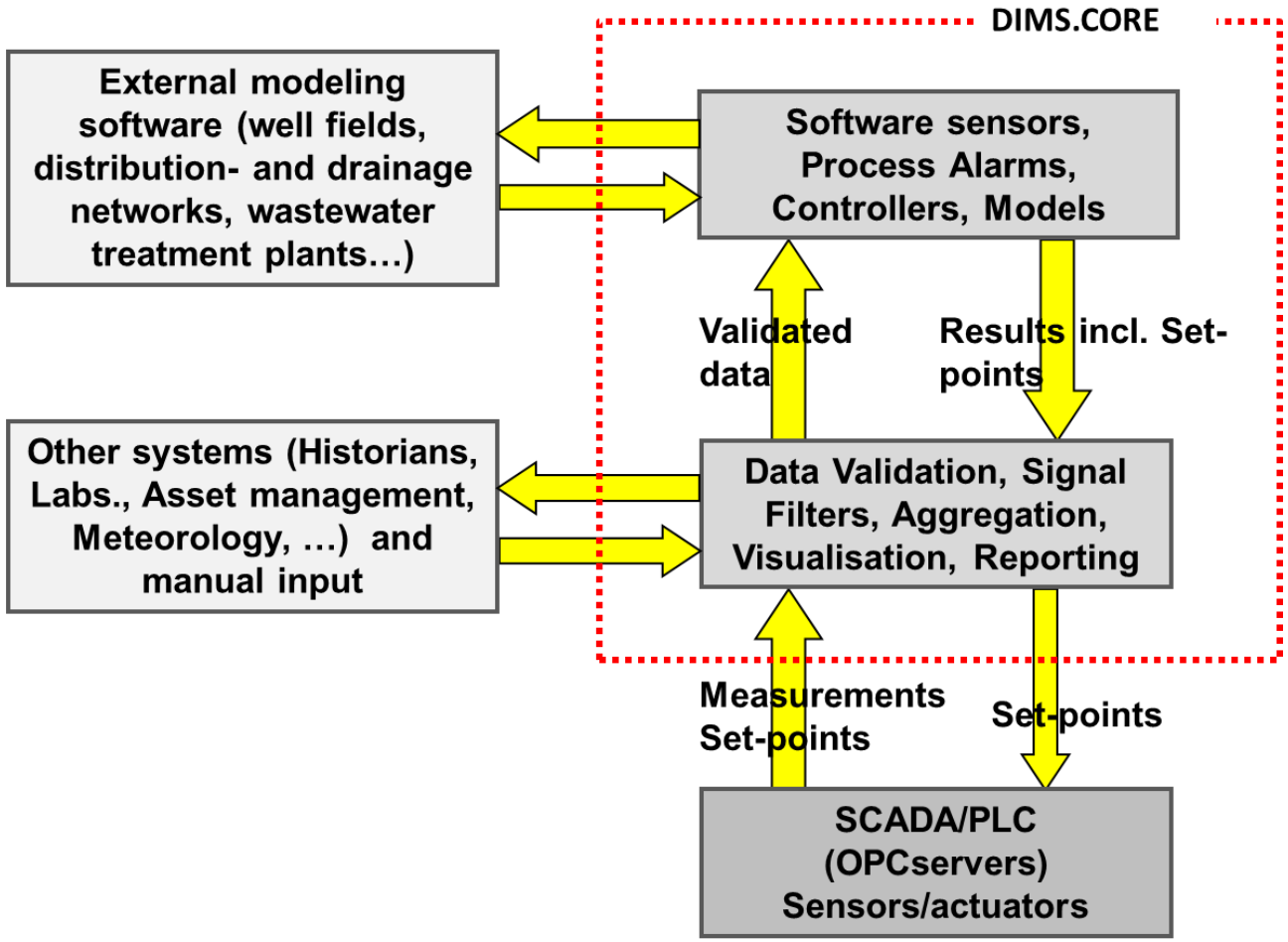


Internal structure of operational units

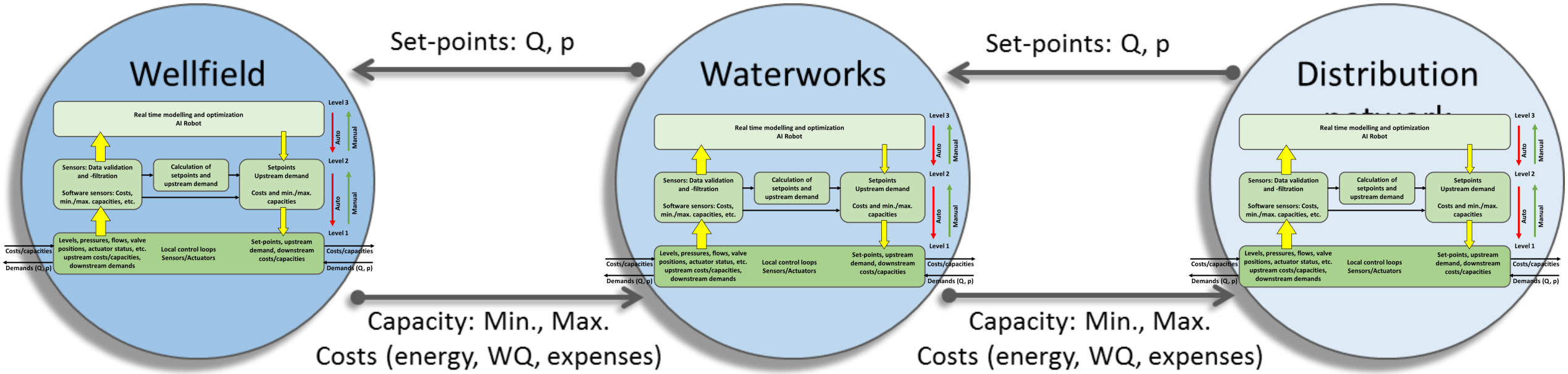


Automation platform – layered structure



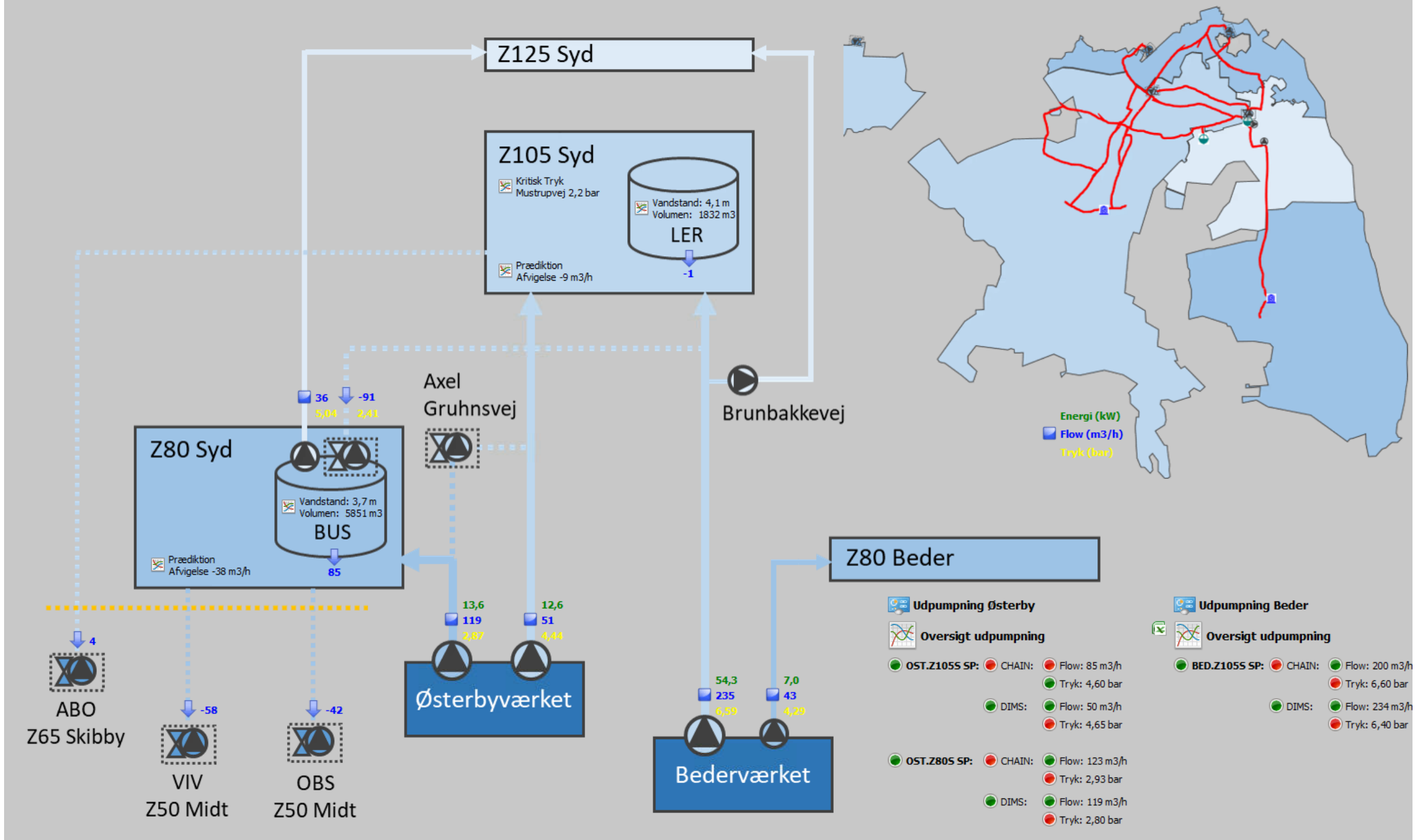


Architecture

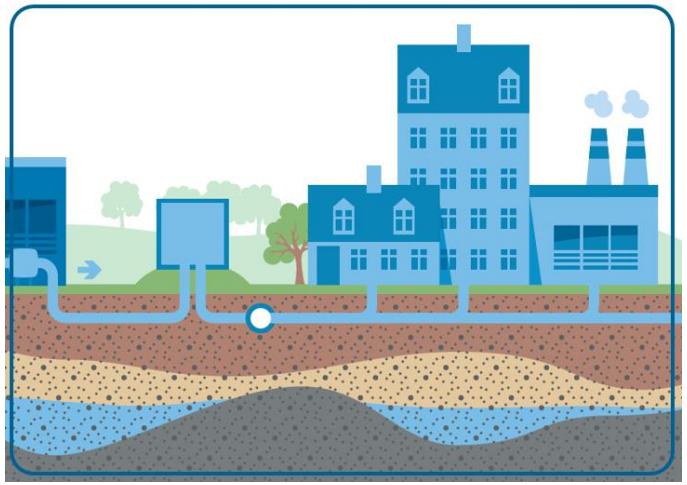


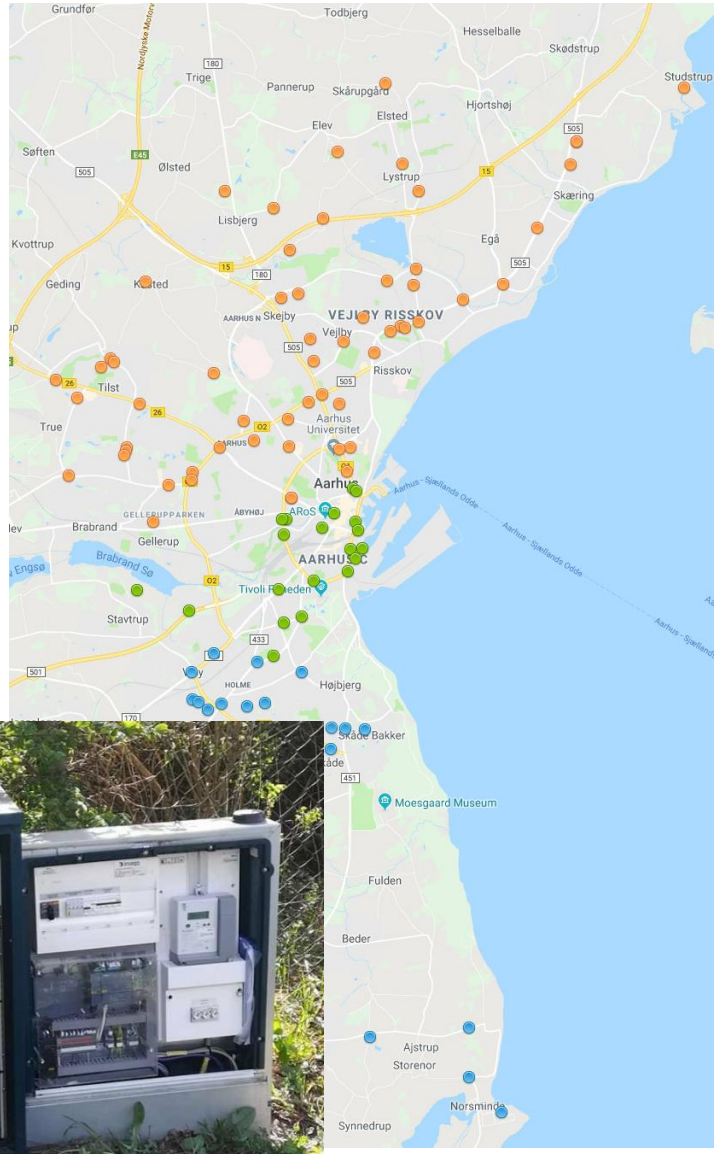
Robust design:

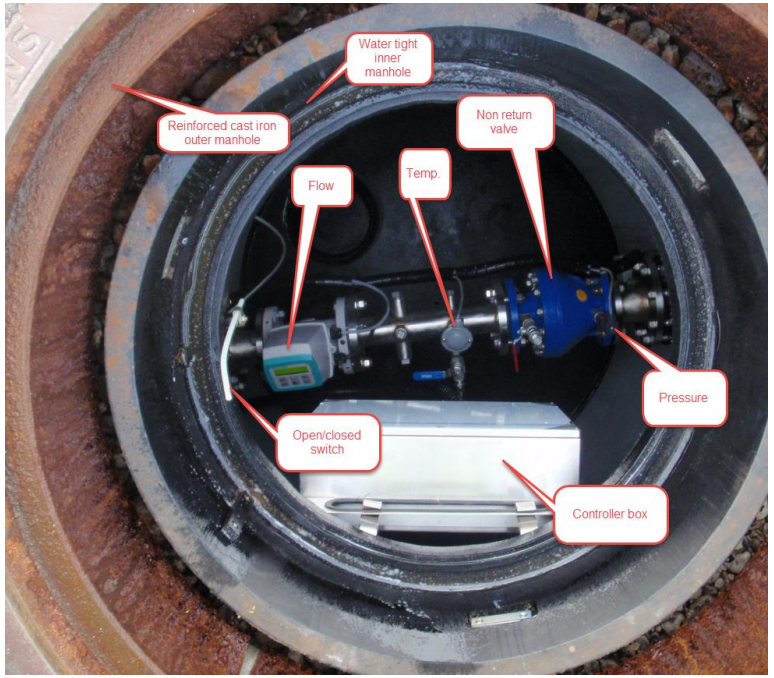
- Independent implementation
- Independent training and re-training due to infrastructure changes
- Independent of type of water resource and water treatment


Z125 Syd
Z105 Syd
Kritisk Tryk
Mustrupvej 2,2 bar
Vandstand: 4,1 m
Volumen: 1832 m3
LER
-1
Prædiktion
Afvigelse -9 m3/h
Axel
Gruhnsvej
Brunbakkevej
36
5,04
-91
2,41
Z80 Syd
Vandstand: 3,7 m
Volumen: 5851 m3
BUS
85
Prædiktion
Afvigelse -38 m3/h
Energi (kW)
Flow (m3/h)
Tryk (bar)
13,6
119
2,87
12,6
51
4,44
Østerbyværket
54,3
235
6,59
7,0
43
4,29
Bederværket
Z80 Beder
4
ABO
Z65 Skibby
-58
VIV
Z50 Midt
-42
OBS
Z50 Midt
Udpumpning Østerby
Oversigt udpumpning
OST.Z105S SP:
CHAIN:
Flow: 85 m3/h
Tryk: 4,60 bar
DIMS:
Flow: 50 m3/h
Tryk: 4,65 bar
OST.Z80S SP:
CHAIN:
Flow: 123 m3/h
Tryk: 2,93 bar
DIMS:
Flow: 119 m3/h
Tryk: 2,80 bar
Udpumpning Beder
Oversigt udpumpning
BED.Z105S SP:
CHAIN:
Flow: 200 m3/h
Tryk: 6,60 bar
DIMS:
Flow: 234 m3/h
Tryk: 6,40 bar

Sections



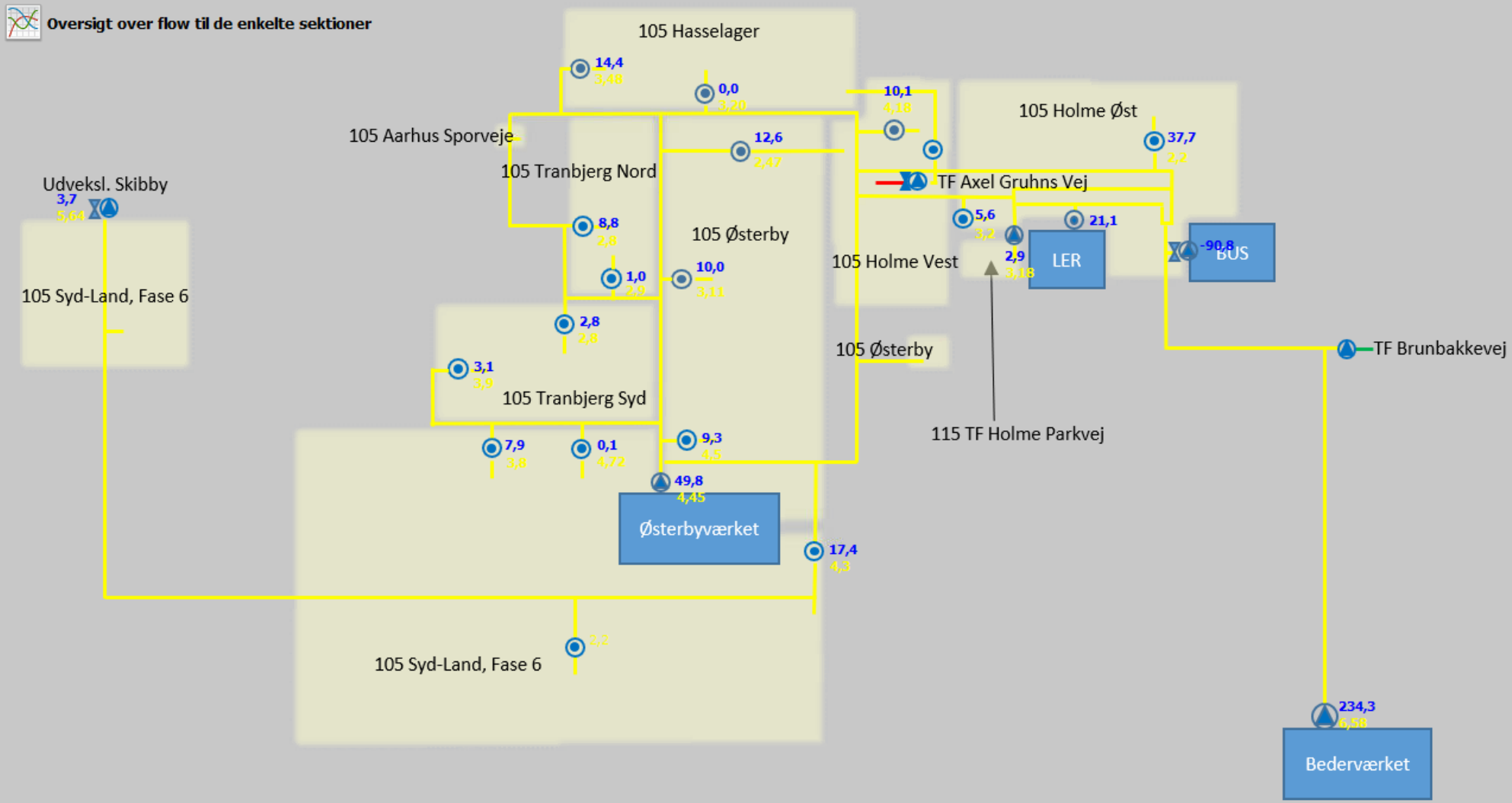




Generations of District Metering – latest version to the right

Flowbalance Z105 Syd

Oversigt over flow til de enkelte sektioner



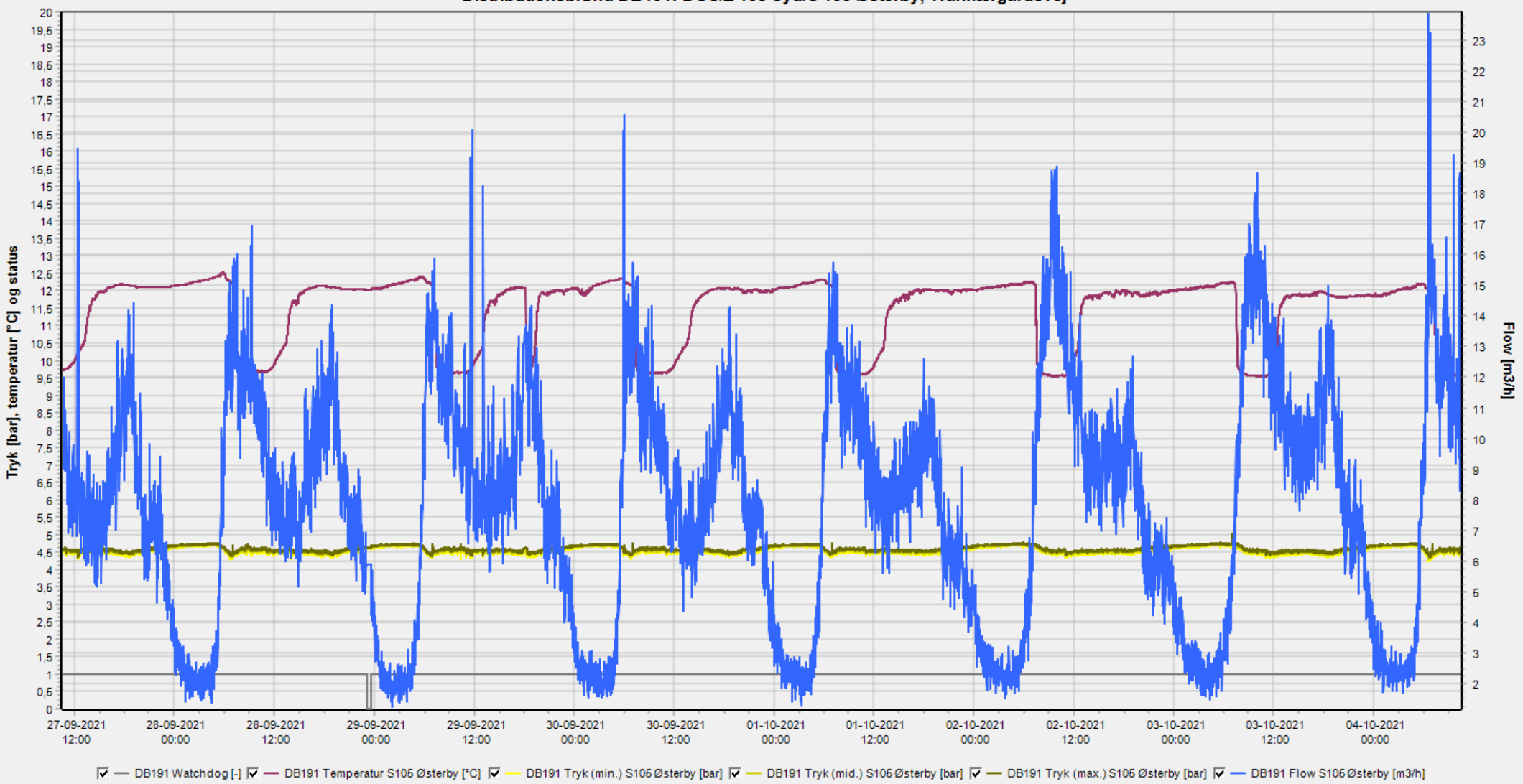
Signatur:

Flow [m3/h]

Tryk [bar]

Dataset chart

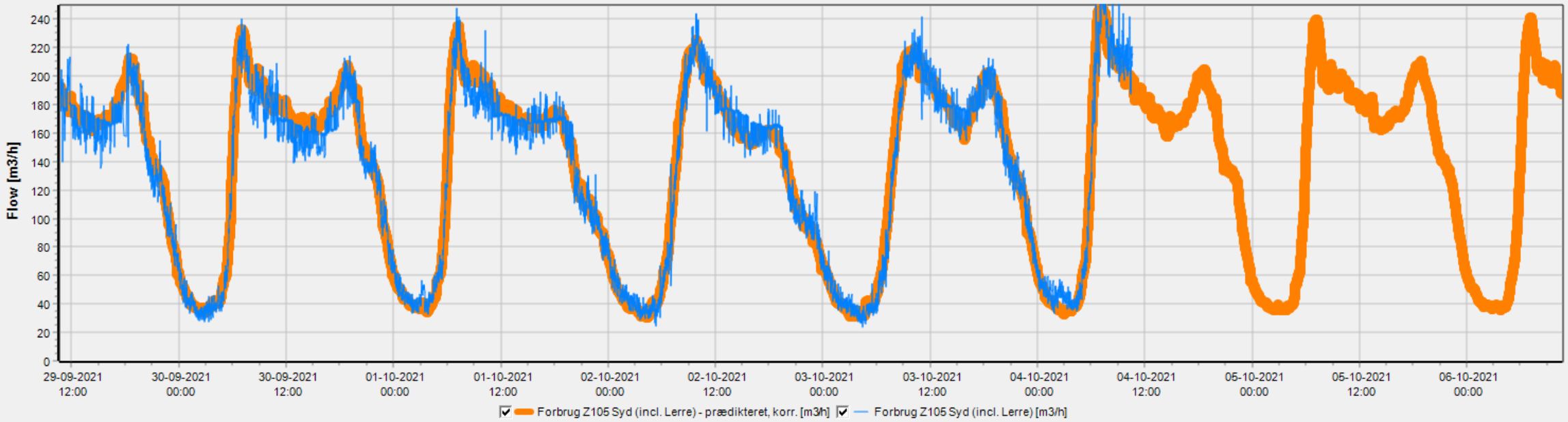
DB191



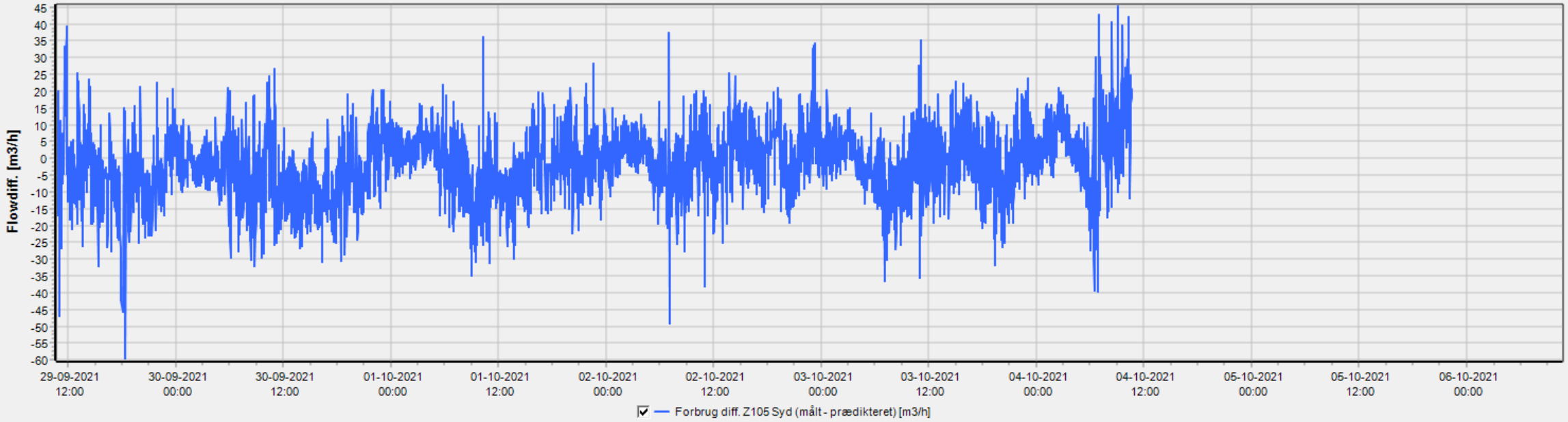
DB PLC\DB191: DOS/Z 105 Syd/S 105 Østerby

Close

Forbrug forsyningszone Z105 Syd



Flowdifference Z105 Syd: målt minus prædikteret [m3/h]



Prædiktion:
7 dage fre for hvert minut beregnes én gang i timen

Q_{-n}: Dette minut - n uger tilbage
Q_{-1}: Dette minut - sidste uge
Q_0: Dette minut
Q_1: Dette minut - næste uge

Fravælg:
$Max(Q_0, Q_{-1}, \ldots, Q_{-n})$
$Min(Q_0, Q_{-1}, \ldots, Q_{-n})$

$$Q_1 = \left(\sum_{k=0}^{-n+2} Q_k \right) / (n - 1)$$

$Q_{1,max} = Max(Q_0, Q_{-1}, \ldots, Q_{-n+2})$
$Q_{1,min} = Min(Q_0, Q_{-1}, \ldots, Q_{-n+2})$

$$Q_{1,expfilt} = Q_{1,expfilt,old} + \varepsilon * (Q_1 - Q_{1,expfilt,old})$$

$Q_{1,korrigeret} = Tidsforskyd(\varepsilon, Q_{1,expfilt})$

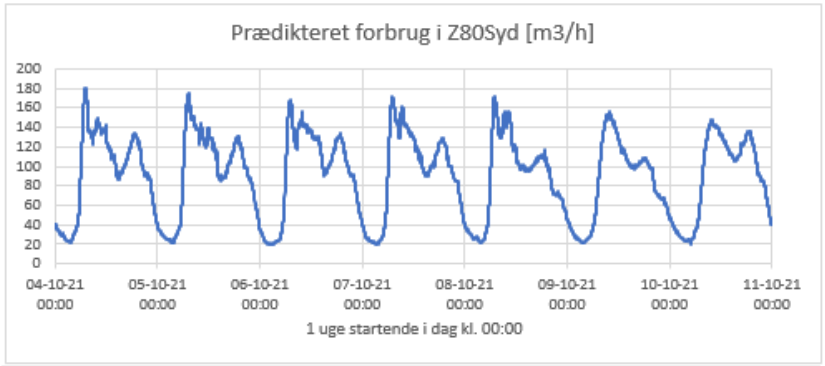
Beholderstyring Bushøj: Volumen = 1600 m2 * niveau

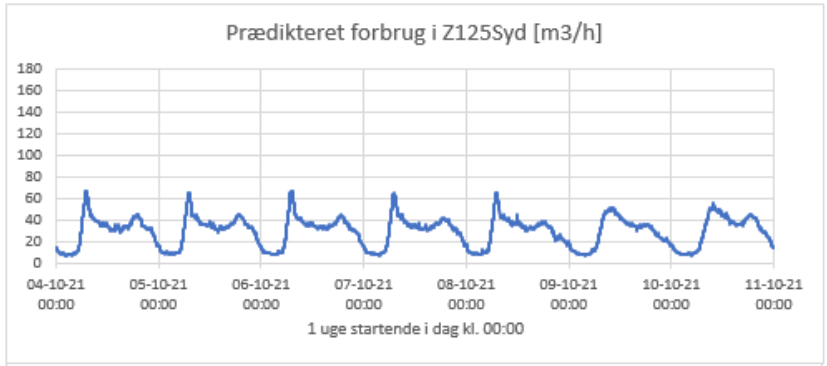
Forstærkning * (ønsket niveau - målt niveau) + fast flow

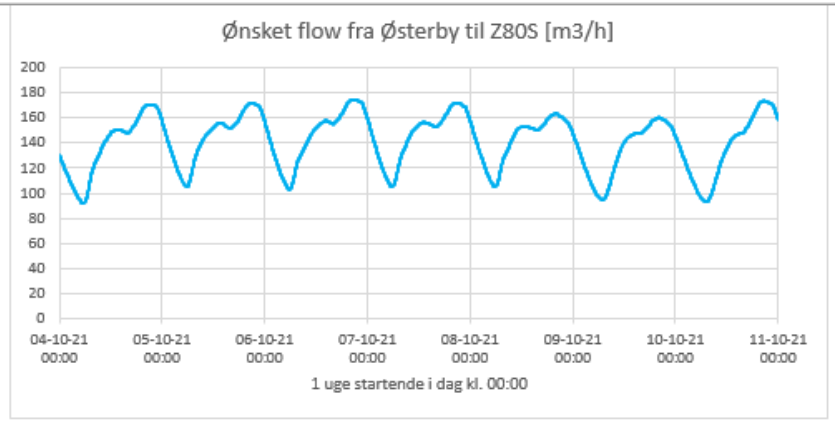
Forstærkning	200	
Ønsket niveau	4,25	m
Fast flow	0	m3/h
Max. flowkrav tilladt	250	m3/h
Ønsket start niveau	3,6	m

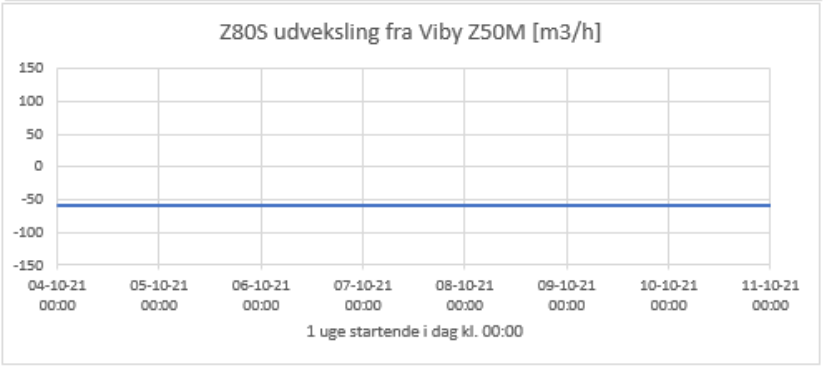
Andre flow til/fra Z80syd

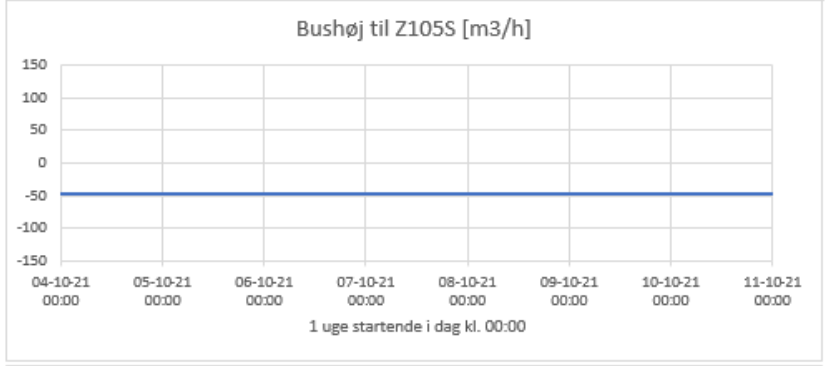
	Flow udenfor perioden	Flow inde i perioden	Periodeangivelse Time start	Time slut
Bushøj til Z105syd	0	-47	0	23
Udveksling fra Viby	0	-60	0	23
Udveksling fra Observato	0	-30	16	22
Simulering af brud	0	0	6	8

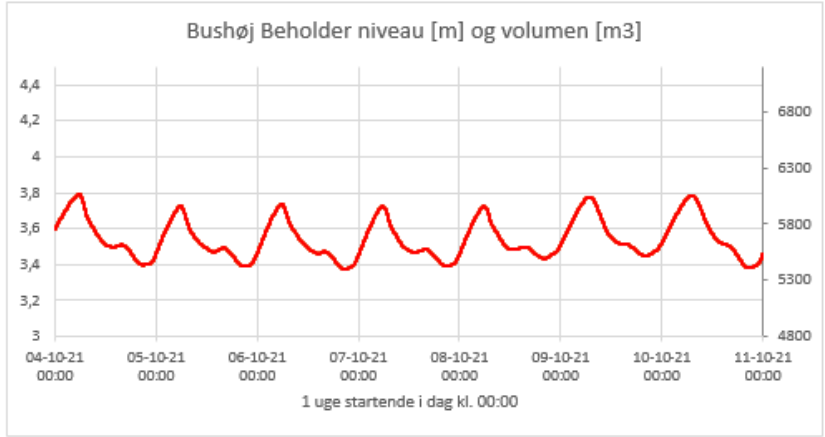


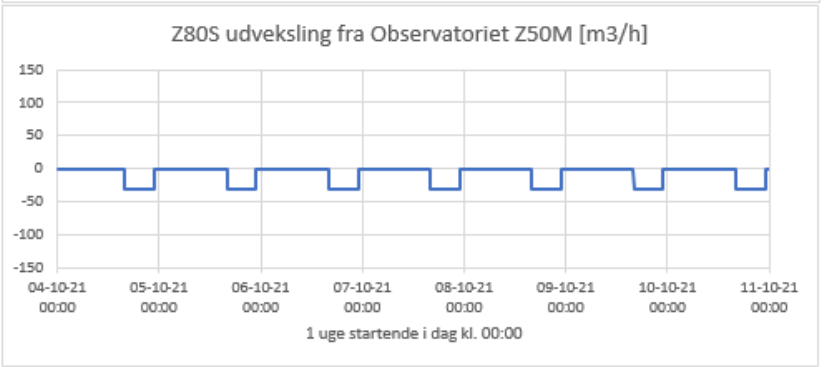


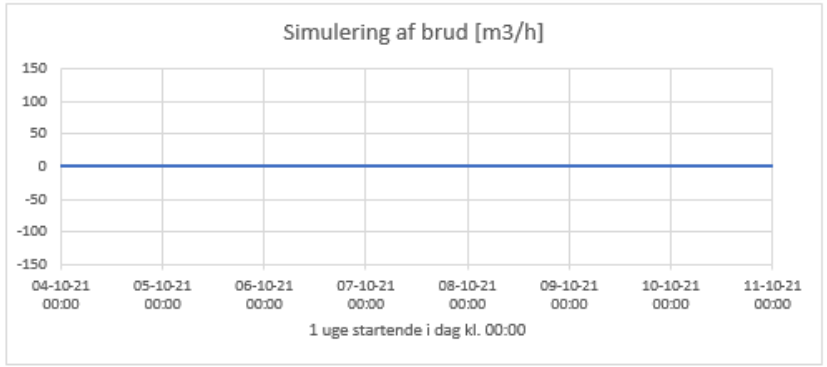


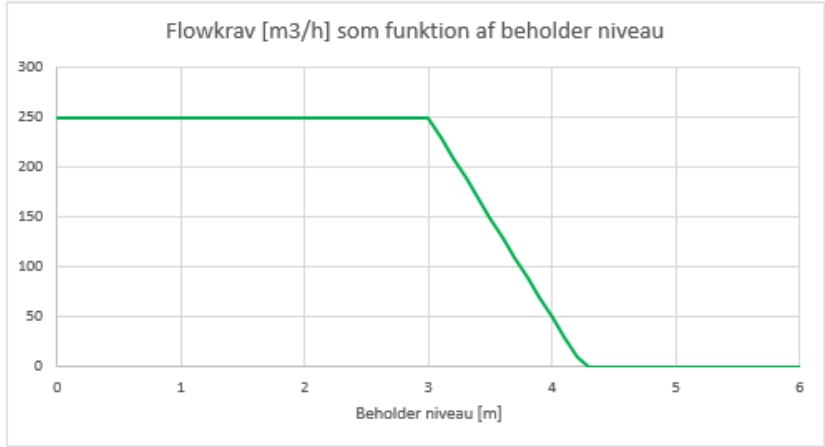




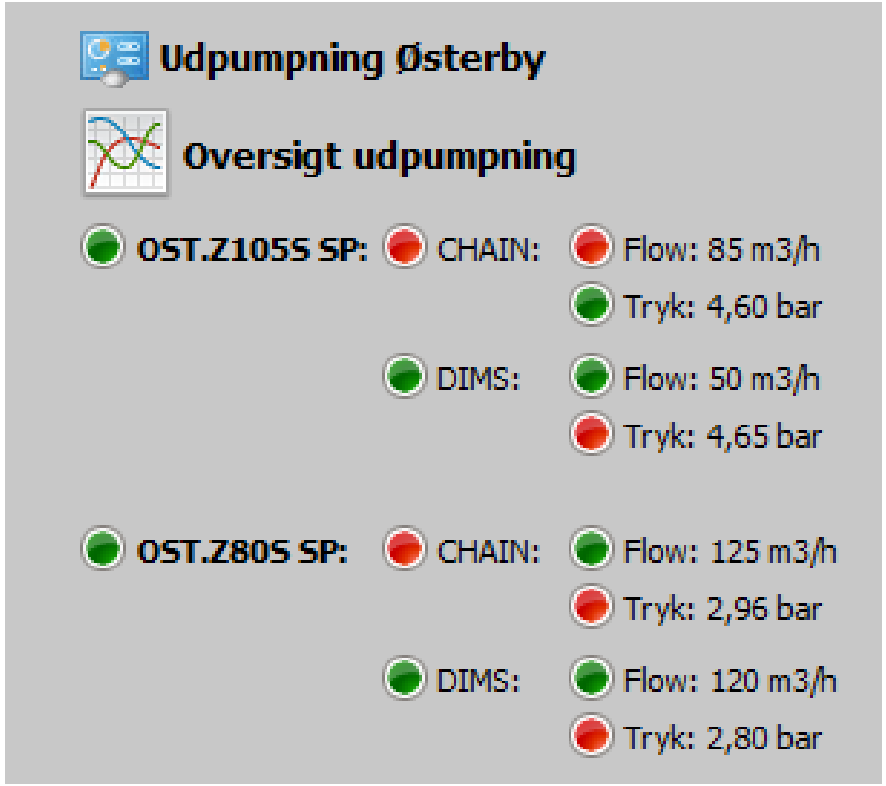


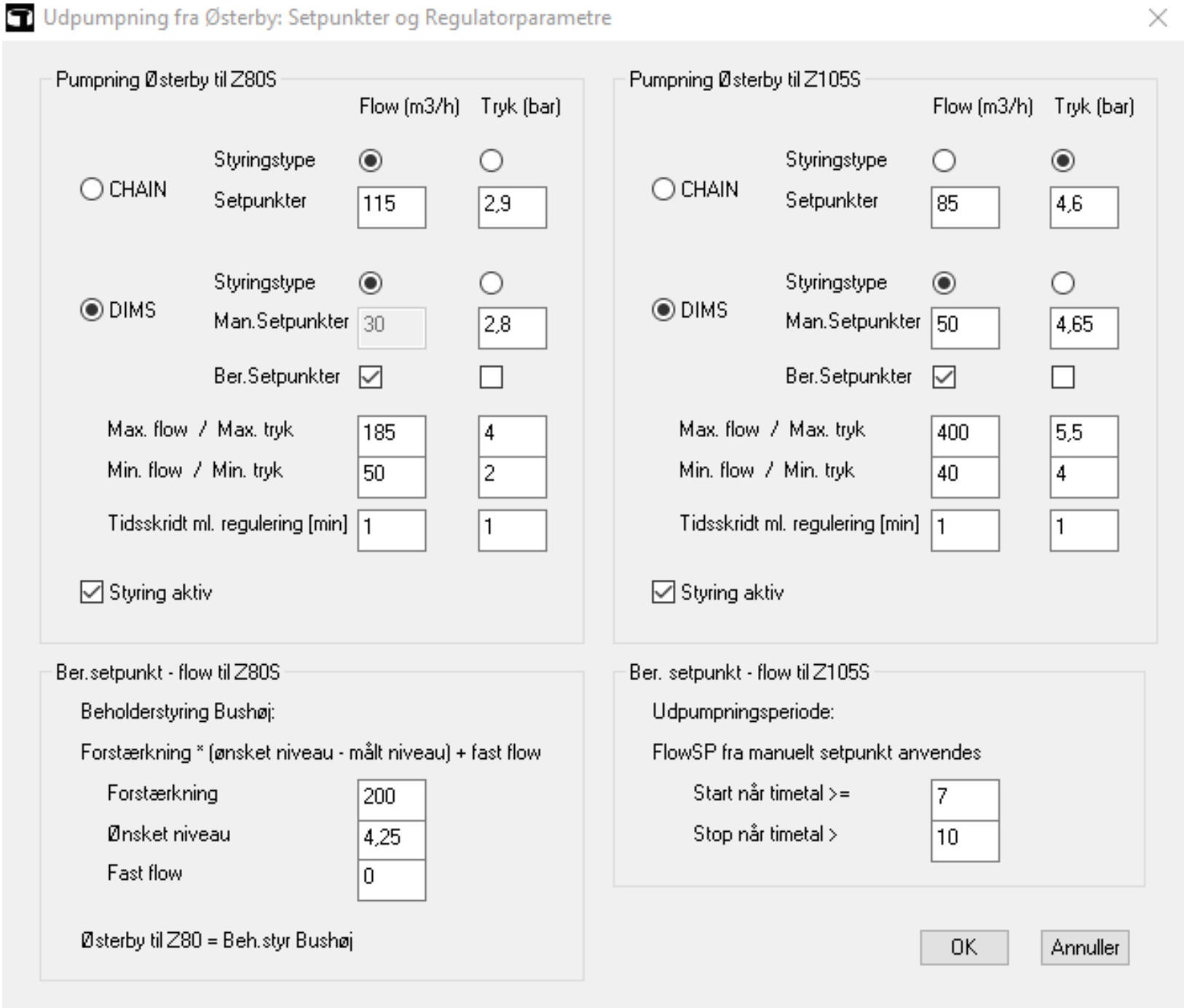






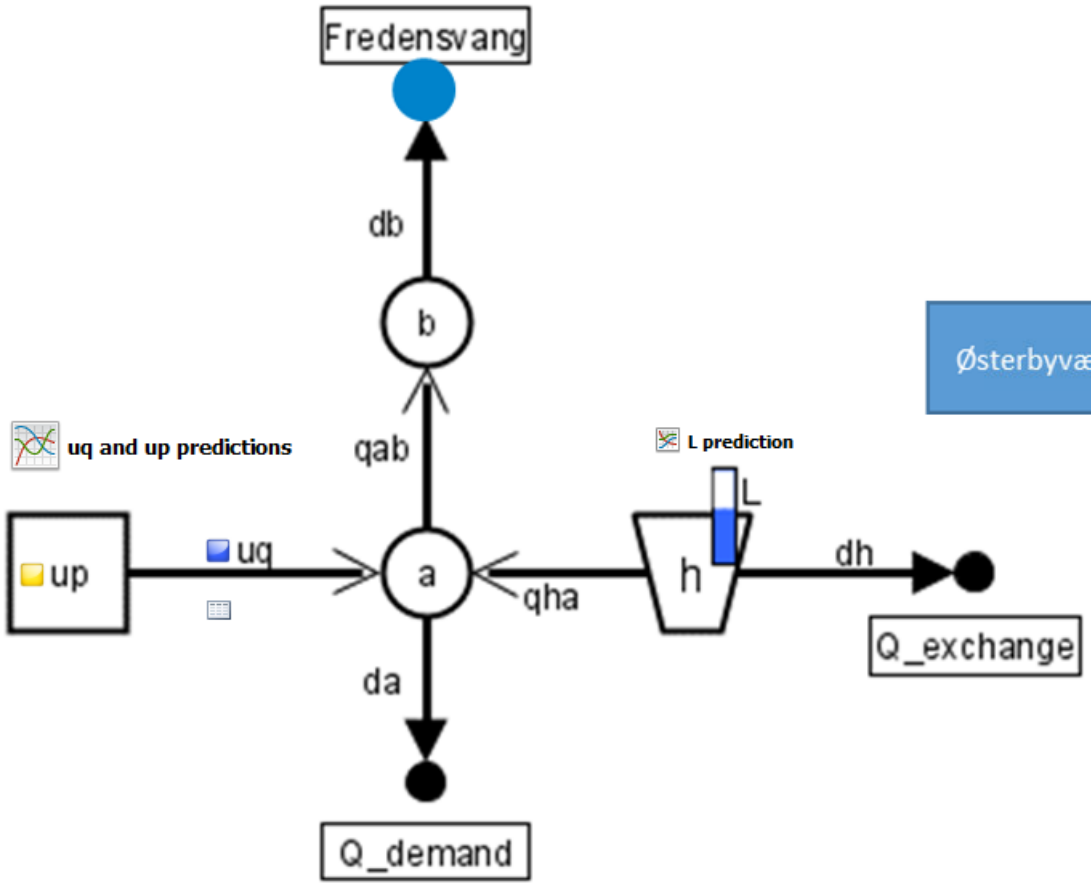
Styring udpumpning

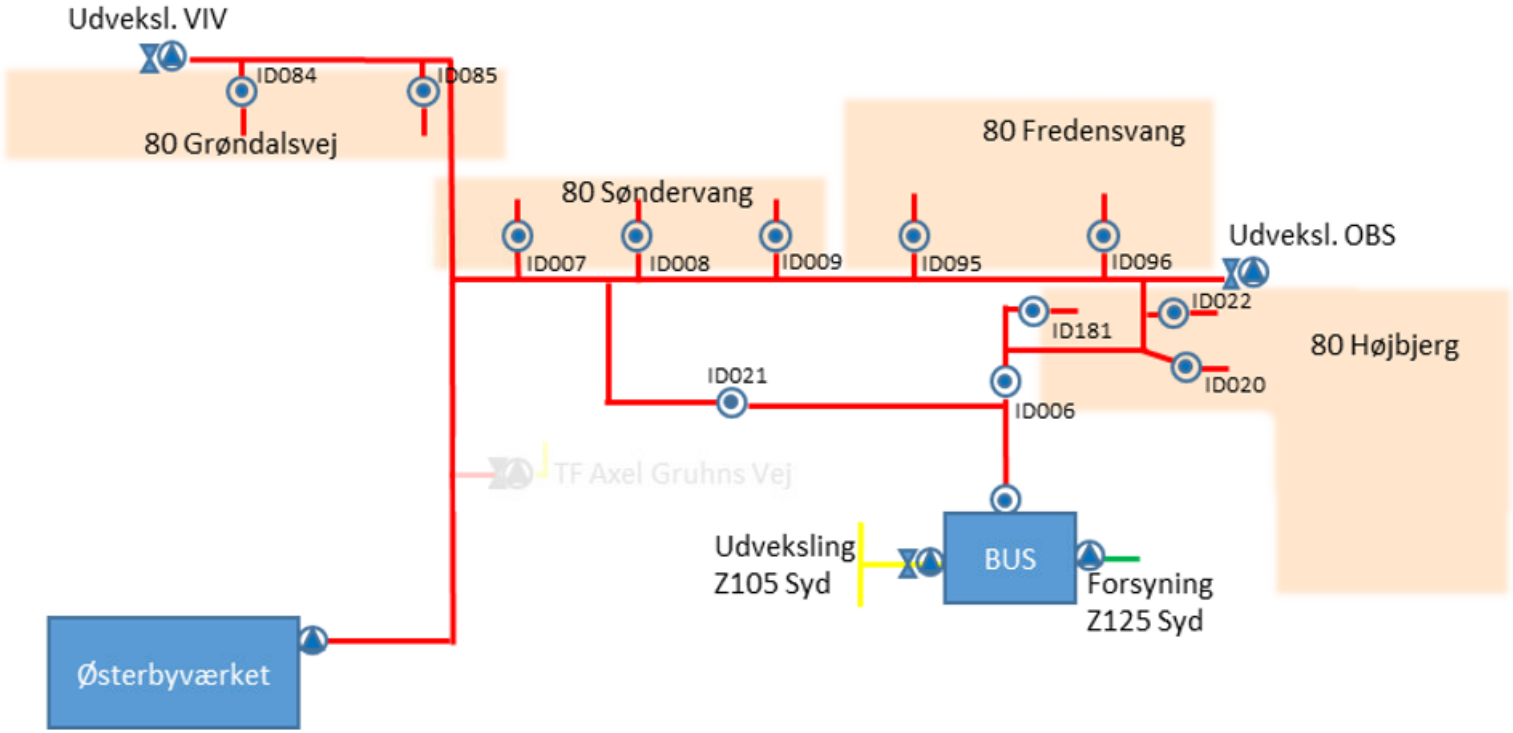


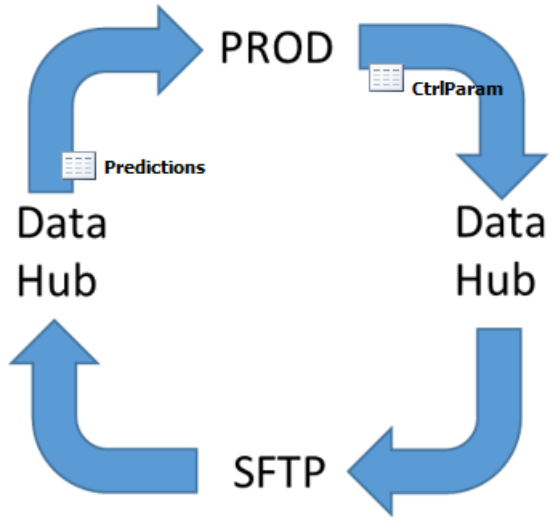


Indstillinger CHAIN controller

$$\min \ \rho_h \left\| h_p \right\|_2^2 + \ \rho_{uq} \left\| \Delta u_q \right\|_2^2$$



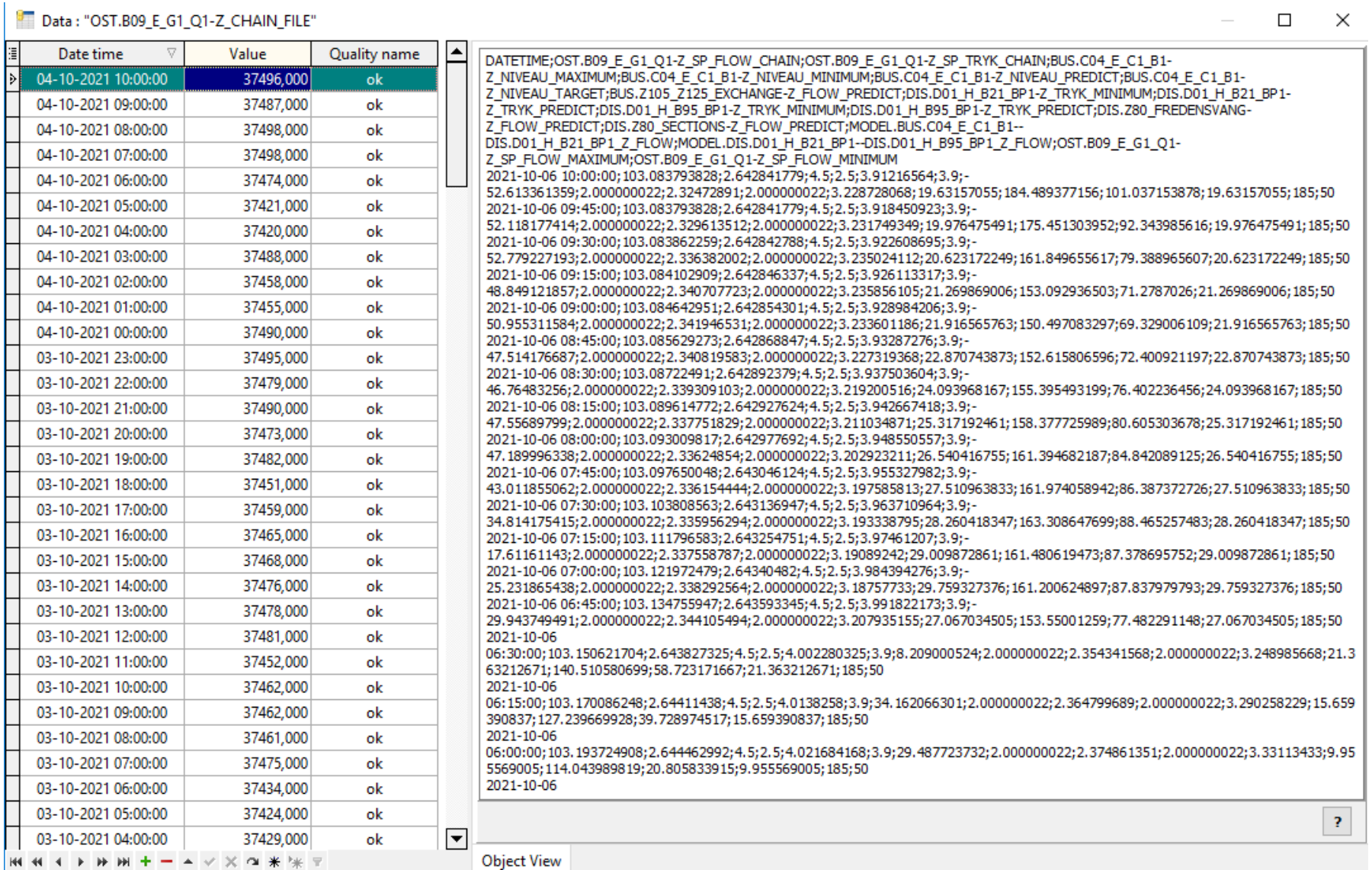




Q_demand = $Q\_section_{(Grøndalsvej+Søndervang+Højbjerg)}$ + $Q\_exchange_{(VIV+OBS)}$

Q_exchange = $Q\_exchange_{(Z105S+Z125S)}$

CHAIN predictions/set-points – 48 h forecast



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04-10-2021 01:00:00	37455,000	ok
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03-10-2021 23:00:00	37495,000	ok
03-10-2021 22:00:00	37479,000	ok
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03-10-2021 20:00:00	37473,000	ok
03-10-2021 19:00:00	37482,000	ok
03-10-2021 18:00:00	37451,000	ok
03-10-2021 17:00:00	37459,000	ok
03-10-2021 16:00:00	37465,000	ok
03-10-2021 15:00:00	37468,000	ok
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Z_FLOW_PREDICT;DIS.Z80_SECTIONS-Z_FLOW_PREDICT;MODEL.BUS.C04_E_C1_B1--
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2021-10-06
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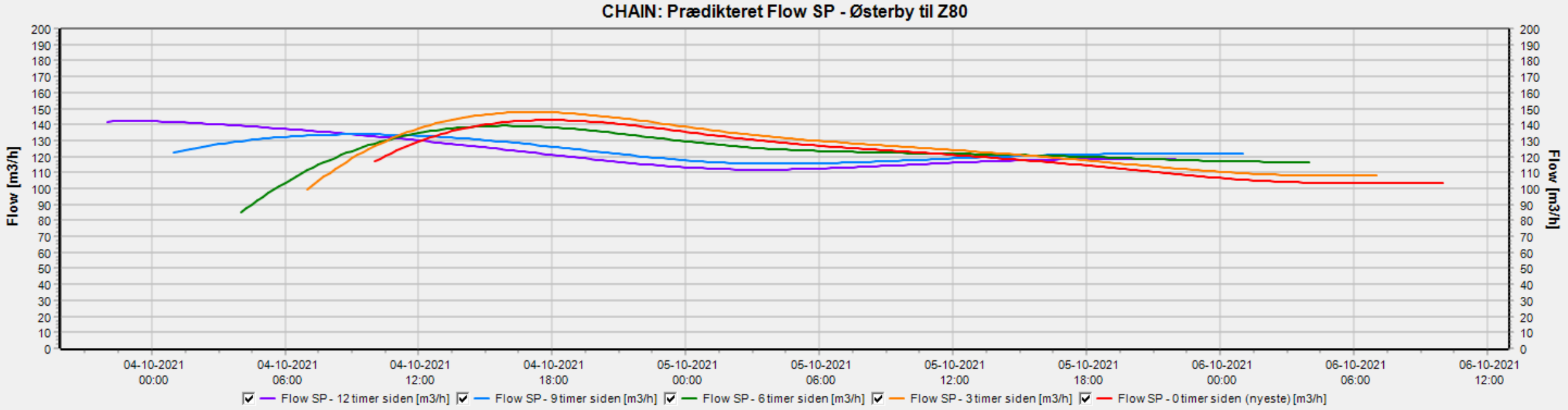
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Flow [m3/h]
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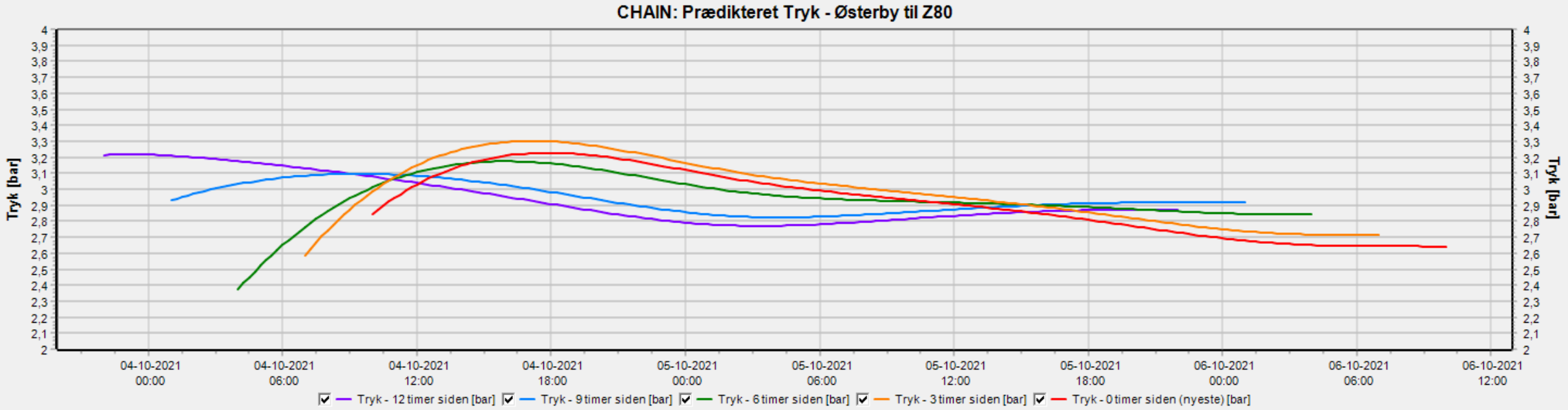
04-10-2021 06:00
04-10-2021 12:00
04-10-2021 18:00
05-10-2021 00:00
05-10-2021 06:00
05-10-2021 12:00
05-10-2021 18:00
06-10-2021 00:00
06-10-2021 06:00
06-10-2021 12:00
Flow SP - 12 timer siden [m3/h]
Flow SP - 9 timer siden [m3/h]
Flow SP - 6 timer siden [m3/h]
Flow SP - 3 timer siden [m3/h]
Flow SP - 0 timer siden (nyeste) [m3/h]


CHAIN: Prædikteret Tryk - Østerby til Z80
Tryk [bar]
Tryk [bar]
04-10-2021 00:00
04-10-2021 06:00
04-10-2021 12:00
04-10-2021 18:00
05-10-2021 00:00
05-10-2021 06:00
05-10-2021 12:00
05-10-2021 18:00
06-10-2021 00:00
06-10-2021 06:00
06-10-2021 12:00
Tryk - 12 timer siden [bar]
Tryk - 9 timer siden [bar]
Tryk - 6 timer siden [bar]
Tryk - 3 timer siden [bar]
Tryk - 0 timer siden (nyeste) [bar]

Smart Water Networks

Tak for opmærksomheden !