Stadtwerke München

Airborn Hydro Mapping @Uppenborn

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Öffentlich

Stadtwerke München

- 100% municipality-owned
- turnover approx. 6 bn €/a
  - public transport
  - water supply
  - swimming pools & Olympic Park
  - oil & gas
  - power generation
    - 100% of Munich‘s private consumption + public transport renewable by 2015 (3.5 TWh/a)
    - 100% renewable including Munich‘s industry by 2025 (7.5 TWh/a)
      - 13 hydro power plants
        - annual production approx. 350 Mio. kWh/a (140.000 Munich households)
        - installed power approx. 160 MW

SWM

Content

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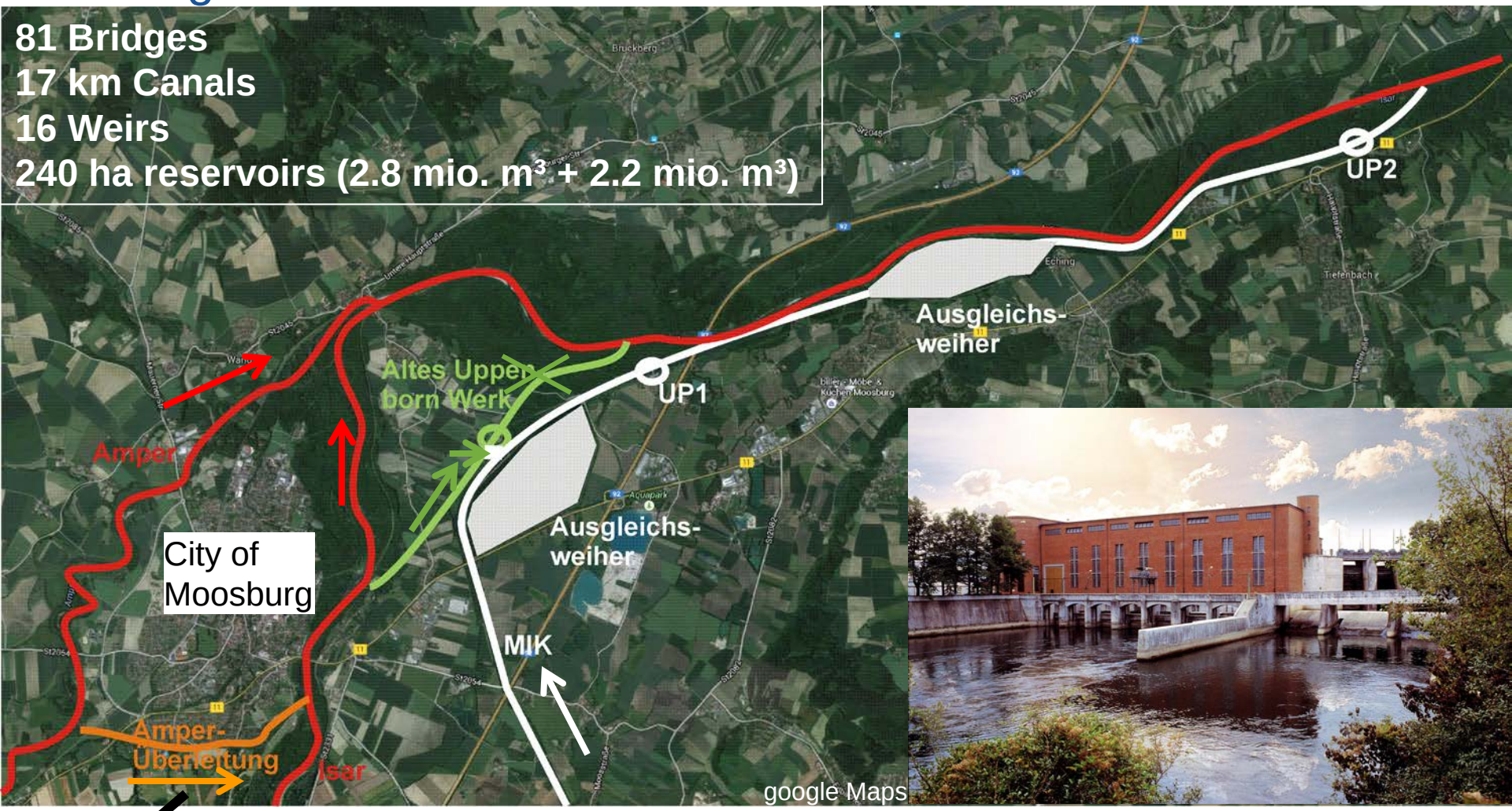
Uppenbornwerke

- Friedrich von Uppenborn (1859-1907)
  - Foundation of „Elektrizitätswerke München“
  - Electrification of Munich
  - 1907 „Altes Uppenbornwerk“, Isar-loop Moosburg (4.4 MW)
- Erection of Amper-Überleitungskanal 1922
- Erection of Mittlere Isar Kanal (1919-1925)
  - Extension of MIK to feed UP1 1926-1929
  - UP1, 24 MW, 1930 → closure
  - UP2, 18 MW, 1951

Setting



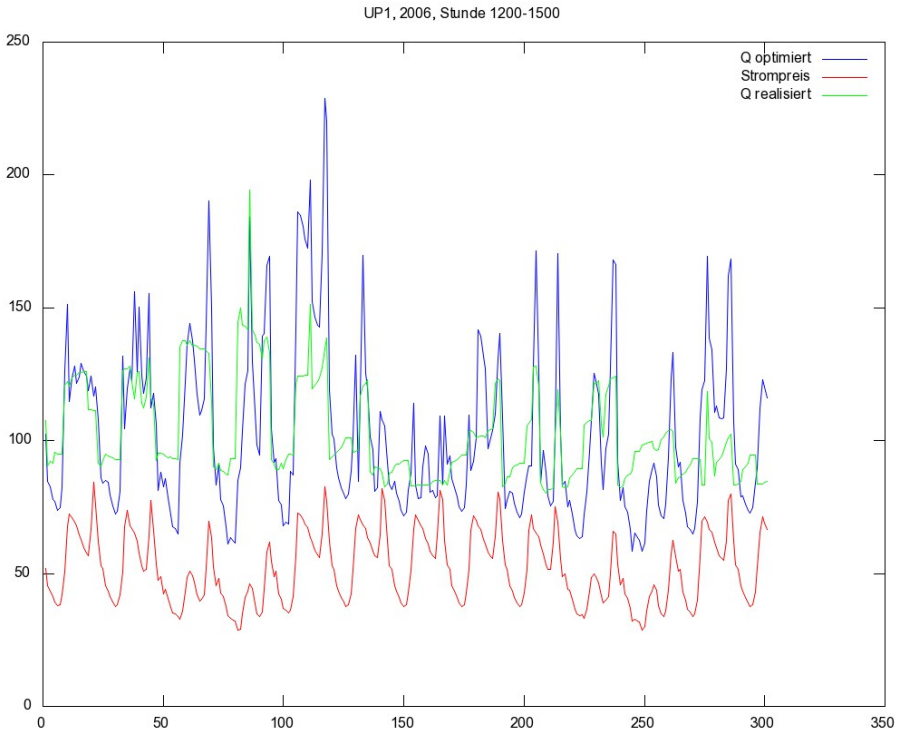
60 km to Munich

Rehabilitation

- facilities erected more than 80 years ago
- execution planning available
- dataset analog … and meanwhile biased?
- condition corresponds to the age of the plants
- secure operation aimed for
- concession ends by 2030 – good condition required for the so called „Heimfall“
- conformity of DIN 19700 → actual dam layout required

Energy Economics Optimization

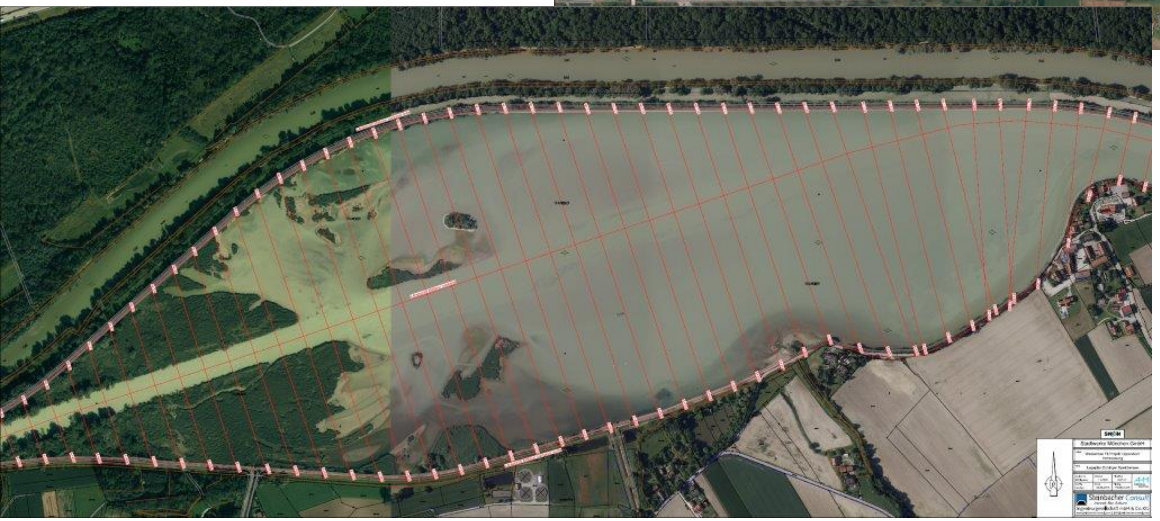
1. management of the reservoirs („Schwellbetrieb“ in UP1) → capacity curves required
   - storage and canal desedimentation measures → capacity curves required
2. controlling power range (premier, secondary and tertiary)
3. maximization of the diversion discharge and operating water level → detailed bathymetry required for hydraulic simulation
4. maximization of the gross head → downstream outflow condition needed at UP2 for hydraulic simulation



linear optimization

Challenges

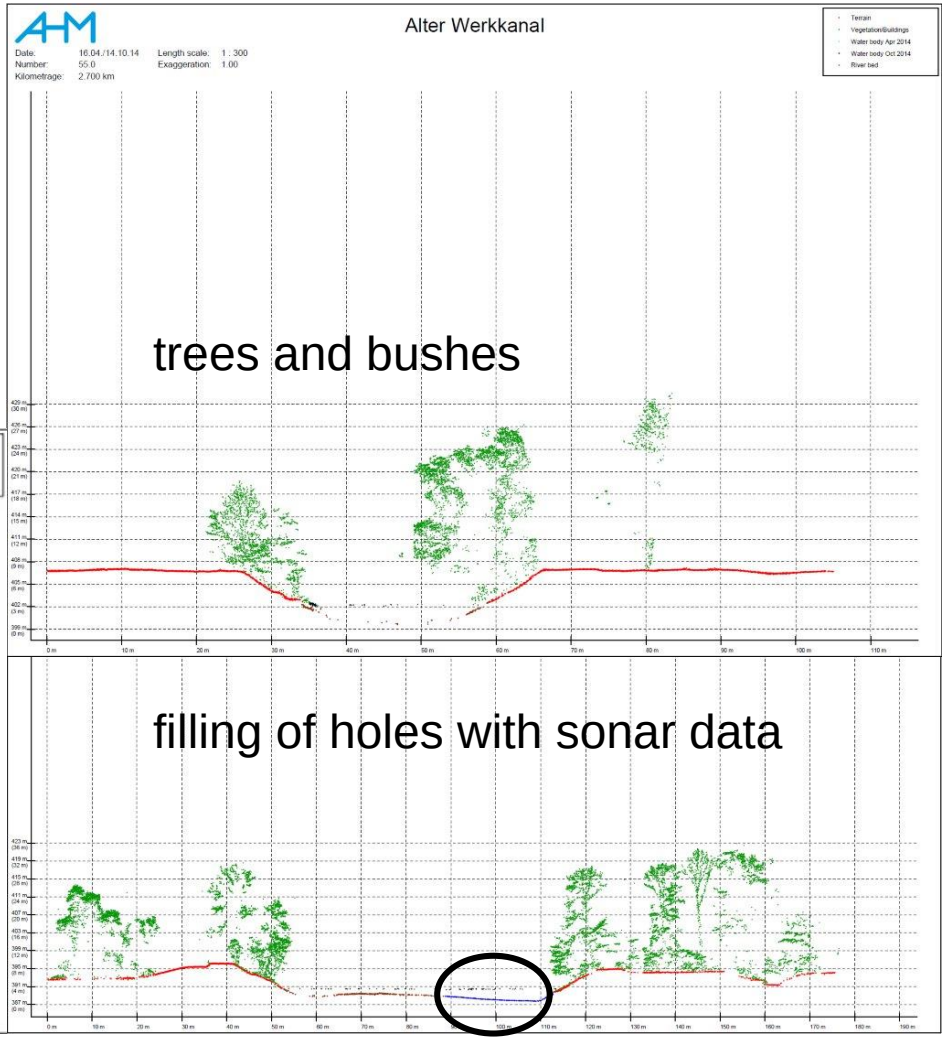
- water depth ≤ 9 m
- suspended load
- vegetation on land
  shadowing screen-
  ing area
- aquatic plants

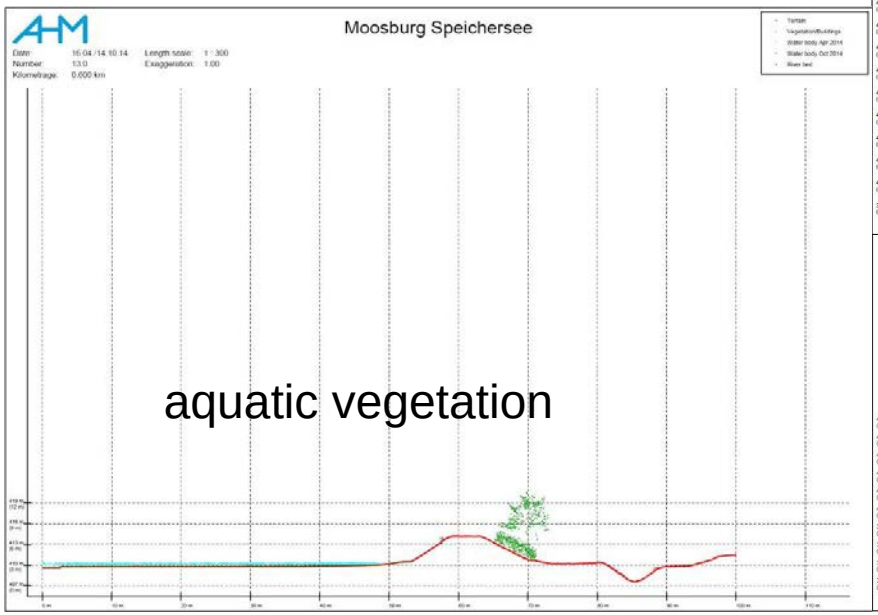


- however, terrestrial surveying hardly possible, time consuming and expensive

Results

- outliers had to be filtered
- holes were filled with terrestrial survey data (sonar)



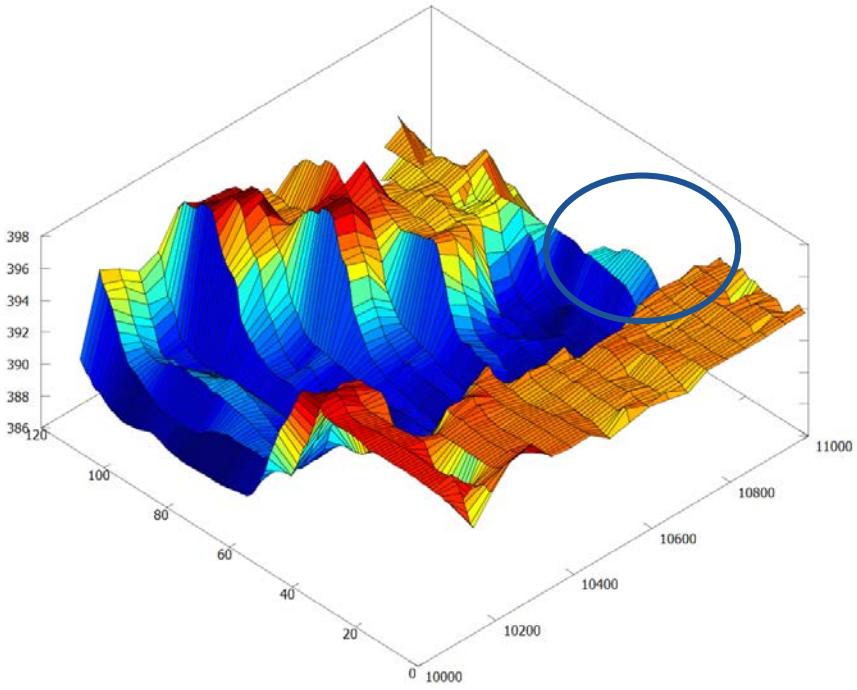


DIN 19700 conformity

- Determination of
  - the slopes
  - the crown width of the dams
  - the accessibility
  - etc.

(De-)Sedimentation

- Determination of the impact on the gross head
  - sedimentation area downstream of UP2 at confluence of MIK and Isar
    - impact on the downstream flow-depth of UP2
    - gross head gain if removed
    - probability of re-sedimentation evaluated
    - decision not yet taken



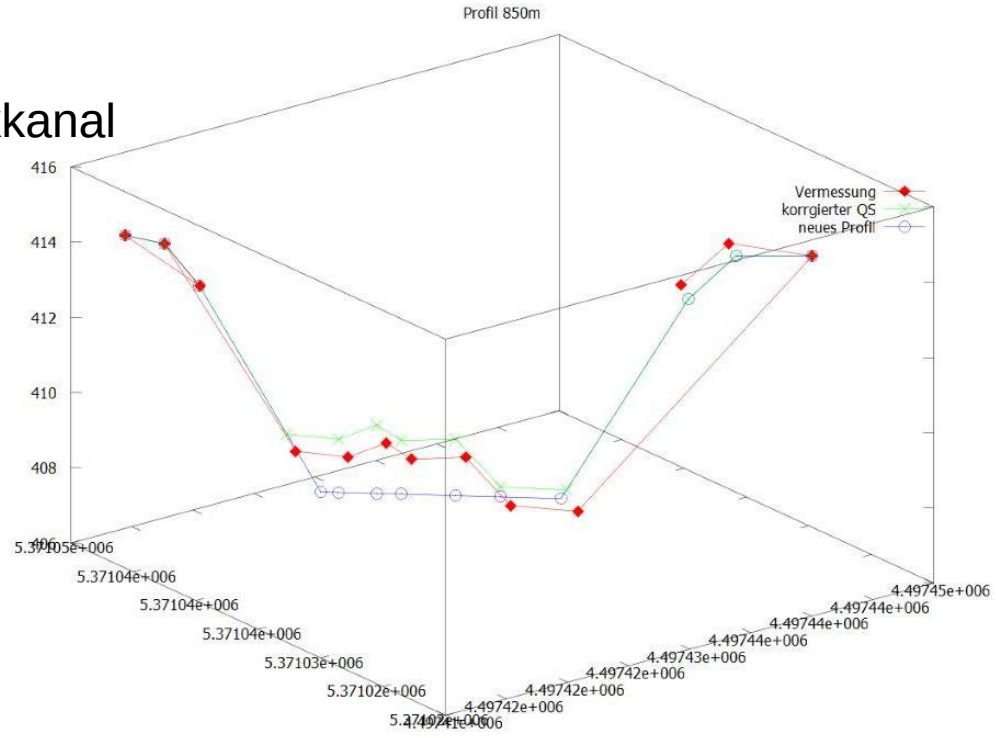
(De-)Sedimentation

- determination of the lost volume capacity of the two reservoirs
  - upstream basin within respective water levels minor
  - downstream basin not negligible, however, removal with respect to environmental specifications hardly realizable

Impact of the sedimentation on the hydraulic head losses

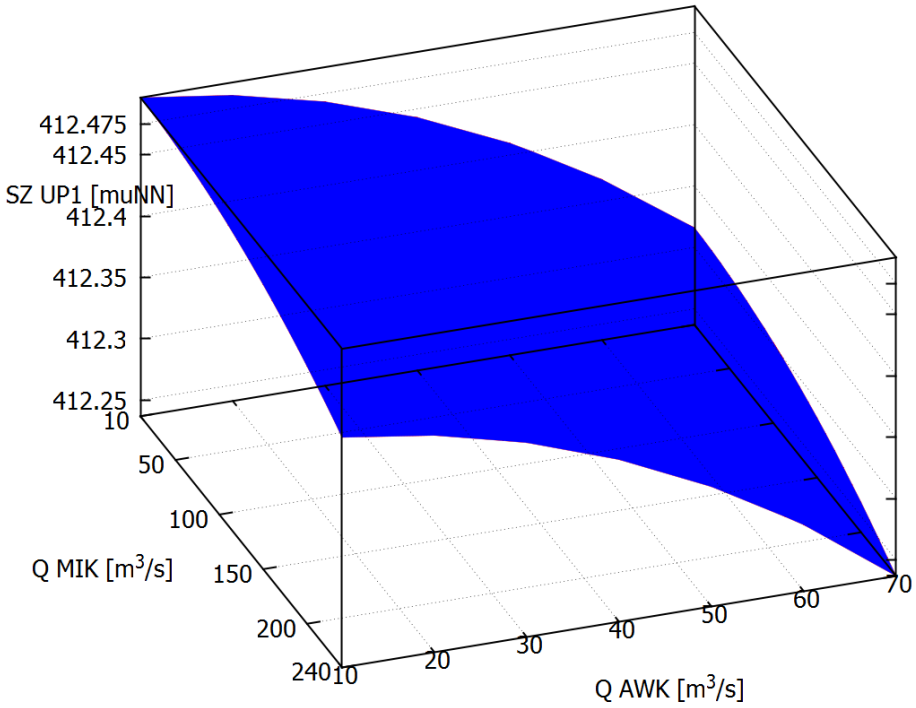
- 1D hydraulic simulation (own development) at Amper-Überleitungskanal
  - sedimentation area detected
  - ≈5000 m³ removed, capacity increased by approx. 4 m³/s allowing to increase production by ≈5 MWh/a

- 1D hydraulic simulation @Alter-Werkkanal
  - sedimentation area detected
  - additional gross head loss determined to be 5 cm @70 m³/s
  - removal would yield additional 300.000 kWh/a
  - not yet decided



Optimization of operating water level at UP1

- water level at Isar weir max.: 412.47 mNN
- max. water level at UP1: 412.47 mNN
- optimization of gross head at UP1 depending on
  - $Q_{\text{Alter Werkkanal}}$
  - $Q_{\text{MIK after confluence}}$



Conclusion

- setup very challenging for laser scanning
- appropriate replacement of outliers through sonar measurements mandatory
- data acquisition at hardly accessible places possible (e.g. protected areas)
- handed-over dataset met requirements
- application of the data yielded valuable results

… makes the customer happy.

Outlook

- data processing could be improved and accelerated
- improvement of data acquisition at challenging conditions desired

… will make the customer even more happy.

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Thank you for your attention