Storage Sizing for Renewable Energy Systems
– Its Dependence on the Sequential Characteristics of the Meteorological Data, discussed for Autonomous PV + Storage Systems

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- sizing PV systems : selecting installed PV Capacity, + storage size
  to shown required security of supply
  based on knowledge on meteorological conditions

required (multi-) annual set of irradiance data
(today: satellitee derived sets, sets from reanalysis = > projected conditions)

- need for validated data sets = > need for appropriate simple measures to test

- with respect to sizing of generation capacity (predicted long term generation) :
  schemes for validation of applied irradiance sets are available
  (based on comparisons: annual means, probability densities)

  with respect to sizing of storage: topic less covered

  discussed here: which characteristics of the irradiance sets govern the storage sizing ?

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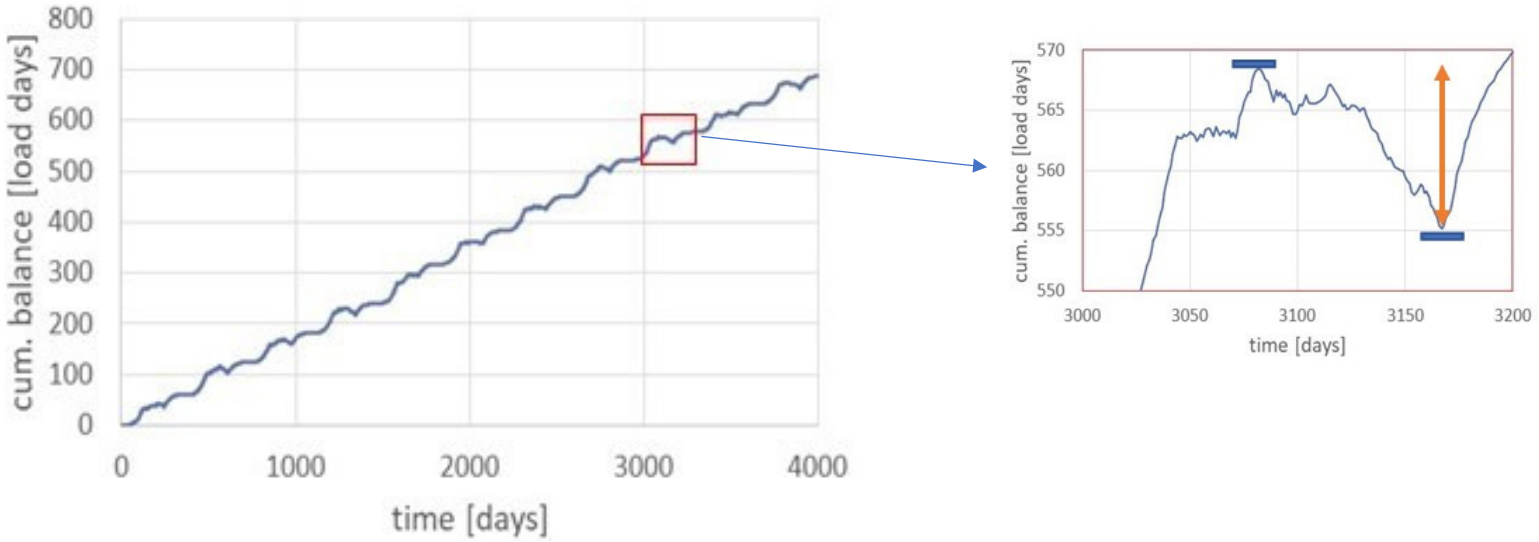
- sizing PV systems : selecting installed PV capacity + storages
  for secure supply / system autonomy

direct access to required storage size: analysing the cumulated balance

$$C_b(t+1) = C_b(t) + (P_{gen}(t+1) - P_{load}(t+1)) * \Delta t$$

example: C_b for a process with oversizes generation $\overline{P_{gen}} > \overline{P_{load}}$
req. storage size: difference of C_b(min) and pevious C_b(max)



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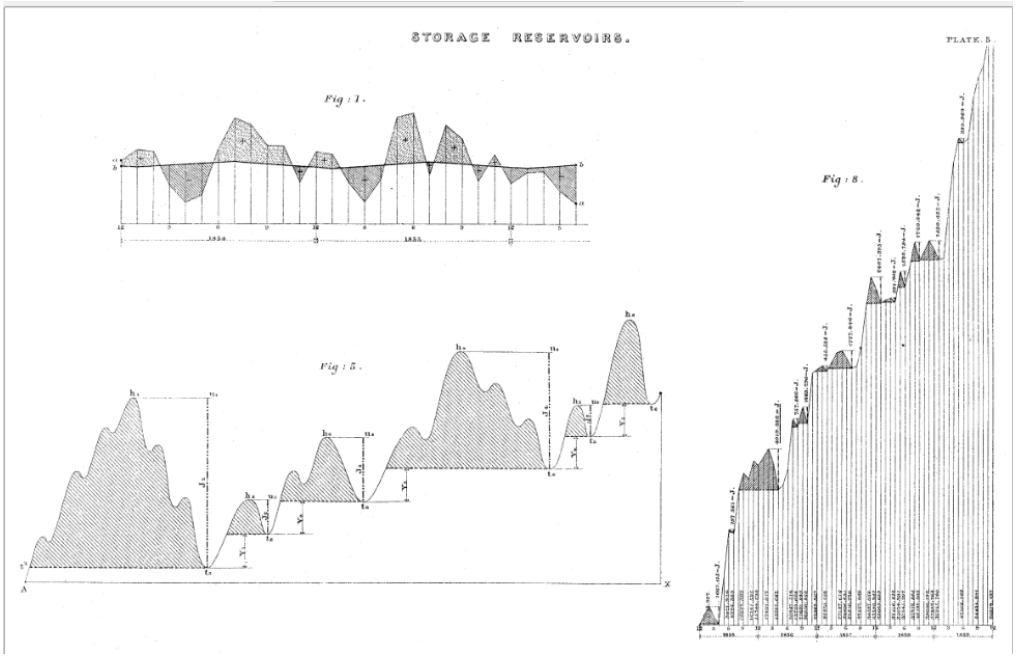
template for this scheme : sizing of hydro reservoirs :

(*Paper No. 1864.*)

"The Capacity of Storage-Reservoirs for Water-Supply."

By W. Rippl, Docent at the Royal Technical High School at Gratz (Styria).

Minutes of the Proceedings of the Institution of Civil Engineers
Volume 71 Issue 1883, pp. 270-278



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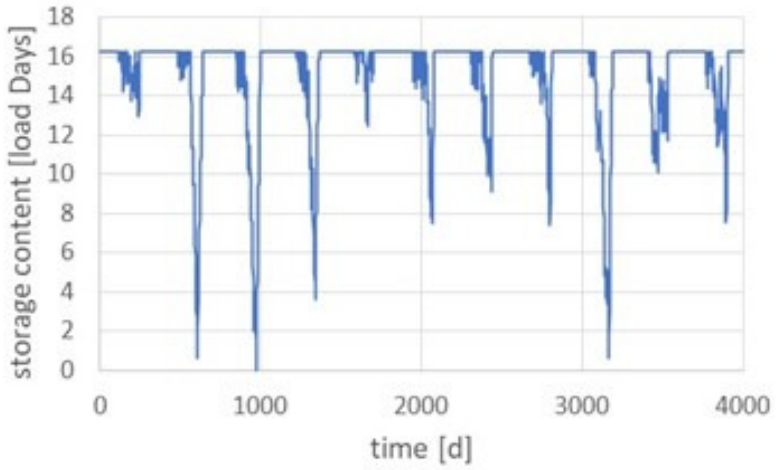
under inspection here:

-> PV + storage system for the supply of a constant load (summertime May – August only)

data base: irradiance data (11 years) from the PVGIS server (two sets inspected: SARAH2 (sat. data) ERA5 (reanalysis)

scheme above used to determine storage size for save supply
for a given generation capacity (default: $\overline{P_{gen}} = \overline{P_{load}}$) [analysed with daily time step]

presented: time trace of storage content for location: Faroe Islands (data base: SARAH2)



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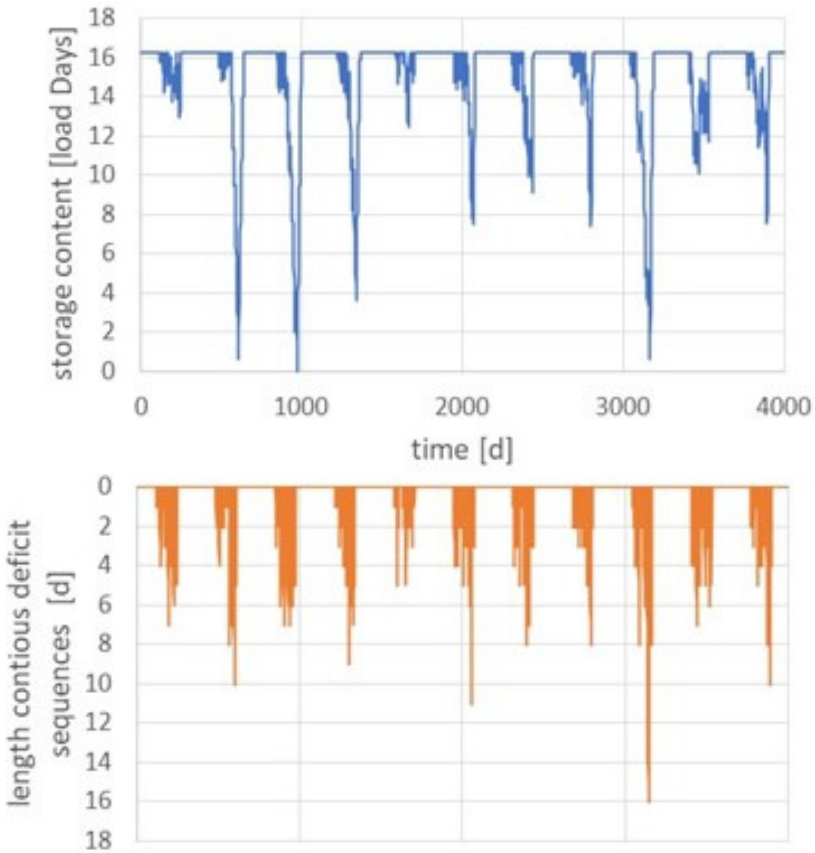
Faroe Islands (database SARAH2)
finding: year 3 determines required storage size



is the critical year detectable by “easy” indicators ?

approach: count length of
“deficit sequences”
number of days with onsecutive
load > generation

=> not reliable

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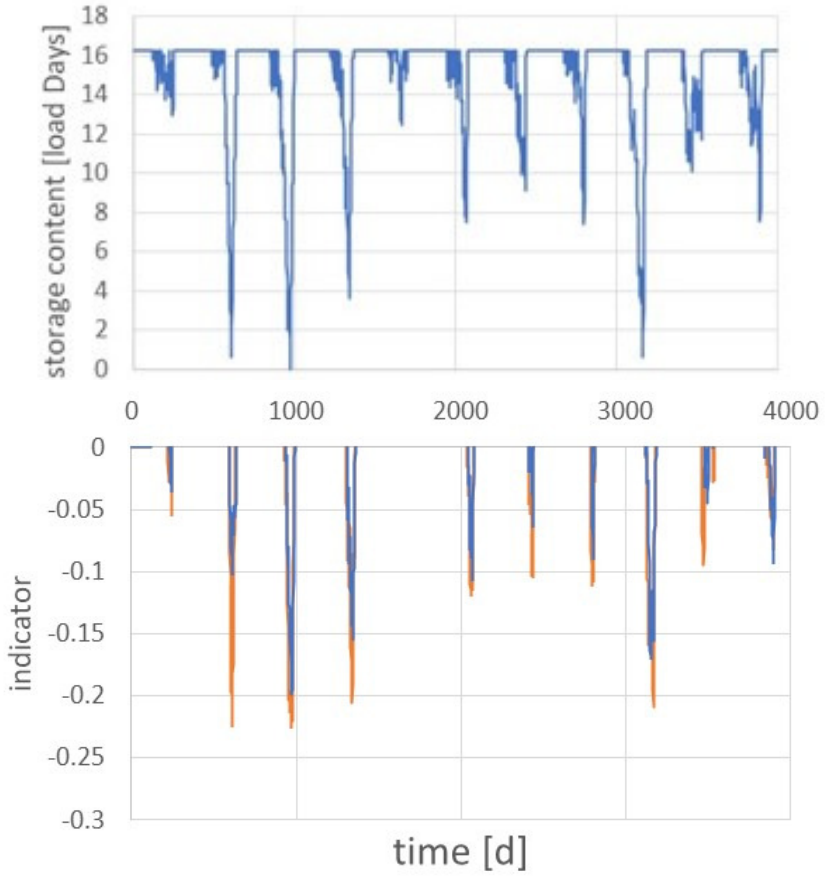
Faroe Islands (database SARAH2)
other option for indicator for critical year ?



another “naïve approach”:

indicator:
negative average balance over longer periods
(used here: 70 days and 55 days)

=> critical year well indicated by average balance

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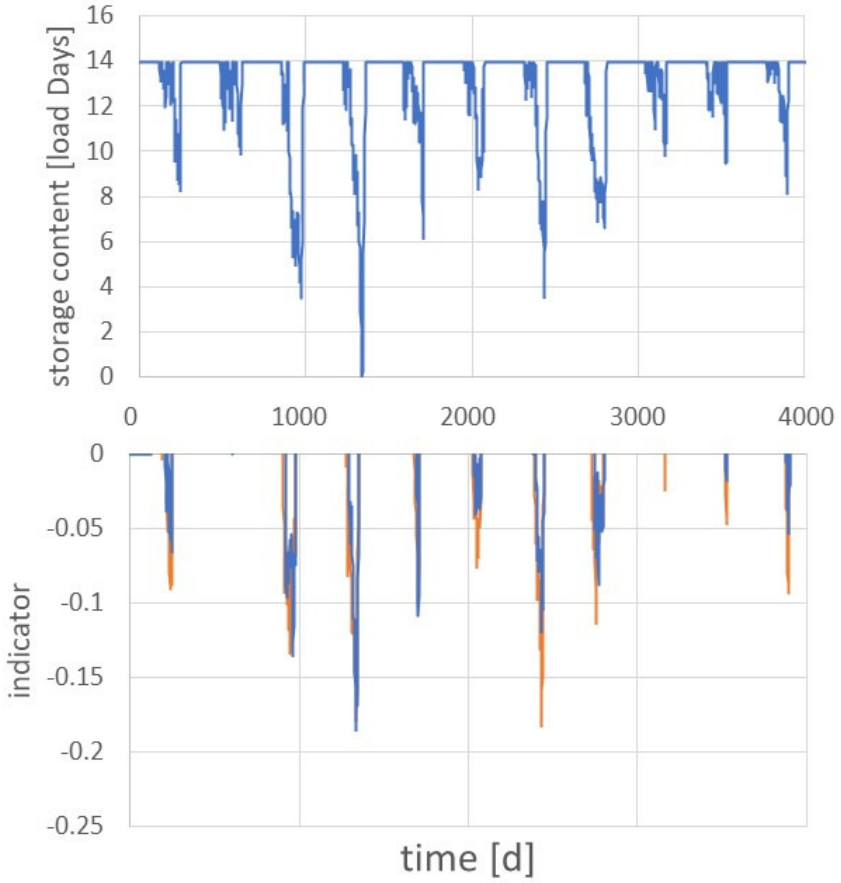
Ireland (database SARAH2)
year 4 determines required storage size



indicator:
negative average balance over longer periods
(used here: 70 days and 55 days)

=> critical year well indicated by average balance

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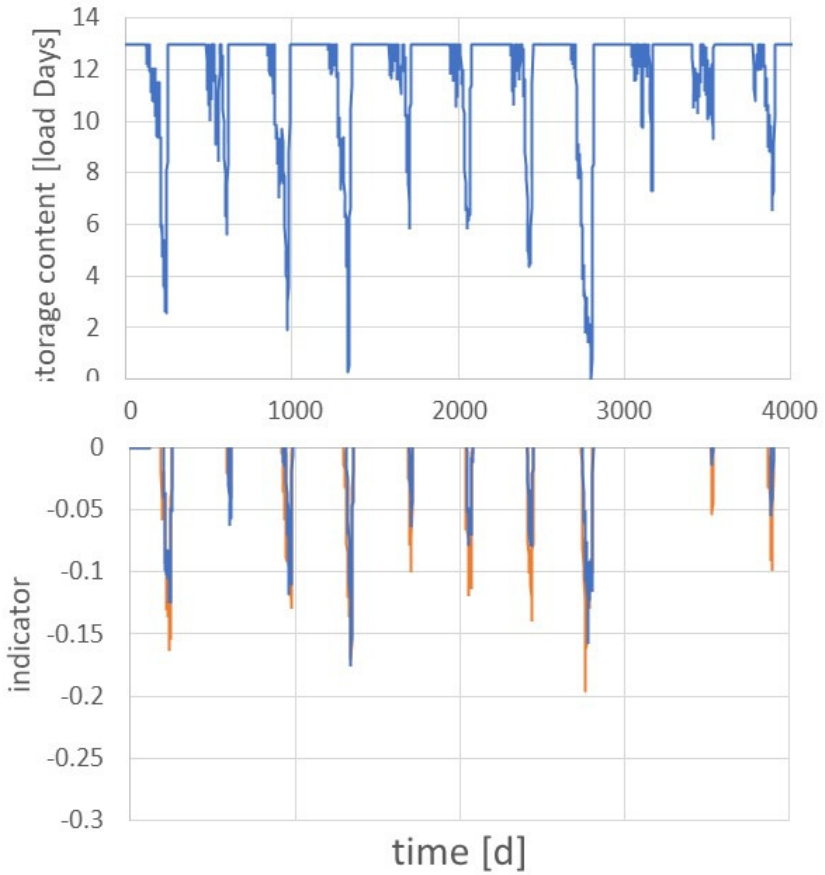
Ireland (database ERA5)
year 8 determines required storage size



indicator:
negative average balance over longer periods
(used here: 70 days and 55 days)

=> critical year well indicated by average balance

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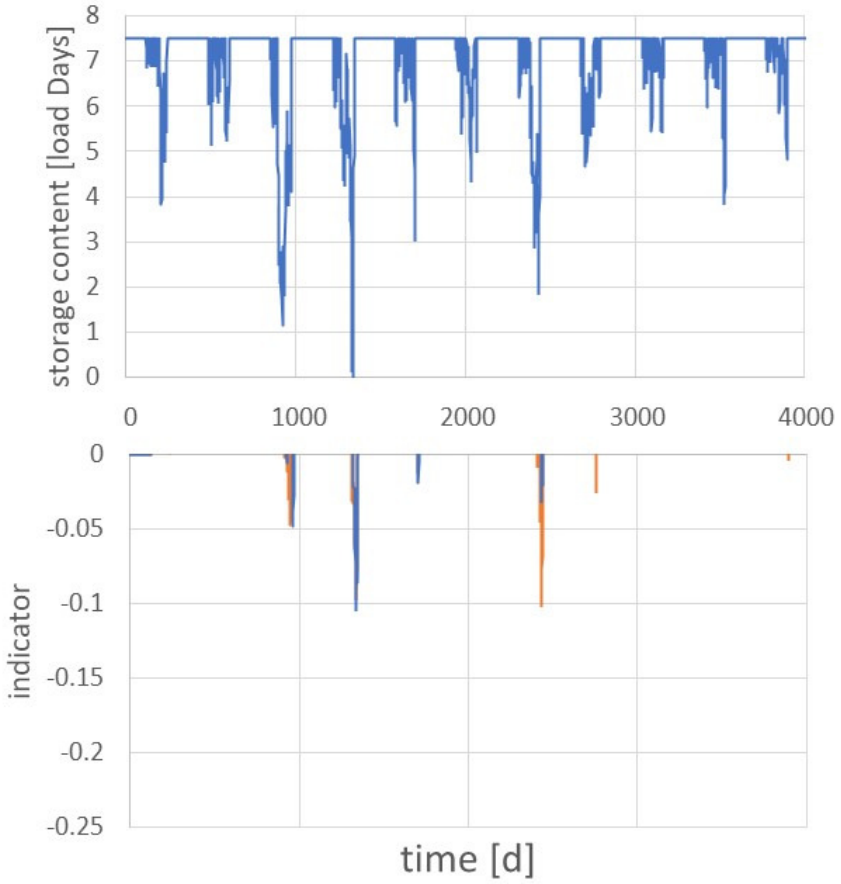
Ireland (database SARAH2)
generation oversized by factor 1.1
year 4 determines required storage size



indicator:
negative average balance over longer periods
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=> critical year well indicated by average balance

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- storage sizing required data sets
  that reflect the cumulated balance of generation and load correctly

  as indicator:
  average balance for relevant time periods (weeks to months) for storage sizes days to week
  (as “proxy”: inspect cumulated deviations of irradiance from its mean)

  => include balance process in measures for data set quality