Detailed analyses of meteorological time series for the sizing of storages in renewable energy systems - uncertainties related to inter-annual and database to database variabilities

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Program
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- Case studied: sizing of generation and storage capacity for stand alone systems
  example PV + storage system for the supply of a summertime (Mai – August load)
  Faroe Islands (62° N)

  - sizing generation capacity (for: average generation > average load)
    bases:
    1st order: (long-term (=> 1 year) renewable resource of (required: validates data)
    2nd order: distribution functions for short term data (solar Irradiances) (validates data)
    3rd ……

    comparatively well covered in literature

  - sizing storage capacity:
    to be based on: long-term time series (measured or modelled) (validates data)

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Example for storage sizing

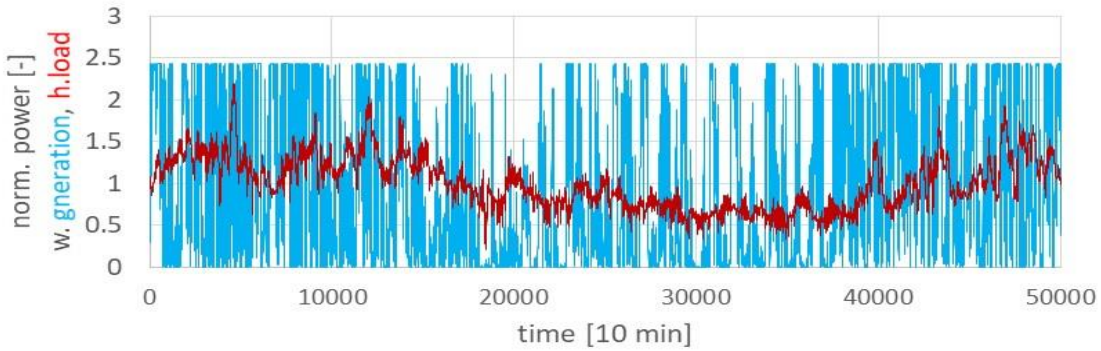
- Sizing a thermal store for a wind turbine heat pump heating system (location Faroe Islands)
  input data :
  - time series of wind turbine generation (based on measured wind data)
  - time series of heating load
    (depending on measured ambient temperature)

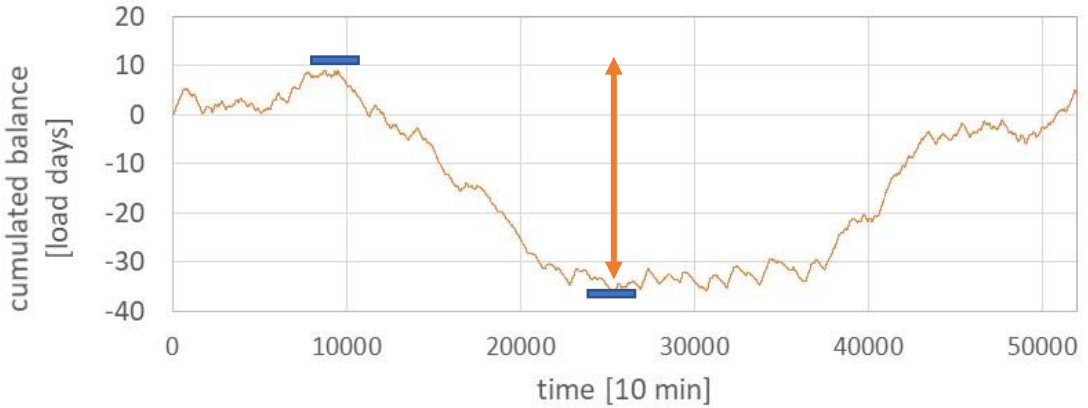
- methods: determine storage size for save supply
  using (available) time series simulation tool
  by search schemes for appropriate storage size

  or:
  inspection of the time series of the cumulated balance
  bc (i+1) = bc(i) + (generation(i)-load(i))*Δt

  example for case studied
  (equal averages of generation an load)

  required storage size:
  distance minimum and previous max.





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example PV + storage system for the supply of a summertime (Mai – August load) Faroe Islands (62° N)

- PV sized for generation = load (Mai – August)

- PV not detached in winter -> System starts with storage loaded 1. Mai

- analysis with daily time steps
  using model for daily PV generation(inclined generator) = f(daily irradiance sum (horizontal) (Beyer EUPVSEC 2019)

- Data base: irradiance data from PVGIS (2005-2015)

- Example foe balance process:

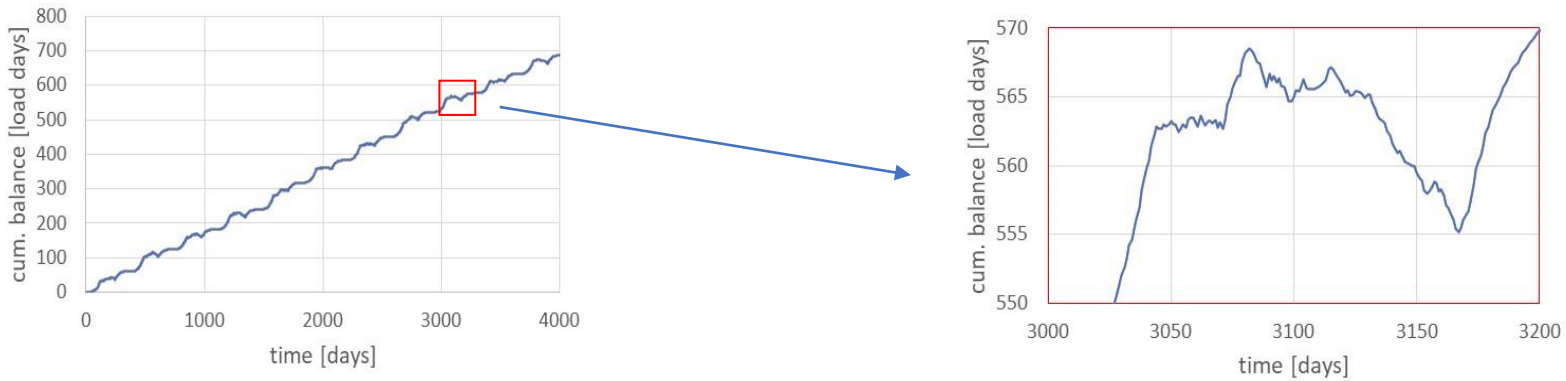

Fig. 2: 56
with a wi
hydro gen

Wind

Reistad, M
B.R., Bidl
waves for
Journal of

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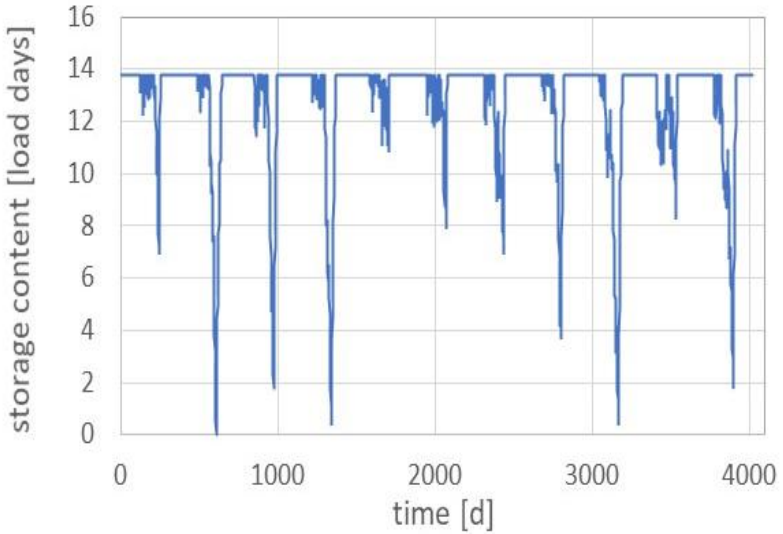
Data bases: irradiance data from PVGIS (2005-2015)

- PVGIS (sat) PG
- Re-analysis data ERA 5
- Re-analysis data COSMO

Results:

Year to year variability of of challenge to storage in one base



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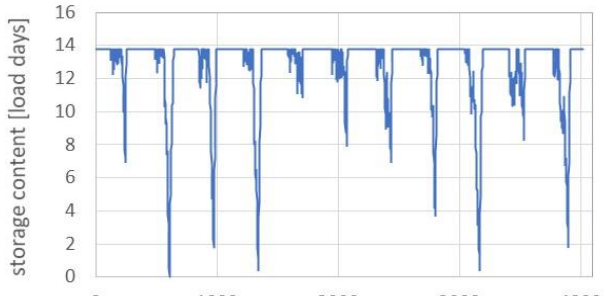
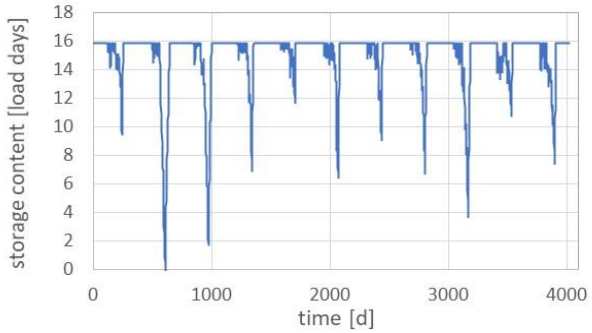
Comparison by bases

PVGIS (sat) PG



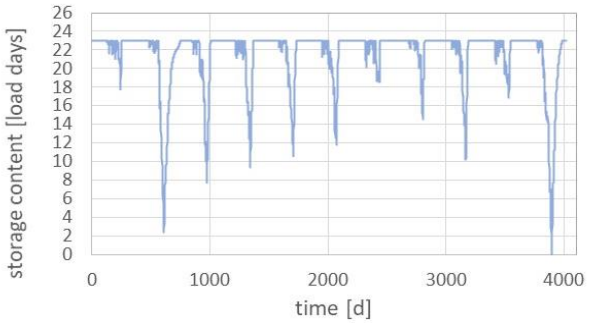
storage size required : 13.8 [days of load]

Re-analysis data ERA 5



Storage size required 15.8 [days of load]

Re-analysis data COSMO



Storage size required 23.3 [days of load]

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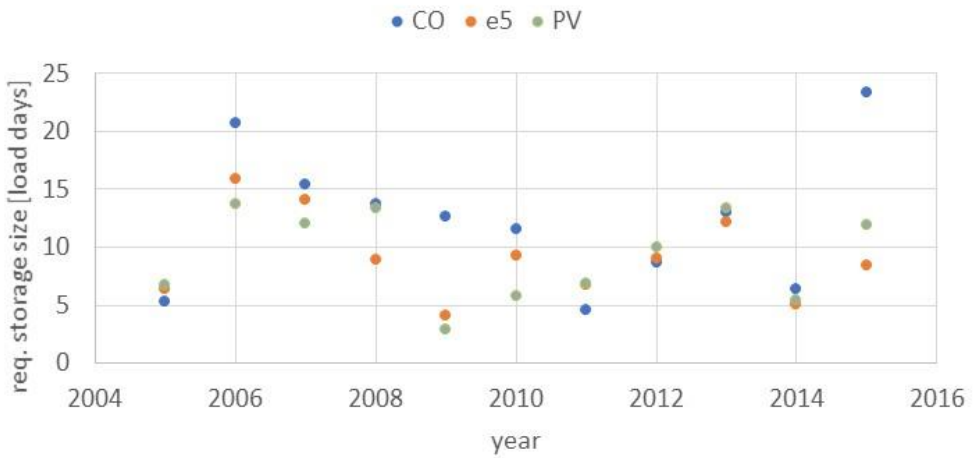
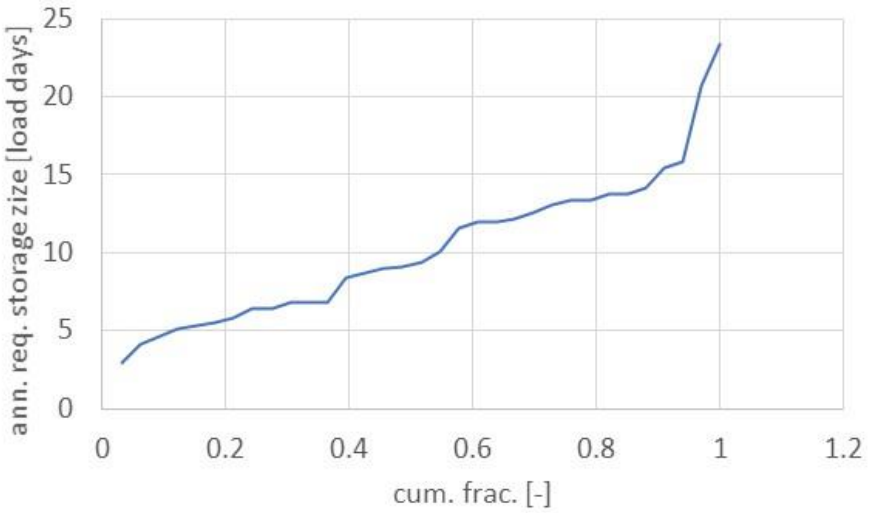
view as ensemble of database specific yearly storage sizes



Cum. distribution for all yearly storage sizes

-> analysing but 50% of available annual series
may underestimate required storage size by > 50%

(when setting same reliability for all data bases)



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Conclusions:

- year to year and database to database variabilities
  force to consider storage sizing for renewable energy systems as the outcome of Monte Carlo experiment

- regarding ensembles formed by results referring to time sections of the data series from various databases
  may reveal information on the uncertainty of the sizing results

- to be used when evaluating layout options