Selecting representative days for long-term planning models

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From raw data to meaningful results

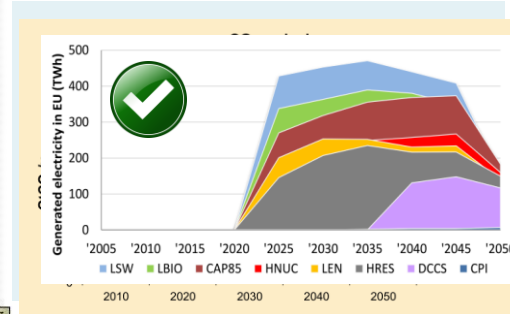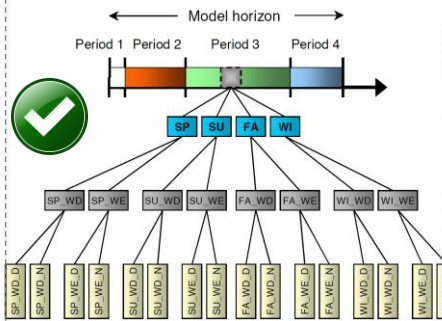Raw data → Data processing → (Planning) Model → Results

Yearly data series (load, wind speed, solar irradiance, etc.)

- Different approaches
- insufficiently documented
- impacts results

?

Model horizon

Period 1 Period 2 Period 3 Period 4

SP SU FA WI

SP_WD SP_WE SU_WD SU_WE FA_WD FA_WE WI_WD WI_WE

SP_WD_D SP_WD_N SP_WE_D SP_WE_N SU_WD_D SU_WD_N SU_WE_D SU_WE_N FA_WD_D FA_WD_N FA_WE_D FA_WE_N WI_WD_D WI_WD_N WI_WE_D WI_WE_N

Generated electricity in EU (TWh)
500
400
300
200
100
0
'2005 '2010 '2015 '2020 '2025 '2030 '2035 '2040 '2045 '2050
LSW LBIO CAP85 HNUC LEN HRES DCCS CPI
2010 2020 2030 2040 2050

14/04/2015

Temporal representation planning models

- Temporal representation = temporal structure + input data processing
- Temporal structure (~=lay-out time-slice tree): typically documented
- Data processing:
  - No simple task:
    - Limited number of time slices => make optimal use of each time slice
    - Different aspects to consider
  - Not sufficiently documented
  - No consistent approach:
    - Aggregating data
    - Representative days ('typedays')
      - Simple Heuristics
      - Clustering algorithms (advanced heuristics)
      - Optimization
  - Rarely validated

Data pre-processing: selecting representative days

🍃 Goals:

- Select a set of historical days, and corresponding weights, such that these days are representative for the data-set
- Make optimal use of available #TS => capture as much as possible information

🍃 Representative?

First order (highest priority)   Second order (lower priority)

Aspect	Yearly average value	Distribution
Important to account for:	Energy yield of different technologies + load	Variability (static) of the load and IRES

Optimization approach to select representative days

Aspect	Yearly average value	Distribution
Important to account for:	Energy yield of different technologies + load	Variability (static) of the load and IRES

Duration curve

p: profile (load, wind, PV, etc.)
b: bin
d: day

Offshore Wind duration curve

$$\sum_{b\prime \leq b}\left(BIN\_SIZE_{p,b\prime}\right)$$

$$BIN\_SIZE_{p,b}$$
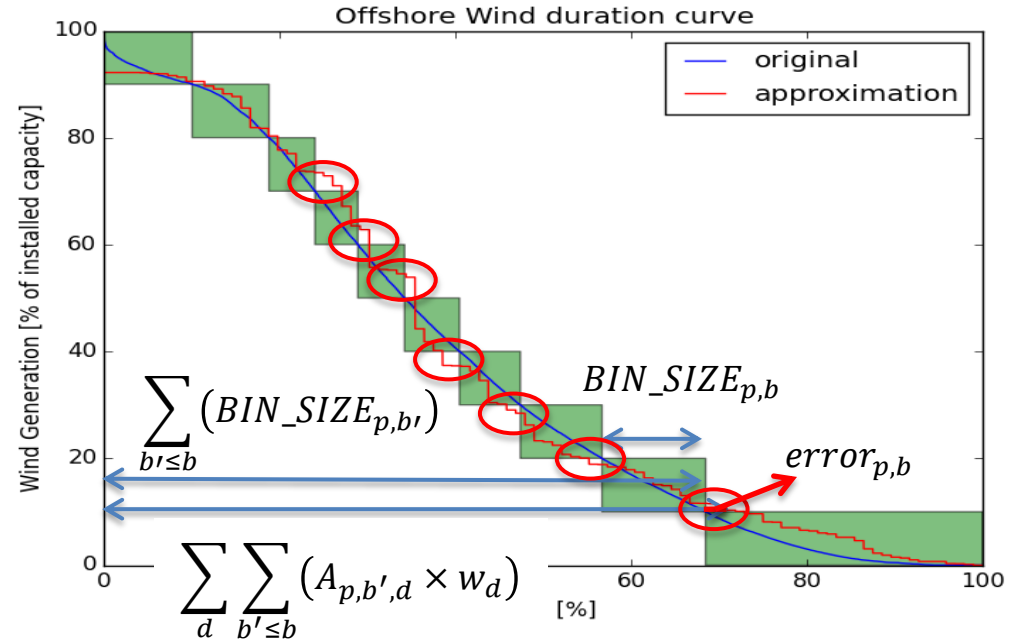
$$error_{p,b}$$

$$\sum_{d}\sum_{b\prime \leq b}\left(A_{p,b\prime,d} \times w_d\right)$$

$$\min_{u_d, w_d} \sum_p W_p \times \sum_b error_{p,b}$$

s.t.:

$$error_{p,b} = \left| \sum_{b\prime \leq b}\left(BIN\_SIZE_{p,b\prime}\right) - \sum_{d}\sum_{b\prime \leq b}\left(A_{p,b\prime,d} \times w_d\right) \right|$$

Hours in day d, belonging to bin b

- Sum of weights correspond to total number of days in the original profile
- Weight of a day can only be > 0 if that day is selected (integer variable u_d)
- Pre-determined number of days are selected

Dynamic aspects and correlation

Aspect	Dynamics				Correlation	
	ST	ST-MT	MT-LT	LT	Between 'profile types'	Between regions
Important to account for:	Ramping rates, start-up times	Start-up costs, Minimum up and down times,	LT storage technologies, maintenance scheduling	Different wind/solar/load years	Impacts the residual load curve => value of electricity generation in different time steps	Impacts value of extending transmission grid + value of electricity generation
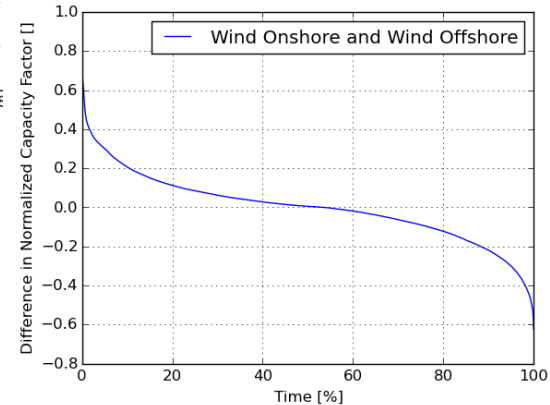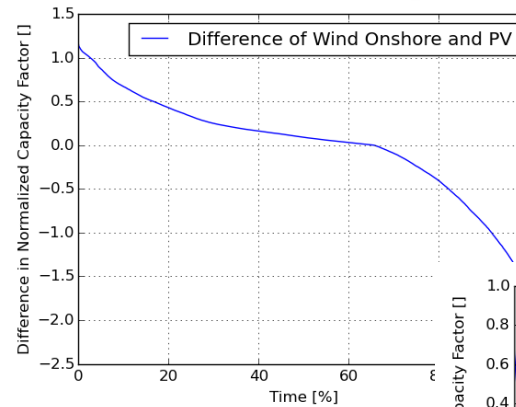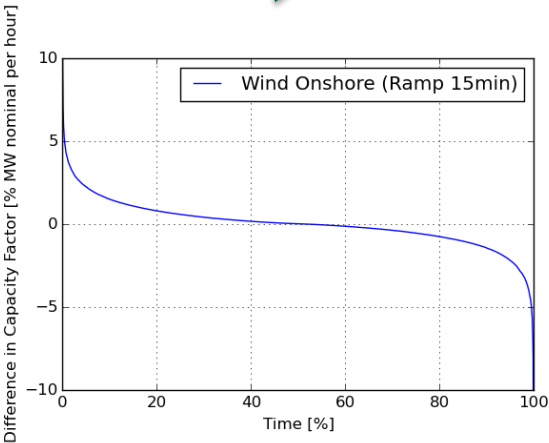
$$\sum_{d \in period} w_d = N^D_{period} \quad \forall\, period$$

$$\sum_d \sum_b A_{p,b,d} \times w_d \times \widetilde{E_{p,b}} \cong \widetilde{E_{p,period}}$$

Conclusions

- Fitting hourly data series in limited number of time slices:
  - No easy task
  - Insufficiently documented
  - No consistent approach
  - Lacks validation
- We present an approach to select a set of days that optimally represents a given data set
  - Consider static aspects, dynamic aspects and correlation aspects

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