Governance of the Integrated North Sea Offshore Grid: Simulation of Expansion Planning Constraints

João G. Dedecca[a]*; Sara Lumbreras[b]; Andrés Ramos[b]; Rudi A. Hakvoort[a]; Paulien M. Herder[a]

This dataset contains:

- Setup files for the sensitivity analysis on discount rates (input folder)

- Results for the original case studies and the discount rate sensitivity analysis (output folder)

Each results folder contains an expansion_pathway.xlslx file with the generation and transmission expansion pathways for all periods (2030-2050). The parameters.csv file provides the main simulation parameters, while the parameters.npy file provides the same data in a Python Numpy file format. The folder common_files may contain files that are common to all simulations, and the contents should be copied to the simulation folder.

The results for each period contain three folders: base, expansion and final. For a description of the expansion algorith for each period consult (Dedecca et al., 2017). Each of those folders contain the result of the mixed-integer linear optimal power flow of the modified PyPSA package (Brown et al., 2016) provided in (Dedecca, 2017). Due to storage limitations the results time series for the full-year base and final optimizations are not provided – please contact the corresponding author for the files.

The mixed-integer linear modification of PyPSA includes the following new attributes. All other attributes are presented in the PyPSA documentation at pypsa.org.

- Buses
  - country: Country of the bus
  - system: System of the bus (continental Europe, British isles, Scandinavia, North Africa, Eastern Europe, North Sea)
  - base_bus: Used for tracking the base AC bus of DC buses
- Generators
  - inflow: Maximum annual inflow (GWh) for energy-constrained generators
- Lines and links
  - branch_class: Separates between onshore and offshore (interconnector, farm-to-farm, connector) classes. Used to determine whether branch is conventional or integrated.
  - branch_type: Transmission technology of branch (AC, point-to-point HVDC or multiterminal HVDC)
  - Cooperative: indicates integrated (cooperative == True) or conventional lines

[a] Faculty of Technology, Policy and Management, Delft University of Technology
Jaffalaan 5, 2628BX Delft, The Netherlands [b] Institute for Research in Technology, Comillas Pontifical University
Santa Cruz de Marcenado 26, 28015 Madrid, Spain
* Corresponding author. Tel.: +34 91 542 2800 ext. 2771. E-mail: j.dedecca@tudelft.nl

    - marginal_cost: Penalty in the objective function for transmission on the branch to prioritize local generation in degenerate solutions
- MILP_objective
    - Actual solution objective function value
- Storage units
    - storage_class: Differentiates between storage technologies with inflow (e.g. concentrated solar power) and purely for storage (e.g. batteries or pumped hydropower)

Table 1: Folder abbreviations

Type	Abbreviation	Meaning
Case study	base	Base simulation, without expansion
	unc	Unconstrained expansion
	pw	Pareto welfare expansion
	c0	Disintegrated expansion
	c1	Complex integration expansion
Scenario	100	100% RES
	LSR	Large-scale RES
	BNM	Big & Market
	SNL	Small & Local
	FNN	Fossil & Nuclear
Sensitivity analysis	CCH	High DC converter costs
	CCL	Low DC converter costs
	CLH	High DC cable costs
	CLL	Low DC cable costs
	DCB	DC breakers inclusion
	HIH	High hydro inflow
	HIL	Low hydro inflow
	OWS	Alternative offshore wind series
	WCH	High offshore wind CAPEX
	WCL	Low offshore wind CAPEX
	WPH	High offshore wind potential
Verification	IC0	Null cable costs
	MC0	Null generation marginal costs
	MCI	Very high generation marginal costs
	NEC	No generation energy constraints
	NSL	Null storage losses
	WC0	Null offshore wind CAPEX
	WCI	Very high offshore wind CAPEX verification
Parameter	Ns	North Sea offshore expansion case
	par	Pareto welfare constraint
	co	Integration constraint
	sa	Sensitivity analysis

References

Brown, T., Hörsch, J., David, S., 2016. Python for Power System Analysis (PyPSA). http://pypsa.org/

Dedecca, J.G., 2017. OGEM: The Offshore Grid Exploratory Model. doi:10.5281/zenodo.1006739

Dedecca, J.G., Lumbreras, S., Ramos, A., Hakvoort, R.A., Herder, P.M., 2017. Governance of the Integrated North Sea Offshore Grid: Simulation of Expansion Planning Constraints. Unpublished.