

IPSYS Applications: Cape Verde and Faroe Islands power system analyses

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Faroe Islands: Objectives, Present Power System

- Objective
 - How much wind energy can be integrated in the Faroese power system
- 2 Diesel power stations 52.5 MW
 - 5 gensets 47.5 MW
 - 2 gensets 5.0 MW
- 5 Hydro reservoirs (one fed from another) with 7 turbines 28.5 MW
- Wind 2x3x660 kW Vestas 3.96 MW
- Power Generation (load) 18 – 42 MW
 - Diesel (55%)
 - Hydro (41%)
 - Wind (4%)

Faroe Islands: Modelling issues

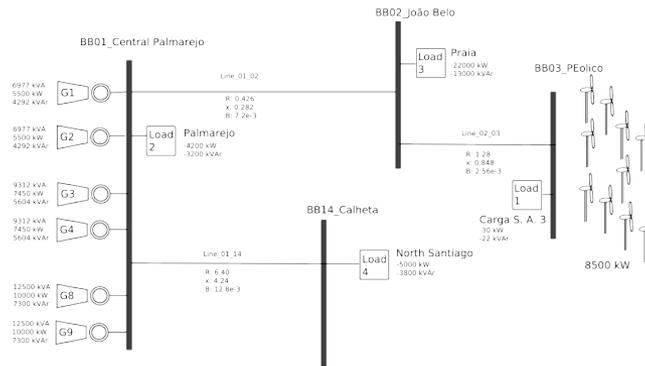
- Reservoir inflow modelling
 - no direct inflow measurement
 - height and production measured for each reservoir/unit
- Control strategy
 - use of water – when to run turbines when inflow is increasing
 - start/stop strategy - minimum runtime
 - load sharing between units – requirements for diesel loading

Cape Verde

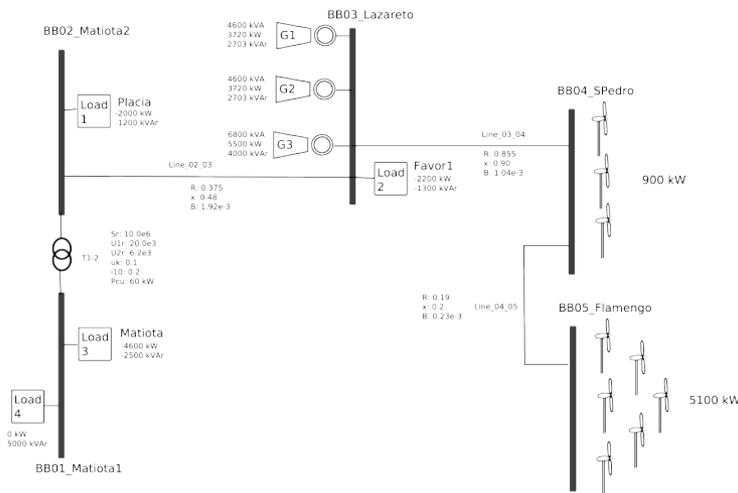


Simplified power system models

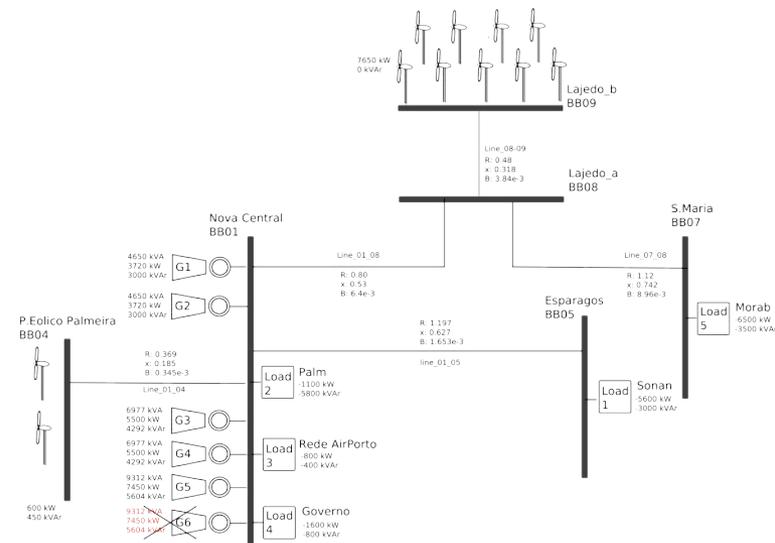
Santiago



São Vicente

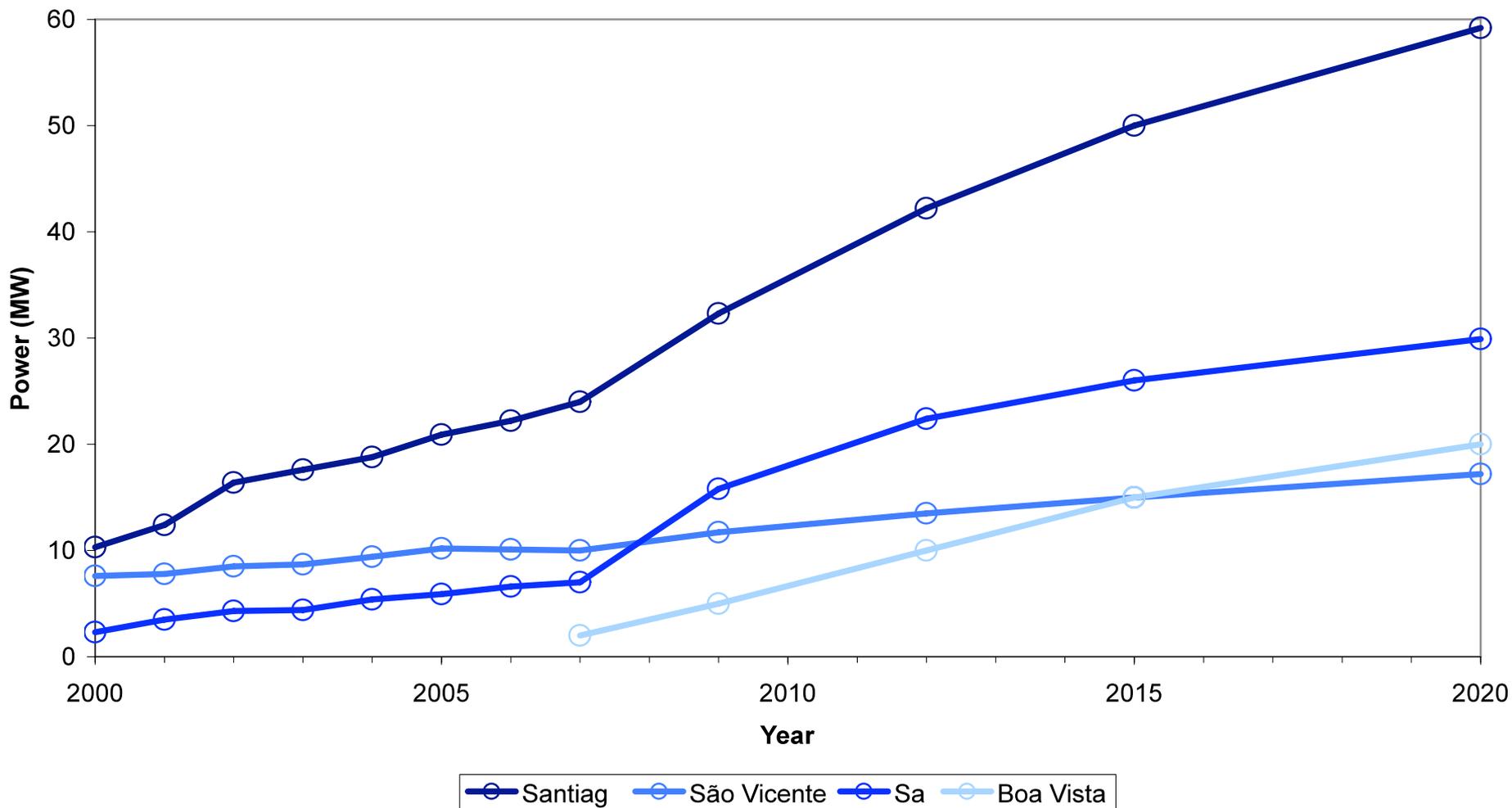


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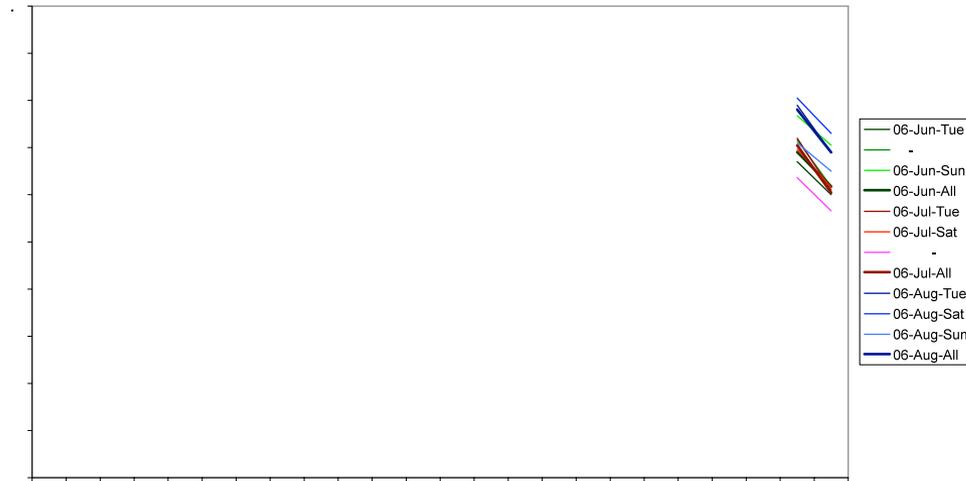
Historical and expected power demand development

Max power load



Power demand fluctuations

São Vicente

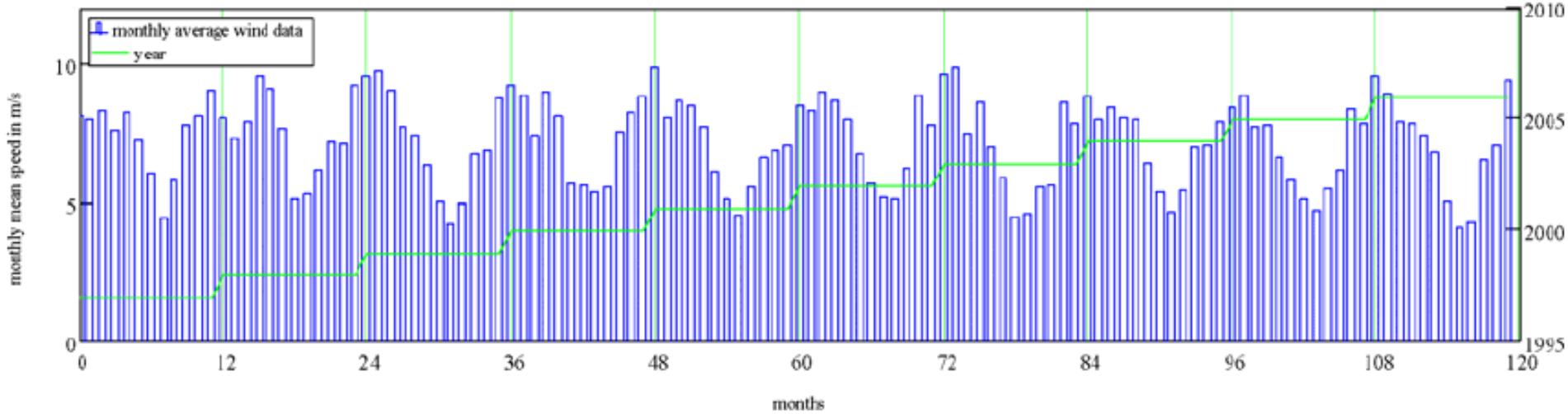


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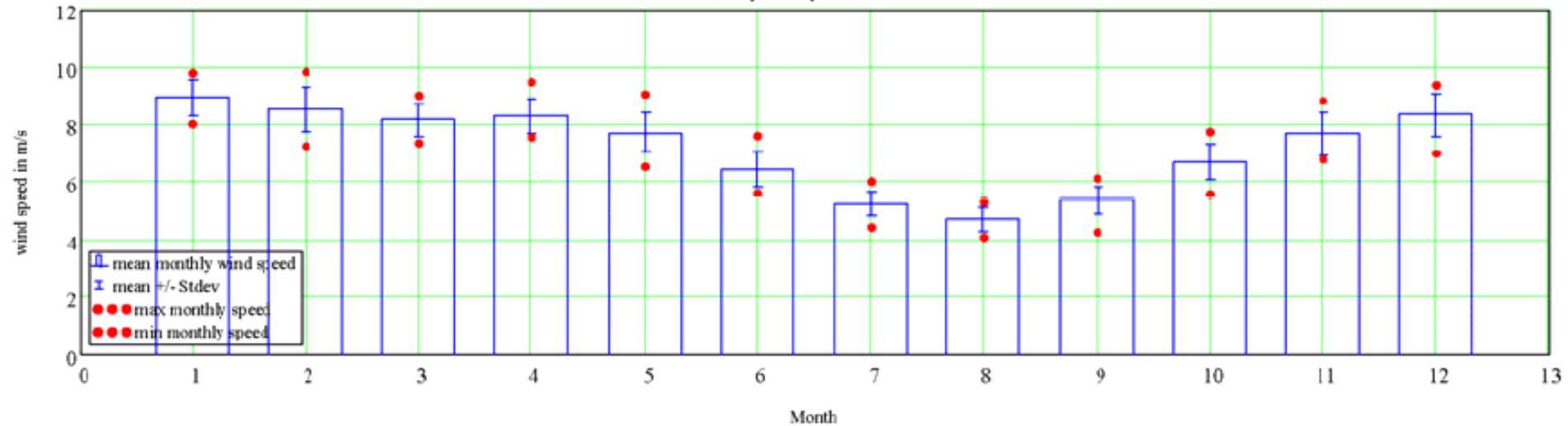


Wind resource fluctuations

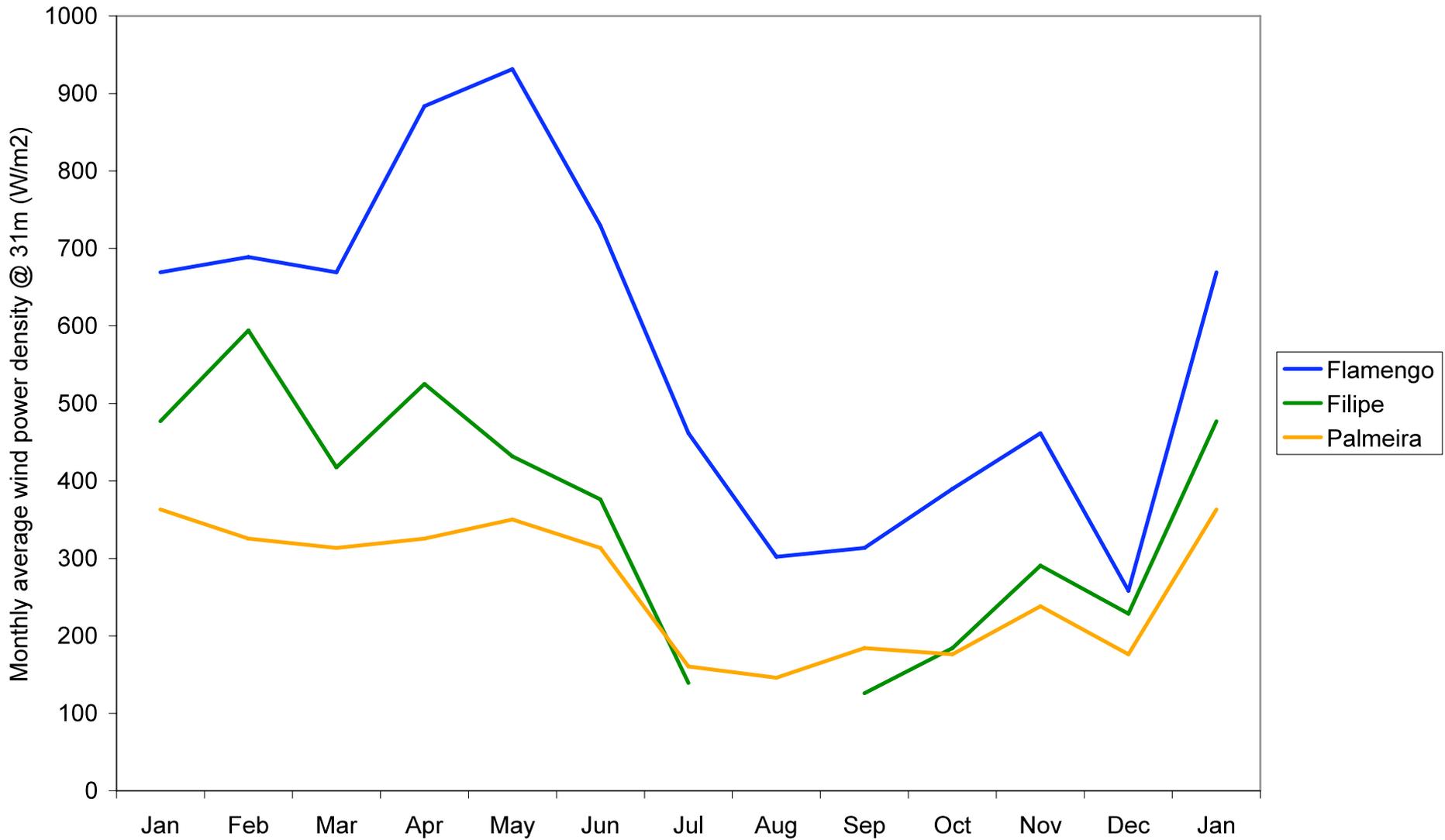
Monthly mean wind speed



Monthly wind speed statistics

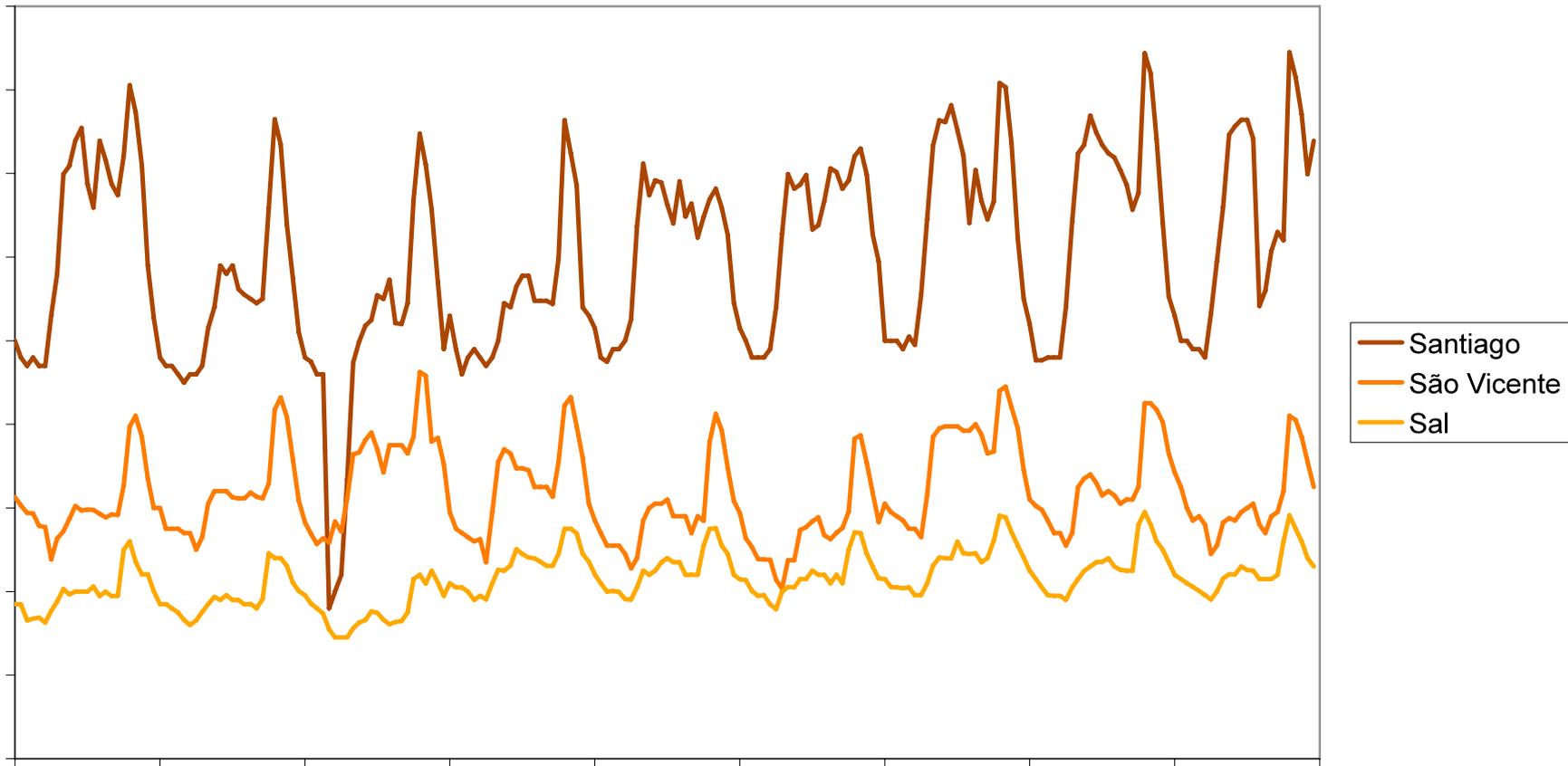


Seasonal variation of wind resource

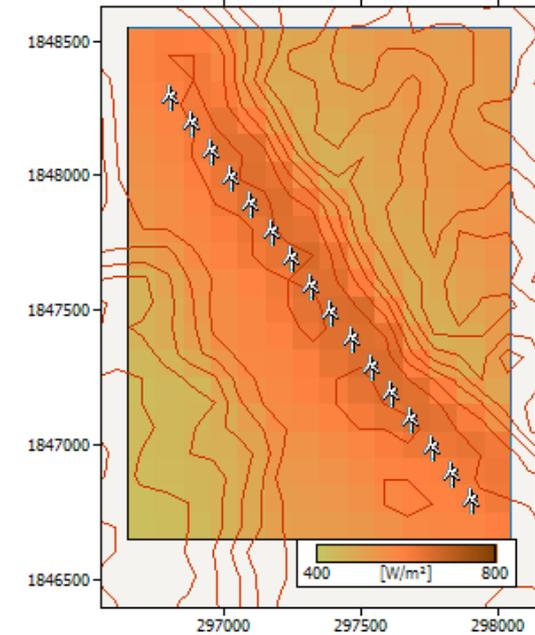
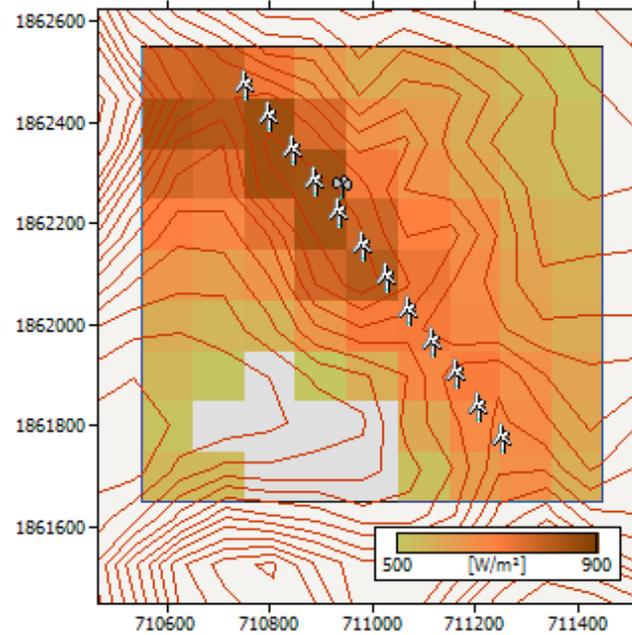
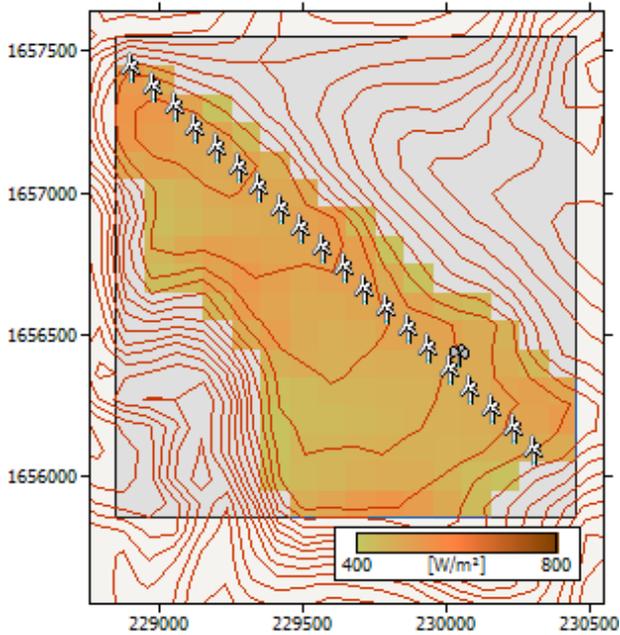
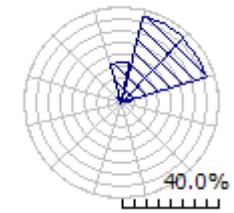
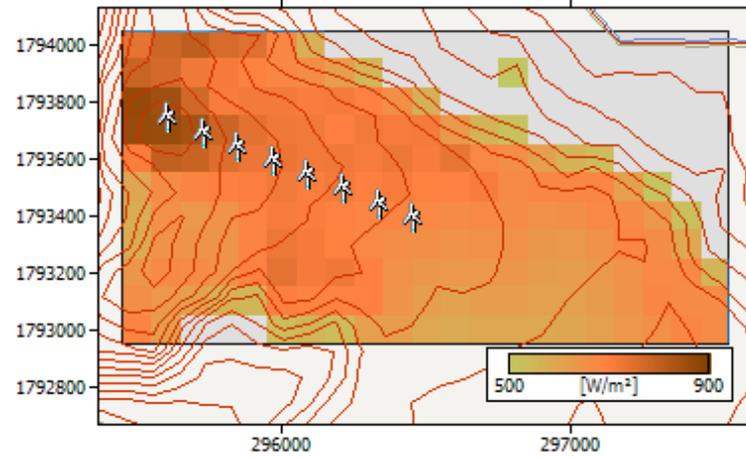
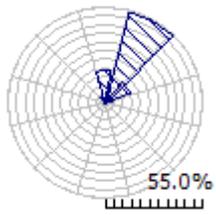


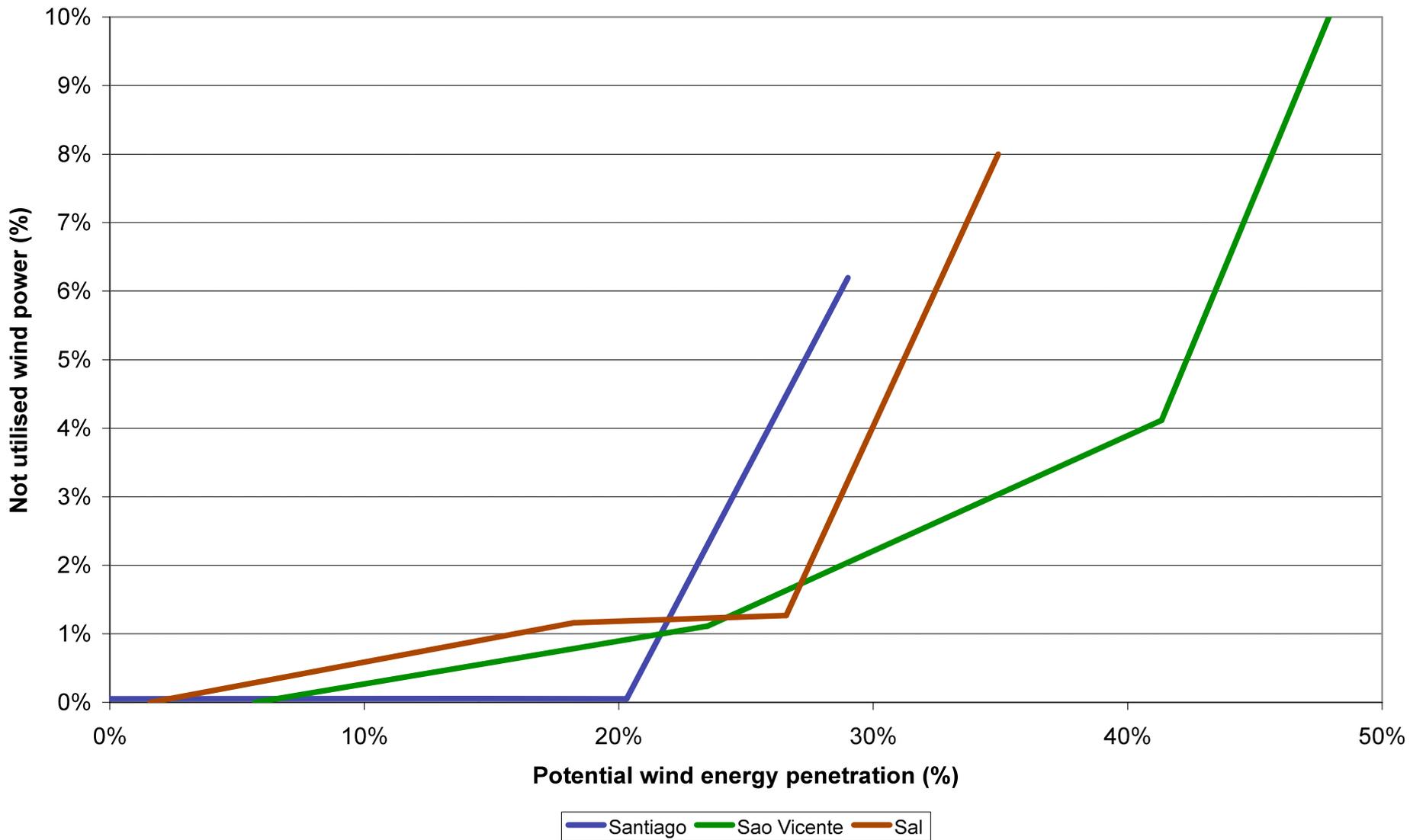
Load profiles - 2006

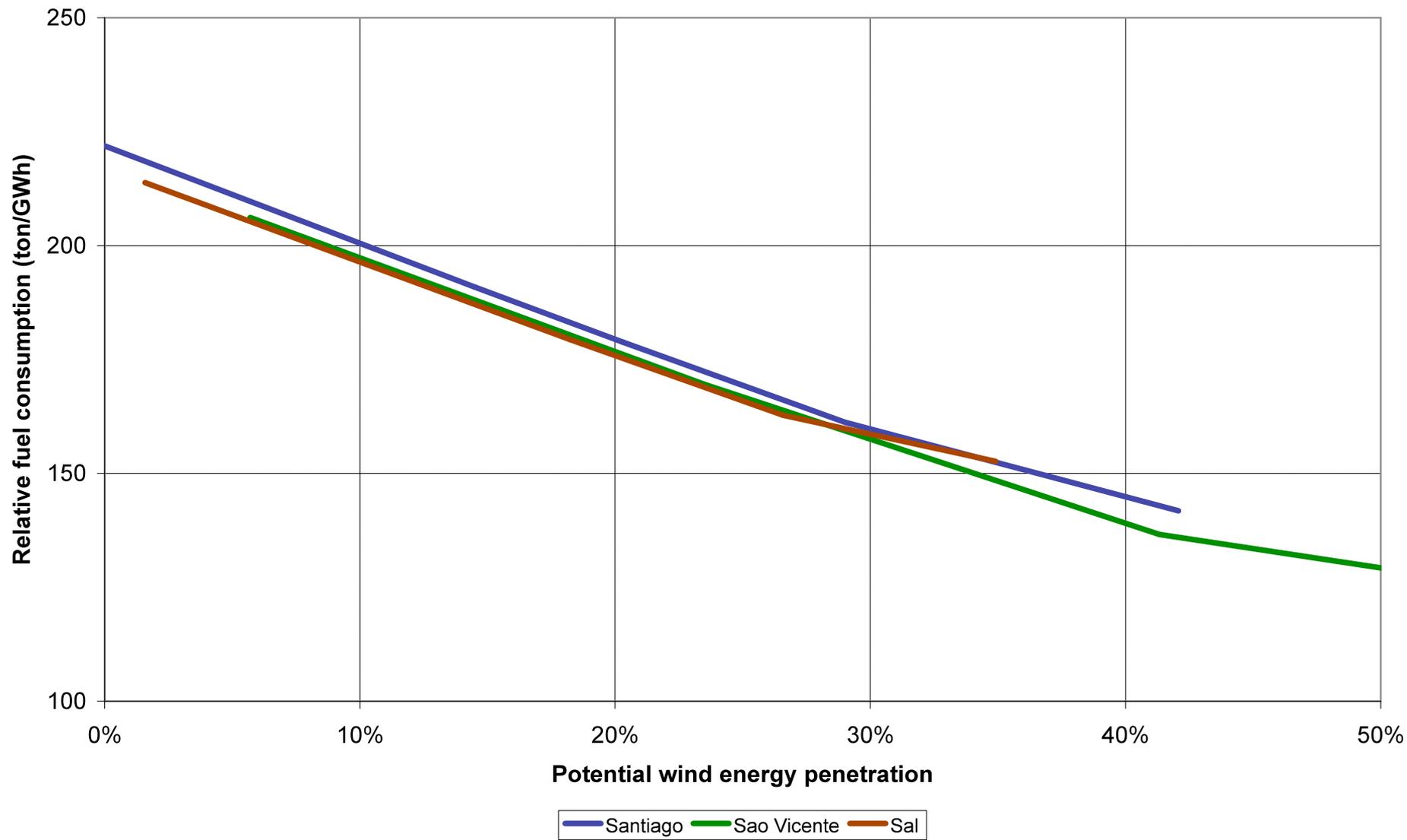
Load profiles



Wind farm layouts







Results from IPSYS simulations

Year	Min load (MW)	Mean load (MW)	Max load (MW)	Diesel power capacity (MW)	New wind power capacity (MW)	Wind energy penetration (%)	Total energy consumed (GWh/y)	Available wind energy (GWh/y)	Unused wind energy (GWh/y) [%]
Boa Vista									
2009	3	4	5	7	4	46	35	19	3 [16]
2012	5	7	10	11	4	30	60	19	1 [5]
2015	7	10	15	15	4	21	90	19	0 [0]
Sal									
2009	7	10	14	20	8	33	90	33	3 [9]
2012	10	15	21	35	8	25	130	33	1 [3]
2015	13	19	26	35	8	19	170	33	0 [0]
Santiago									
2009	16	24	32	44	10	17	210	35	0 [0]
2012	21	31	42	66	10	13	270	35	0 [0]
2015	24	35	48	76	10	11	310	35	0 [0]
São Vicente									
2009	6	8	12	16	6	36	70	28	3 [11]
2012	7	9	14	22	6	33	80	28	2 [7]
2015	8	10	16	25	6	30	90	28	1 [4]