Investigation of large pumped storage on the All-Island system

Presentation to Electricity Storage Seminar

3rd November 2009

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Context

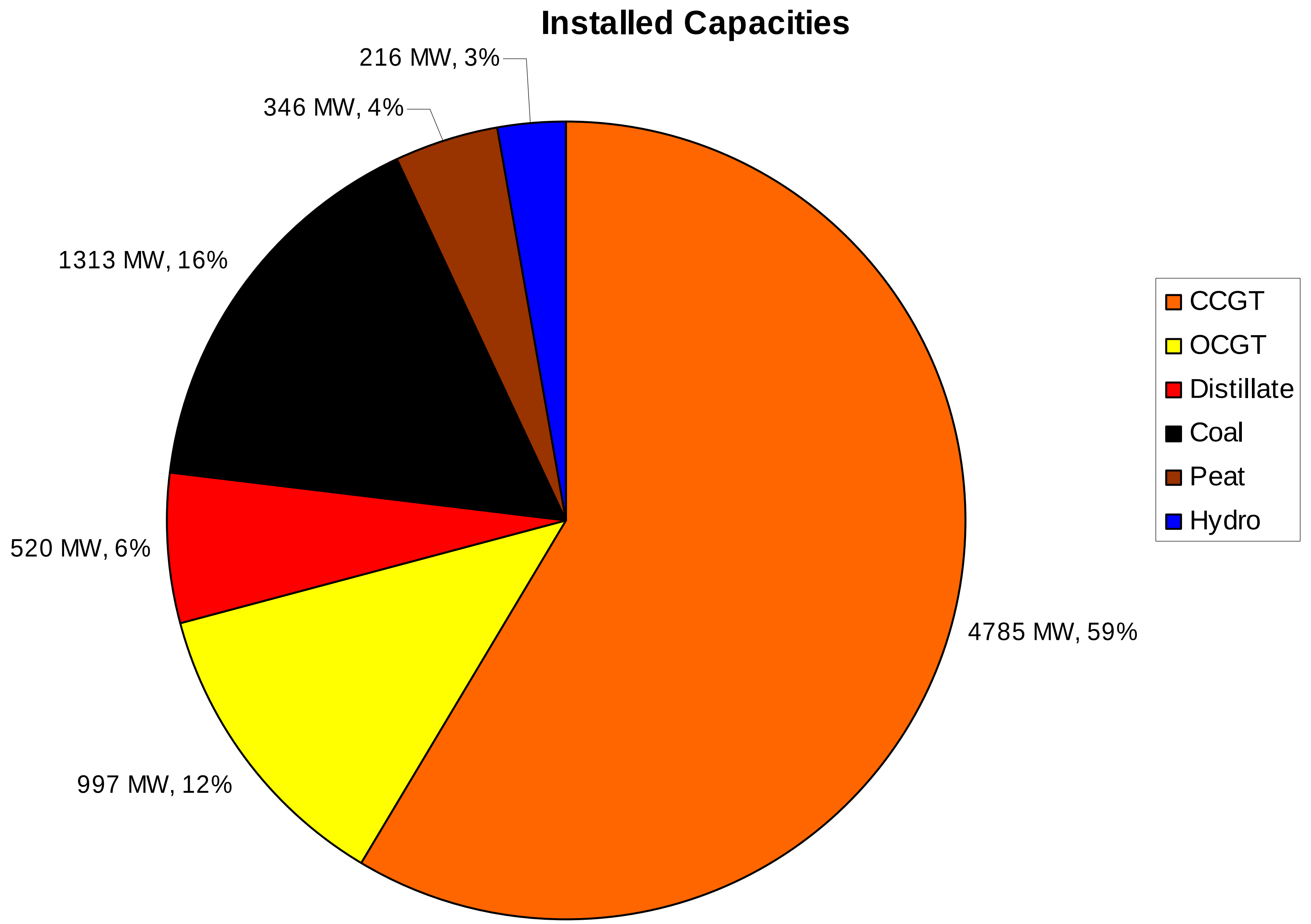
- Increasing wind
  - 6.3 GW after Gate 3 is finished
  - Potentially more: Offshore, non-Gate 3, Marine
- Previously expected increases in demand now unlikely.
  - Older assumption**:** 58 TWh; Peak Demand 10 GW
  - Current Best Guess: 46 TWh; Peak Demand 7.8 GW
- What is the optimal balance of plant to match intermittent generation?
  - increased interconnection
  - storage
  - flexible plant
  - Demand side management

These are the focus of studies presented today.

Input Assumptions

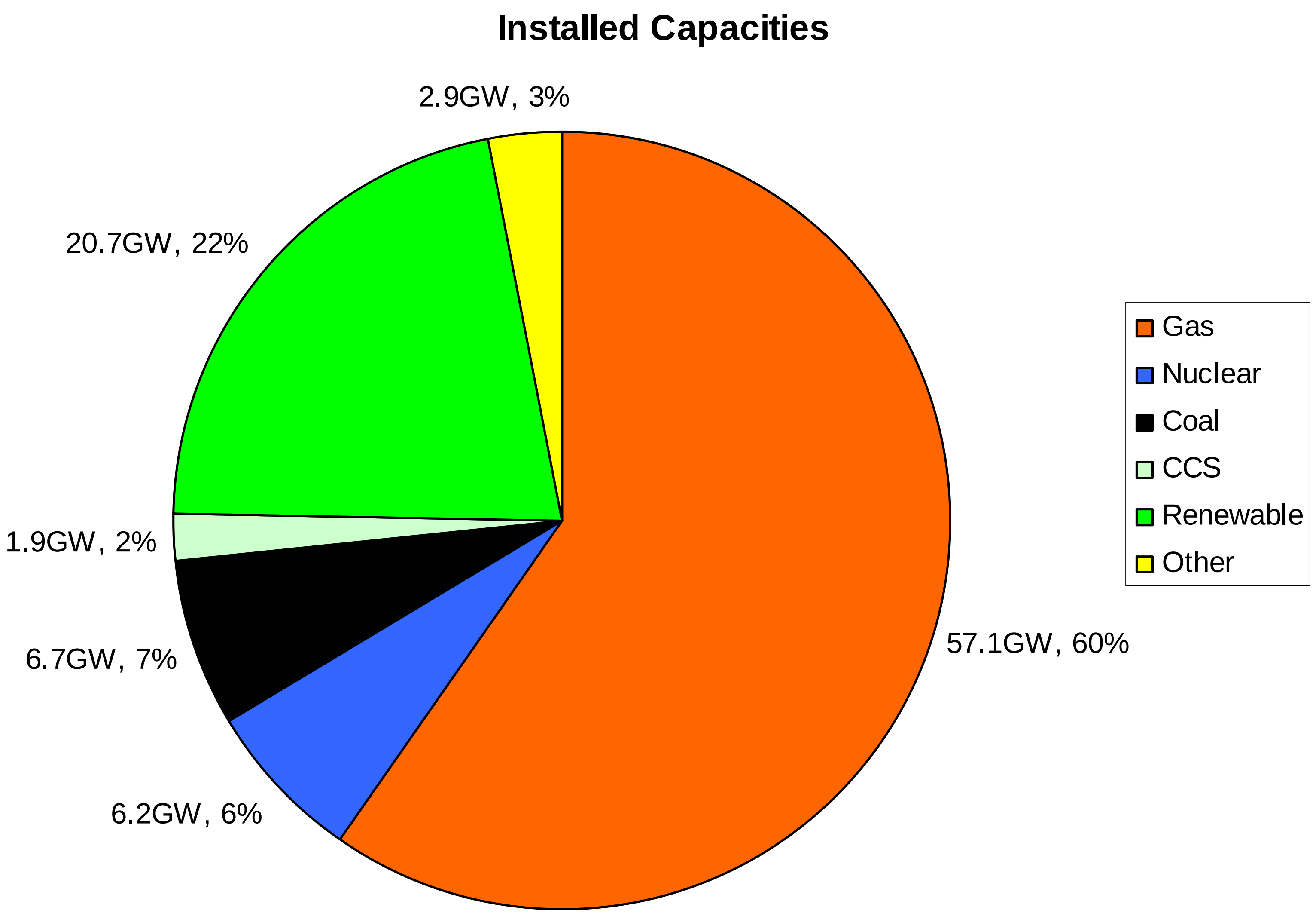
- 2025 All-Island Study
- Demand: 46 TWh; Exported Peak; 7.8 GW.
- Fuel prices:
  - Gas 7.92 €/GJ (winter) / 6.13 €/GJ (summer) ≈ 84 ¢/therm (winter) / 65 ¢/therm (summer)
  - Coal 2.12 €/GJ ≈ 64 €/tonne
  - Carbon 38 €/tonne CO_2
- No transmission constraints.
- Dispatch Rule: Minimum number of sets required online at all times to simulate frequency and voltage control
- Reserve not modelled
- Capacity credit for wind, Interconnection and Storage reduces the required conventional plant.

2025 All-Island Conventional Portfolio



- New plant:
  - 985 MW OCGT
  - 860 MW CCGT
- Decommissioned Plant:
  - Aghada 1 + CTs
  - Northwall
  - Poolbeg 1 and 2
  - Ballylumford 4,5 and 6
- Renewables, Interconnection and Storage Assumptions discussed later

British Portfolio



- Energy Demand: 390 TWh
- Peak Demand: 72 GW
- Interconnection to Europe is not modelled
- Britain is assumed to have adopted a SRMC-based market.
- Note: there are wide-ranging views on how the British portfolio will develop.

Capital Cost Assumptions

	Onshore Wind	Offshore Wind	Interconnection	Pumped Storage	CCGT	OCGT	Other Conventional
€m/MW	1.4	2.1	1	0.8 - 1.6	0.75	0.435	1.4
Economic Life	20	20	30	30	20	20	20
Discount Rate	12%	12%	6%	10%	10%	10%	10%

Scenarios

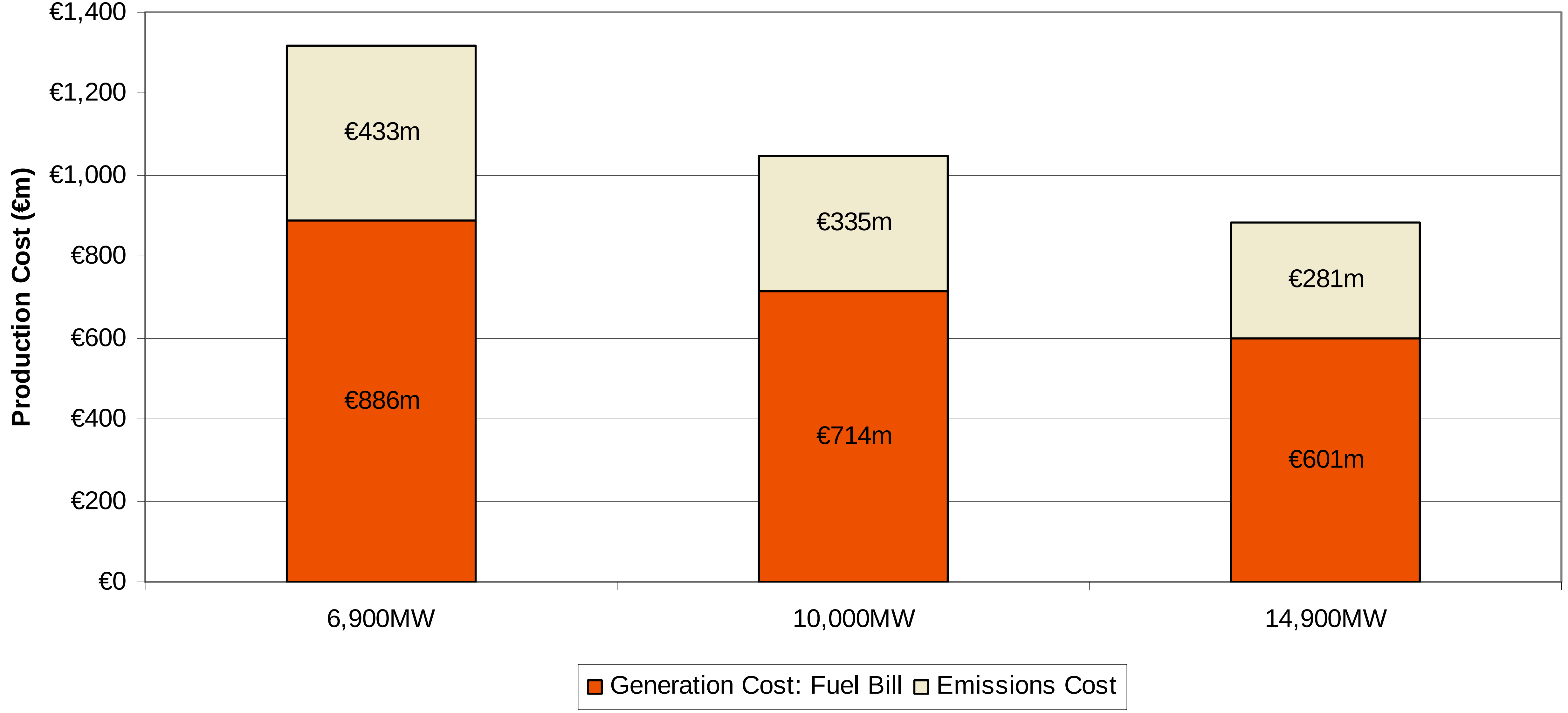
- 3 Renewables scenarios:
  - 6,900 MW. Roughly equivalent to 40%.
  - 10,000 MW. Roughly equivalent to 60%.
  - 14,900 MW Roughly equivalent to 80%.
- 3 Interconnector scenarios
  - Moyle + EWIC: 1GW
  - Moyle + EWIC + 1GW: Total 2GW
  - Moyle + EWIC + 2GW: Total 3GW
- 4 Storage scenarios
  - No extra storage – Turlough Hill only
  - 1 GW capacity with 100GWh storage
  - 2 GW capacity with 200GWh storage
  - 3 GW capacity with 300GWh storage

- This is an artificial study to stress test the modelling.
- EirGrid is not suggesting that these scenarios could work in reality.
- The higher equivalent percentage energies scenarios may be difficult to achieve due to minimum generation requirements, the wind profile, the interaction with Interconnection etc.
- Large amounts of this energy will be exported or curtailed.

- 75% efficiency of pumping cycle assumed.
- 1 week look ahead assumed to attempt to optimise the reservoir usage.

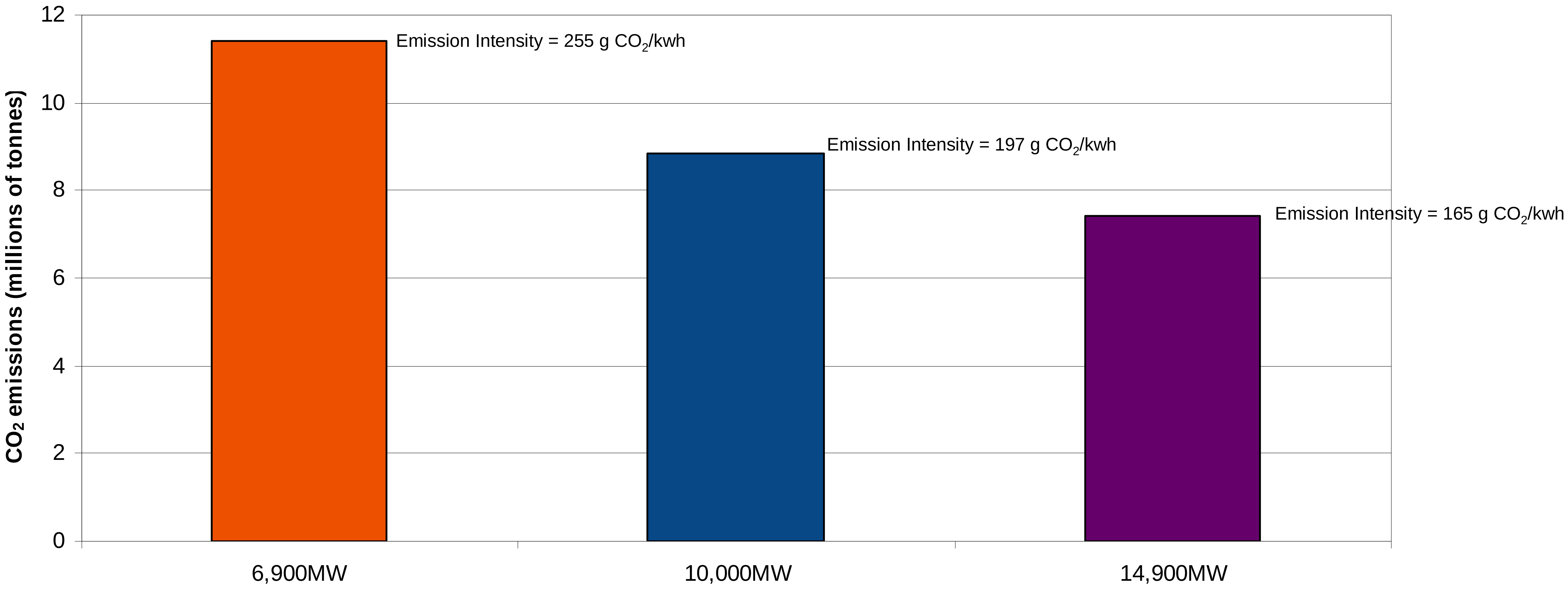
Production Costs with increasing wind

1GW of Interconnection and no large pumped storage

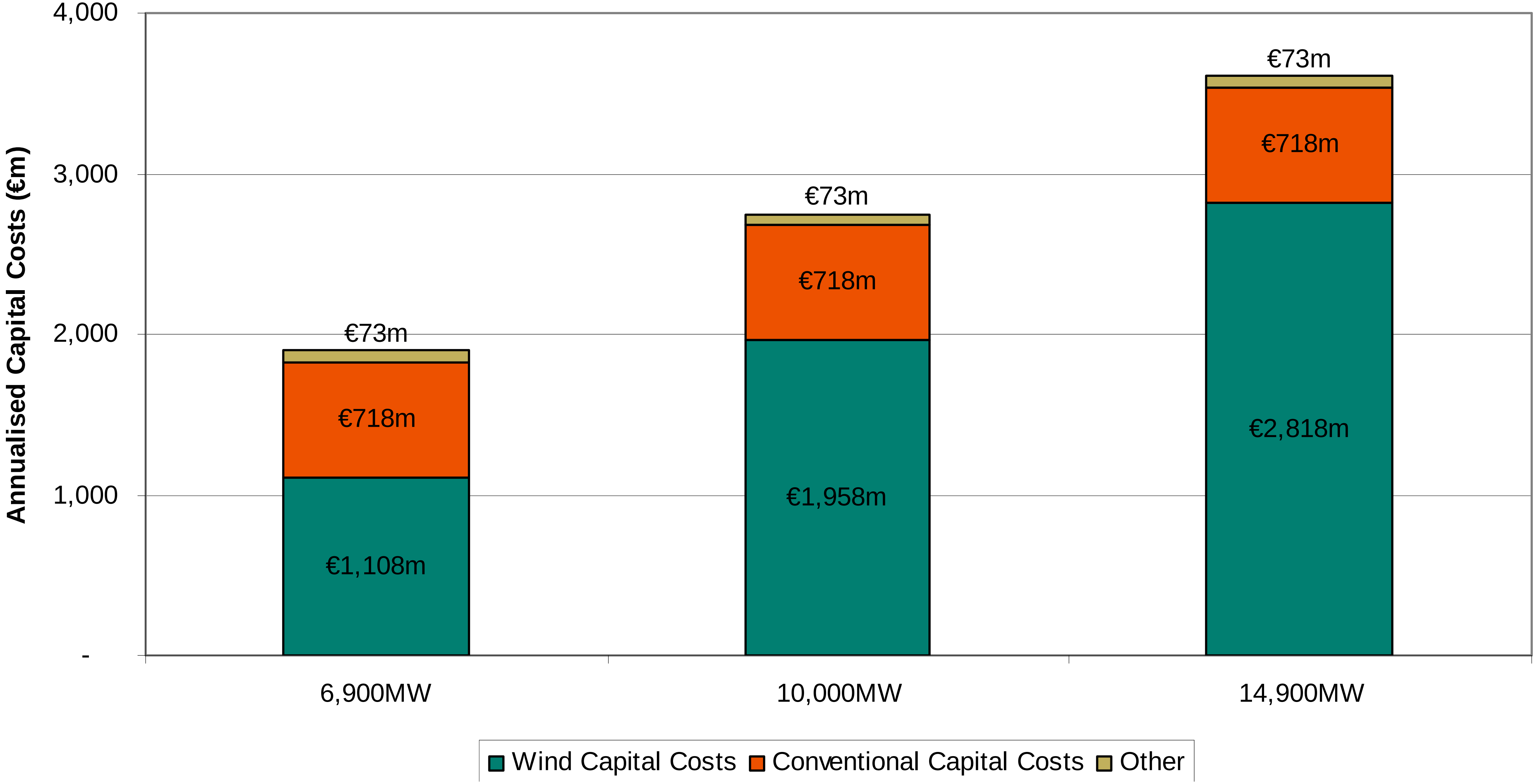


Increasing Wind: Emissions

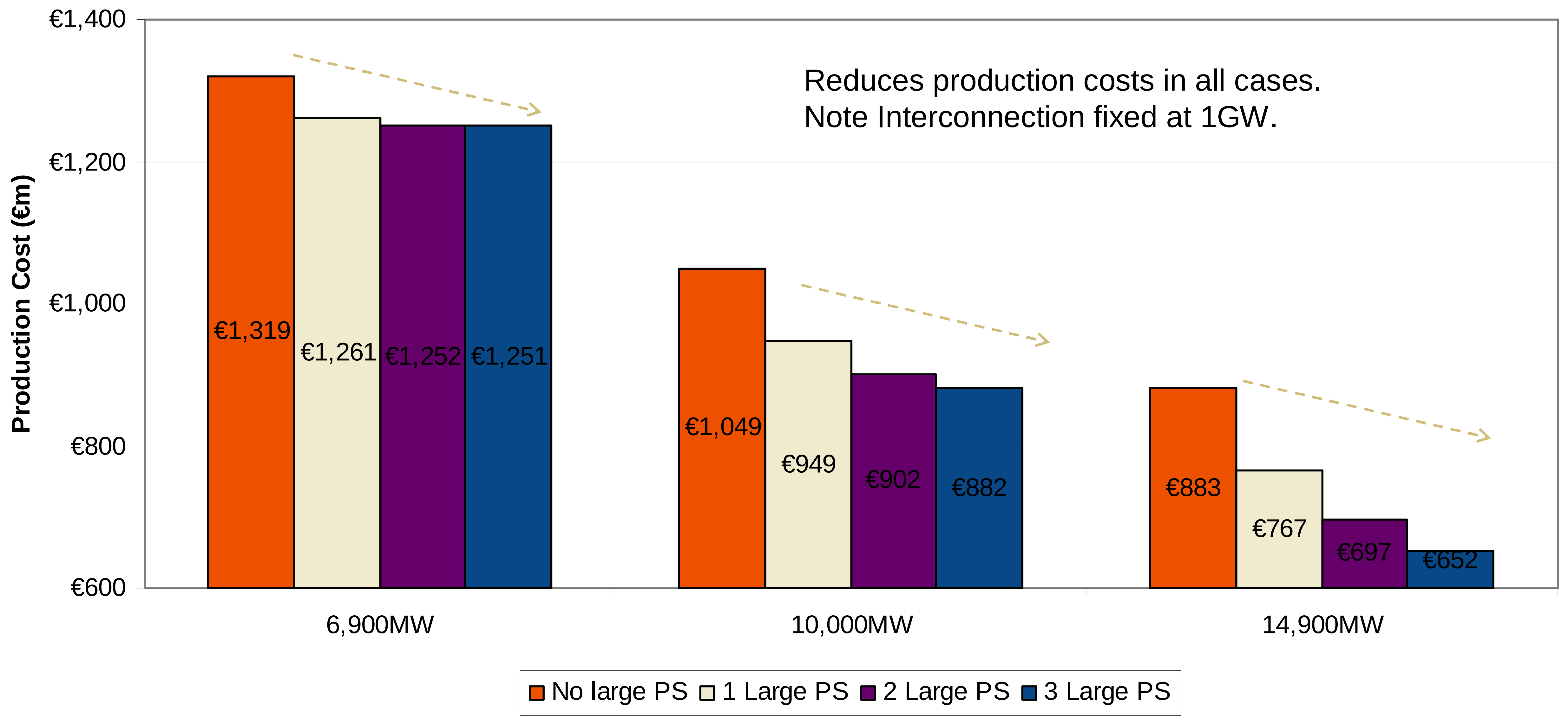
Base case with 1GW Interconnection and No large Pumped storage



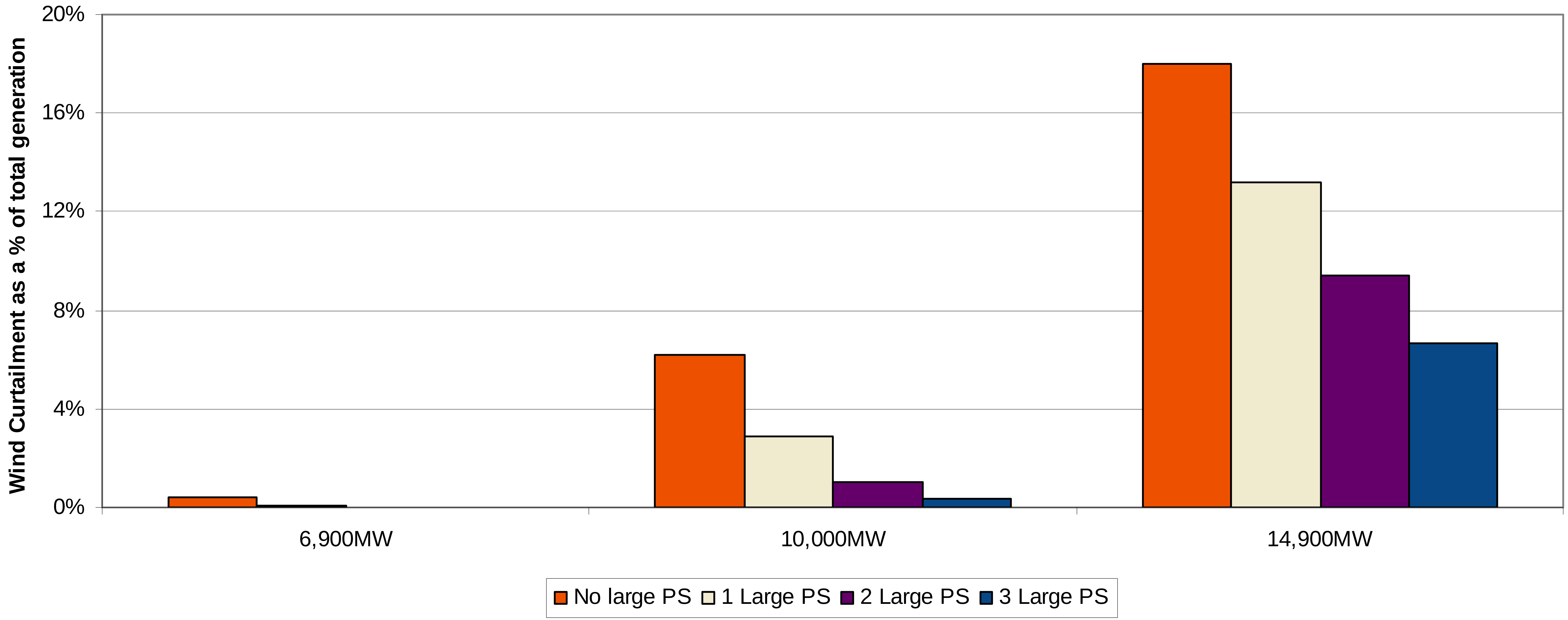
Increasing Wind: Base case capital Costs



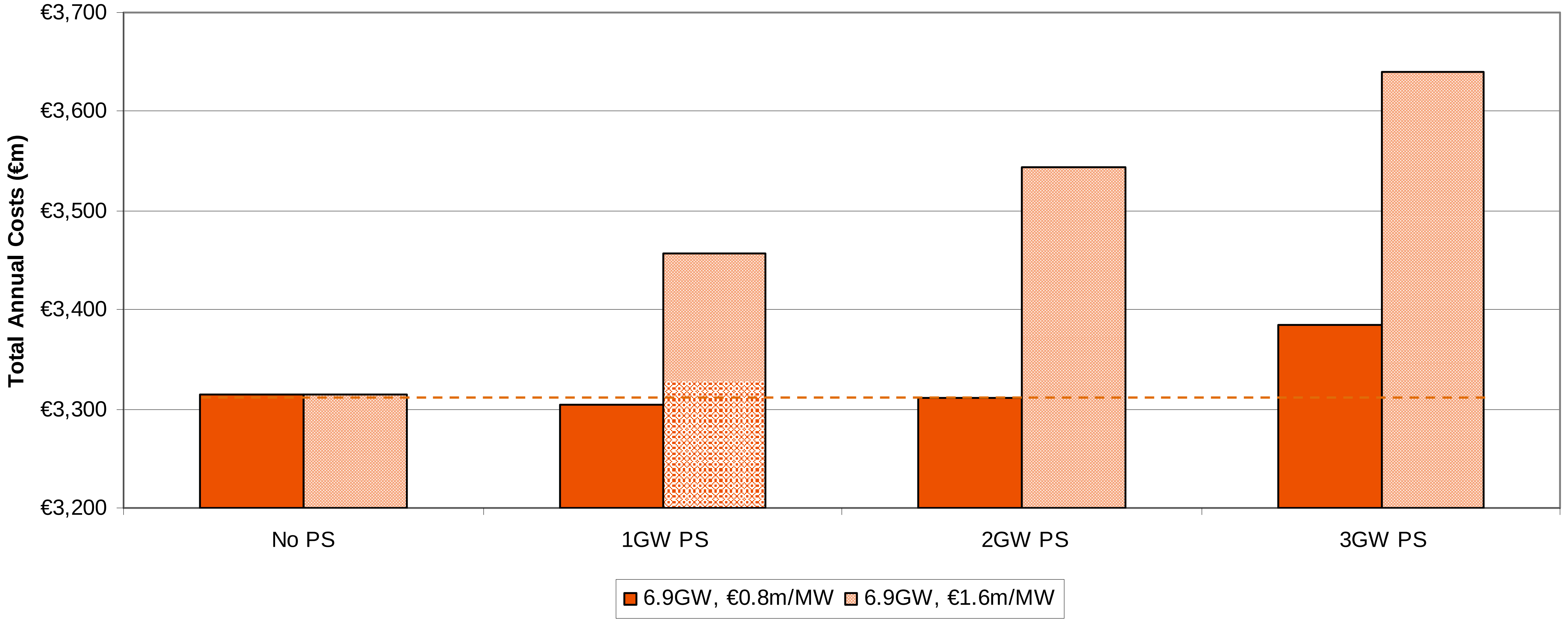
Increasing Pumped Storage: Production Costs



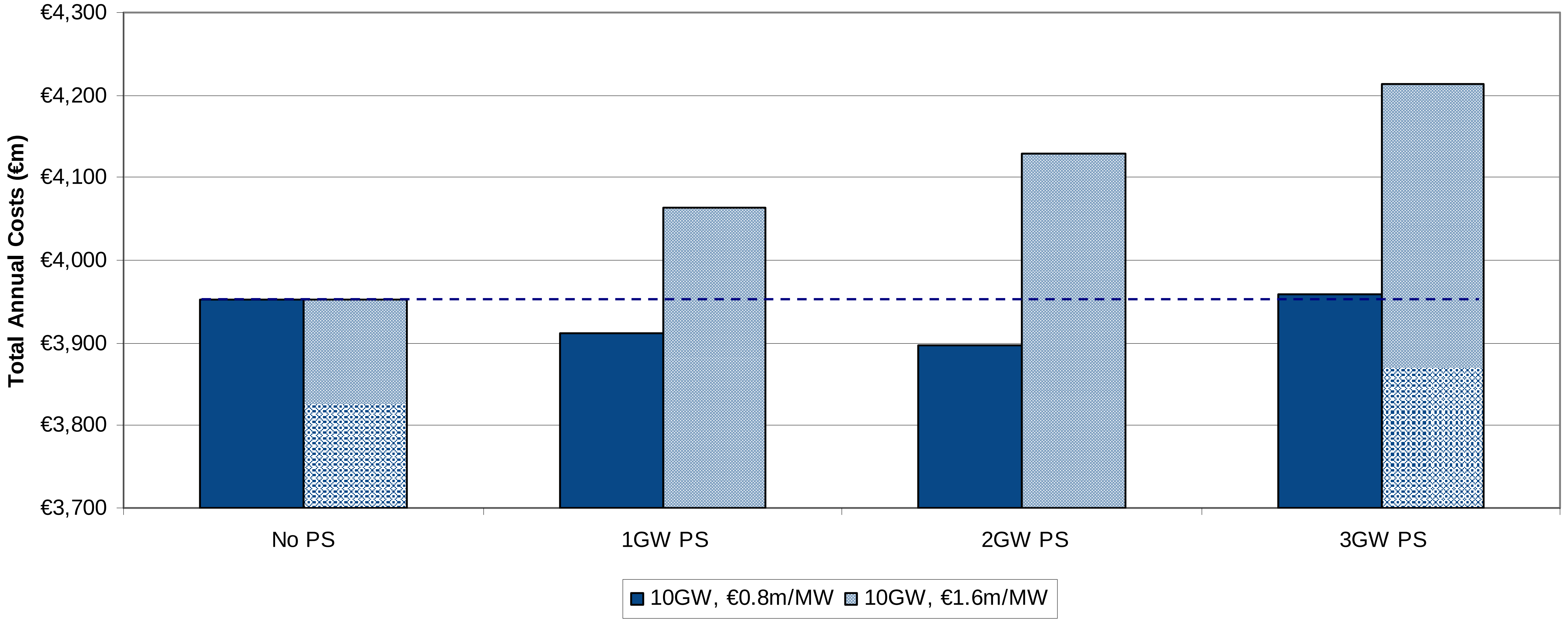
Increasing Pumped Storage: Avoiding curtailment



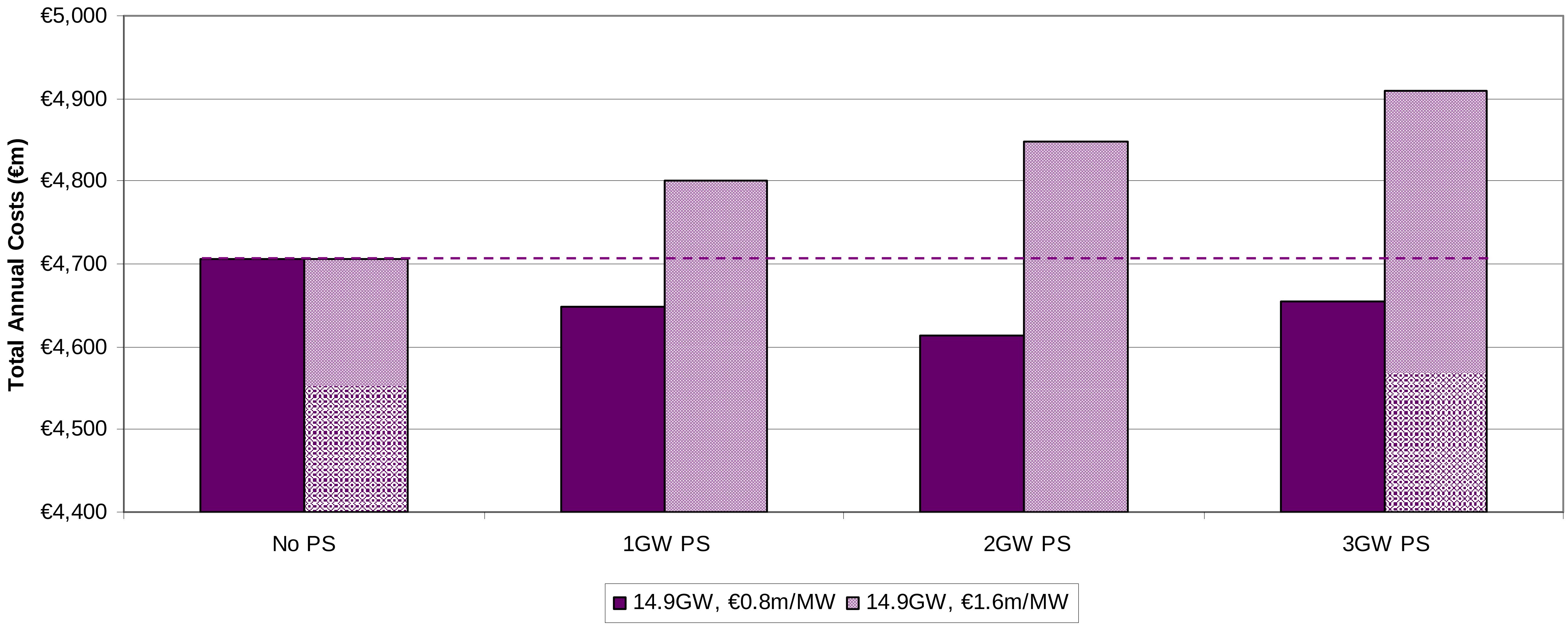
Pumped Storage: 1GW Interconnection, 6.9 GW wind



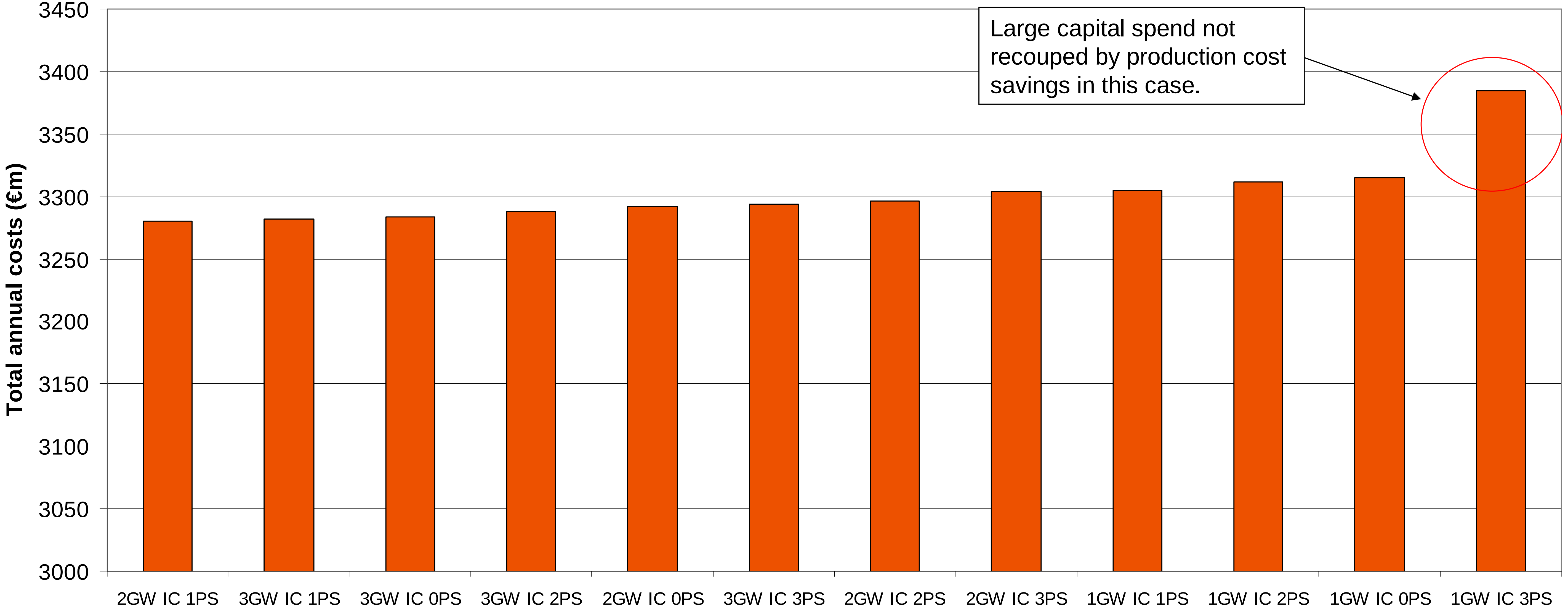
Pumped Storage: 1GW Interconnection, 10 GW wind



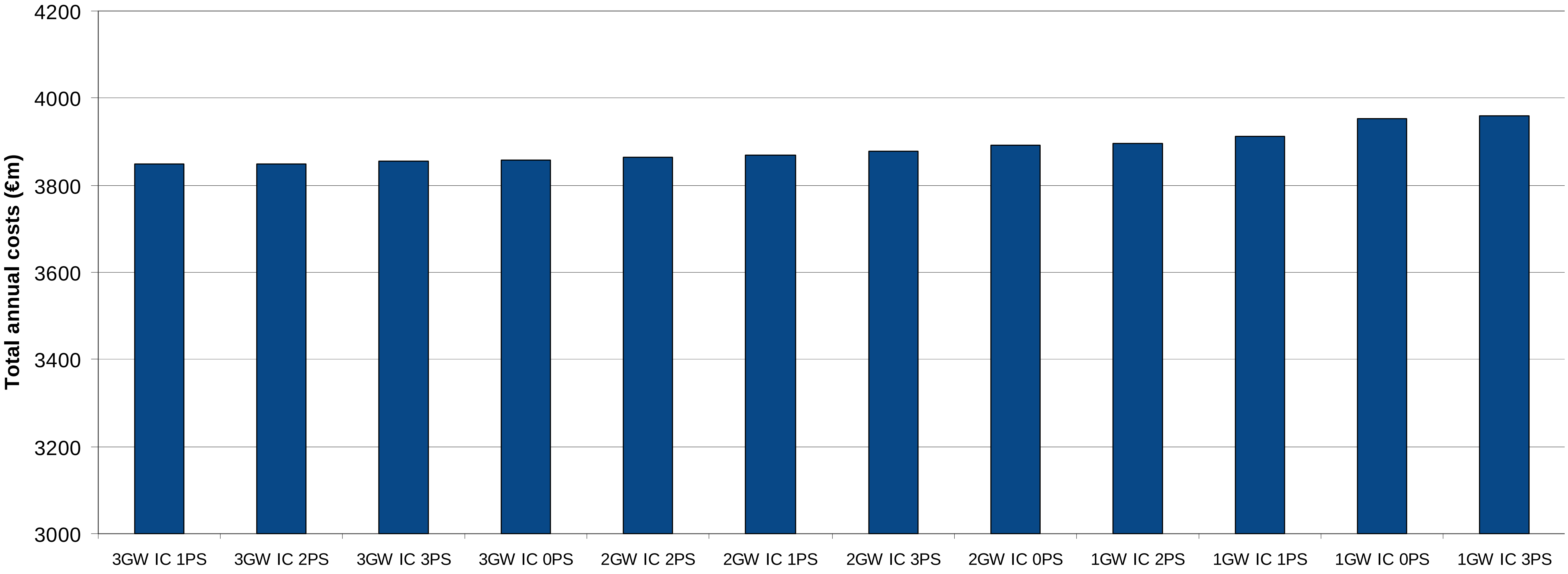
Pumped Storage: 1GW Interconnection, 14.9 GW wind



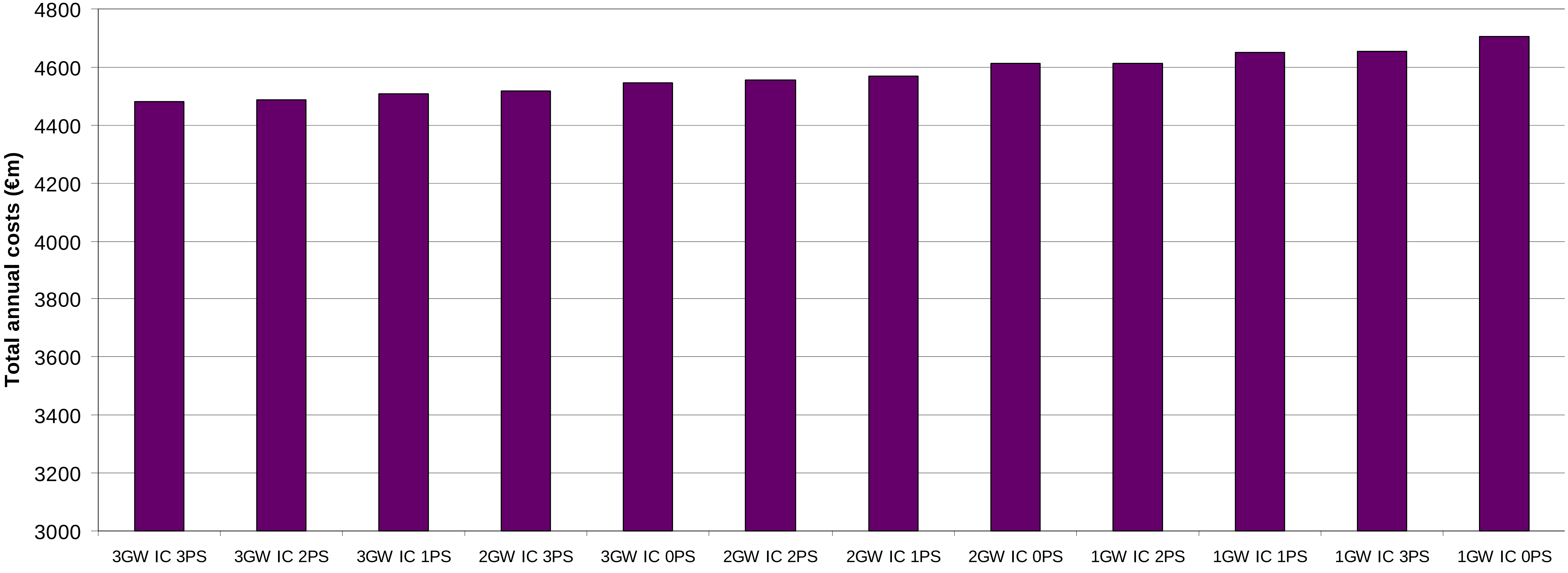
Cheapest Overall Option at 6,900MW Wind



Cheapest Overall Option at 10,00MW Wind



Cheapest Overall Option at 14,900MW Wind



Summary of main findings

The study encompassed a wide range of scenarios with diverse input assumptions.

What findings can we take from these?

At 40% renewables, the benefit of pumped storage is marginal.

At renewable penetration levels beyond 40%:

- system costs become dominated by capital costs instead of fuel costs.
- There are not large differences in total costs in many scenarios, where low pumped storage capital costs are used.

The treatment of capacity credit for Interconnection and Pumped Storage is important when assessing a scenarios overall costs.

Other EirGrid studies

System dynamics studies.

- Interim results due shortly

Interconnector economic feasibility report

- Due out next week – 10th November

Plant portfolio options post 2025.

- Due end of November

EirGrid