Techno-Economic Review of Existing and New Pumped Hydro Energy Storage Plant

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Structure

- Background
- Review of build costs and technical drivers of Existing Plant
- Review of build costs and technical drivers for Proposed Plant
- Conclusion


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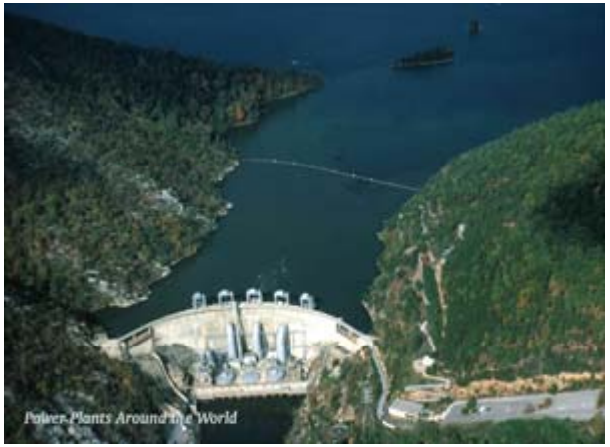
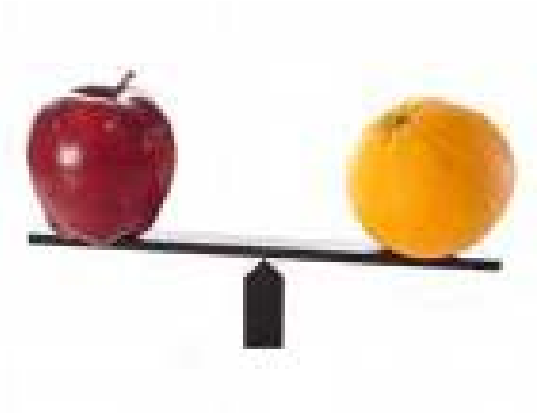

Power Plants Around the World

Understandings Costs

- Must understand context.
- Cost are very site/project specific.
- No ‘average’ plant.
- Limitations
  - Costs are presented price/MW
  - No information on energy storage



Review of build costs of existing Plant

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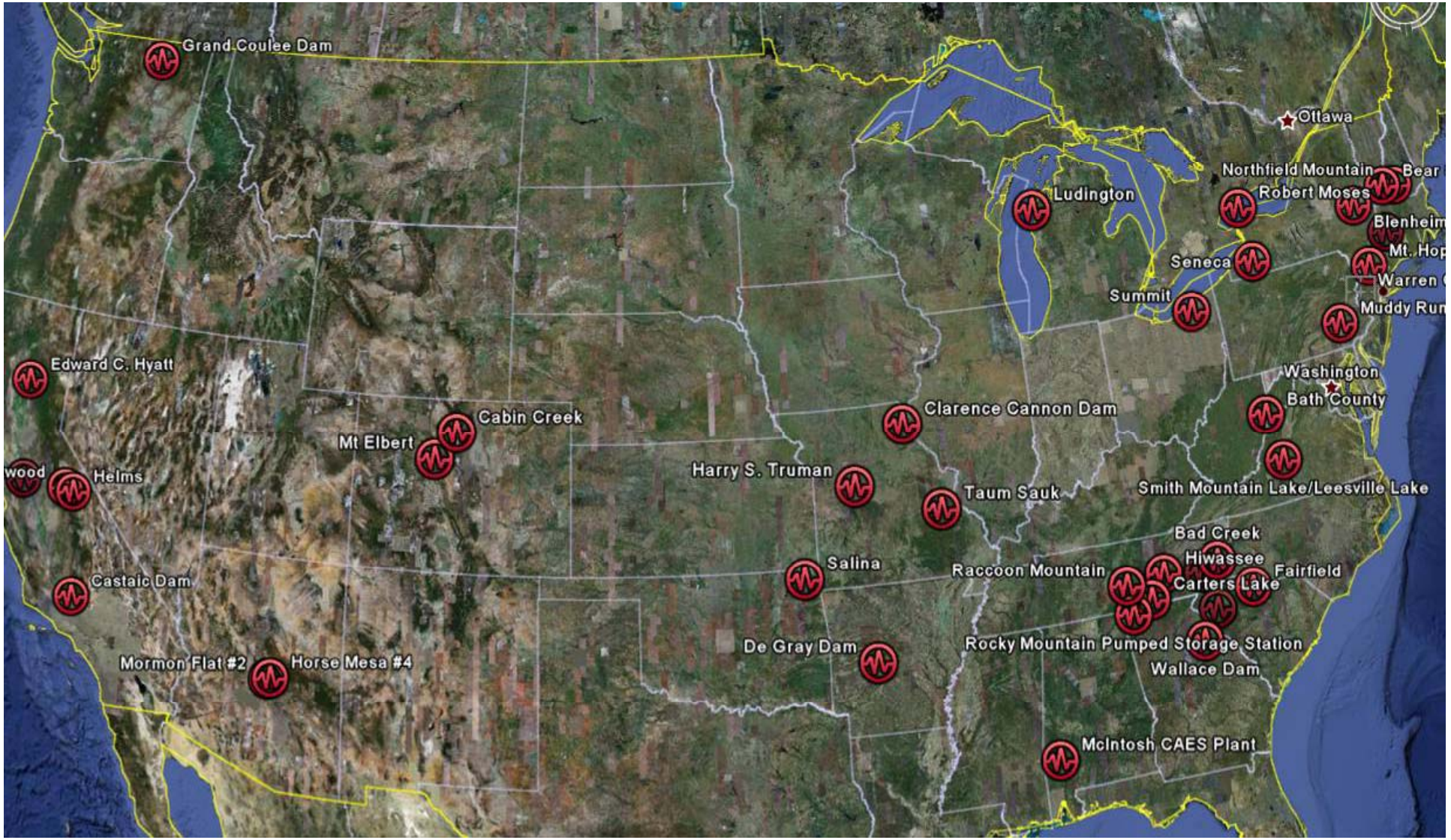
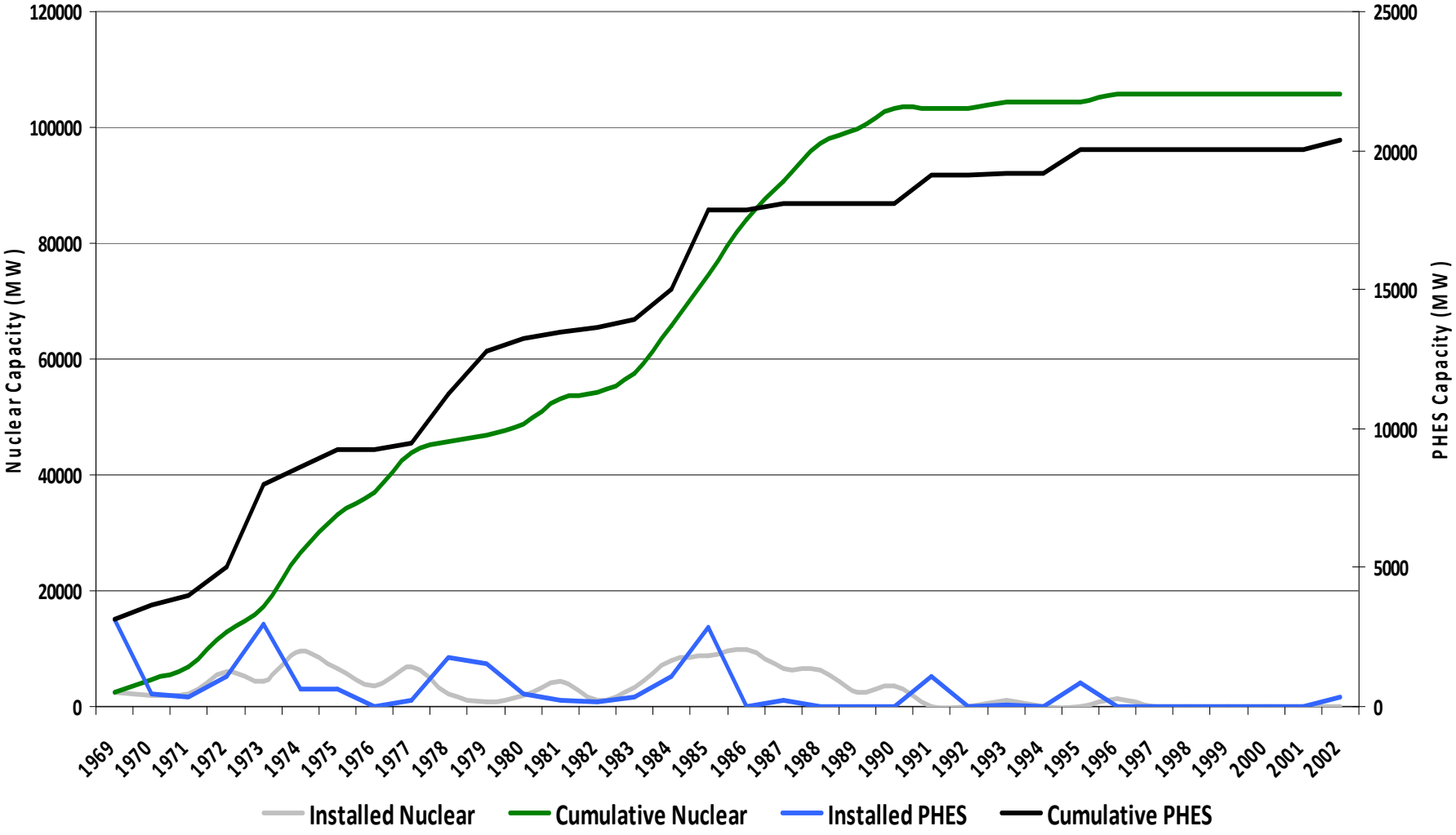
PHES Plant in USA



Development of PHES in the USA



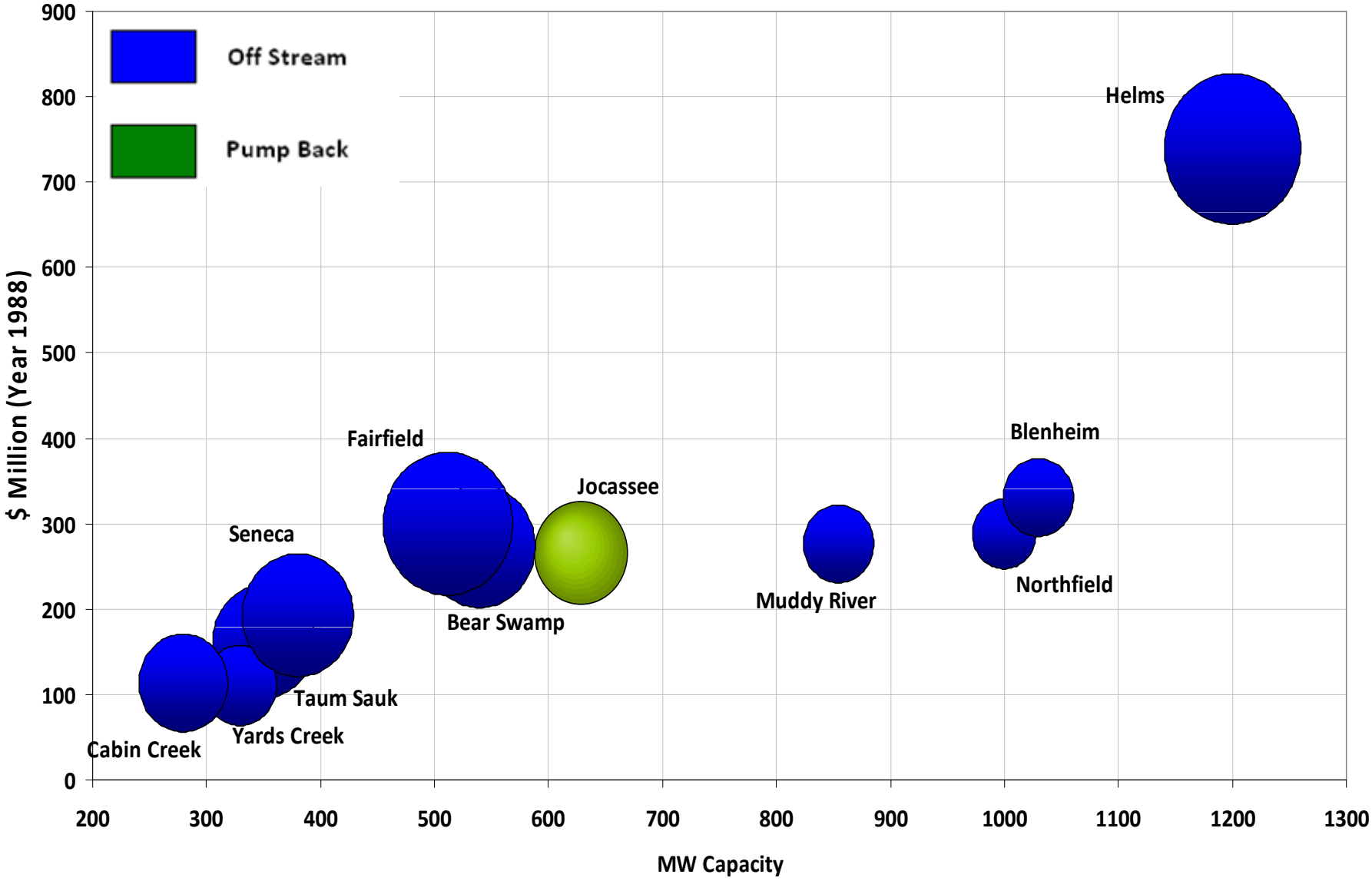
Source: Federal Energy Regulatory Commission

Plant	Operation year	MW Capacity	Stated Actual Total Costs* (Millions$)	Computed Actual Unit Cost** ($/kW)	Type of PHES
Taum Sauk	1963	350	162	462	OS
Yards Creek	1965	330	110	332	OS
Muddy River	1967	855	275	322	OS
Cabin Creek	1967	280	113	404	OS
Seneca	1969	380	192	505	OS
Northfield	1972	1000	288	288	OS
Blenheim	1973	1030	331	321	OS
Ludington	1973	1888	710	376	OS
Jocassee	1973	628	265	422	PB
Bear Swamp	1974	540	274	507	OS
Racoon Mountain	1978	1370	406	296	OS
Fairfield	1978	512	300	586	OS
Helms	1984	1200	739	616	OS
Bath County	1985	2100	1342	639	OS
				Range 288-639 $/kW 1988$	

* Excluding AFUDC and Transmission Costs Lines Costs

**** All costs adjusted to $USA January 1988**

Source :EPRI-Electric Power Research Institute. “Pumped Storage Planning and Evaluation Guide”. Prepared by Harza Engineering Company, Chicago. January 1990



Source :EPRI-Electric Power Research Institute. “Pumped Storage Planning and Evaluation Guide”.
Prepared by Harza Engineering Company, Chicago. January 1990

Review of Build Costs for Proposed Plant

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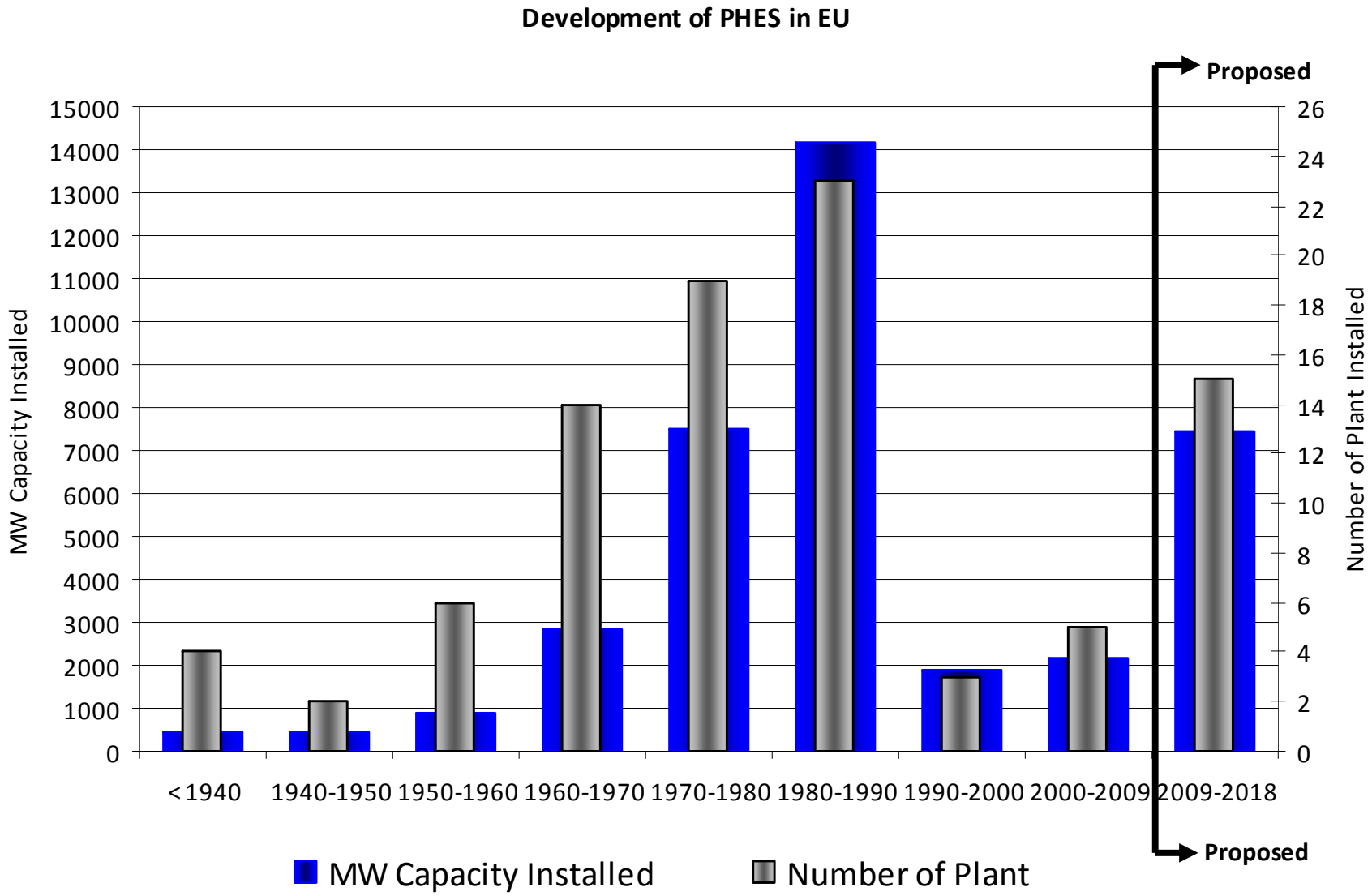
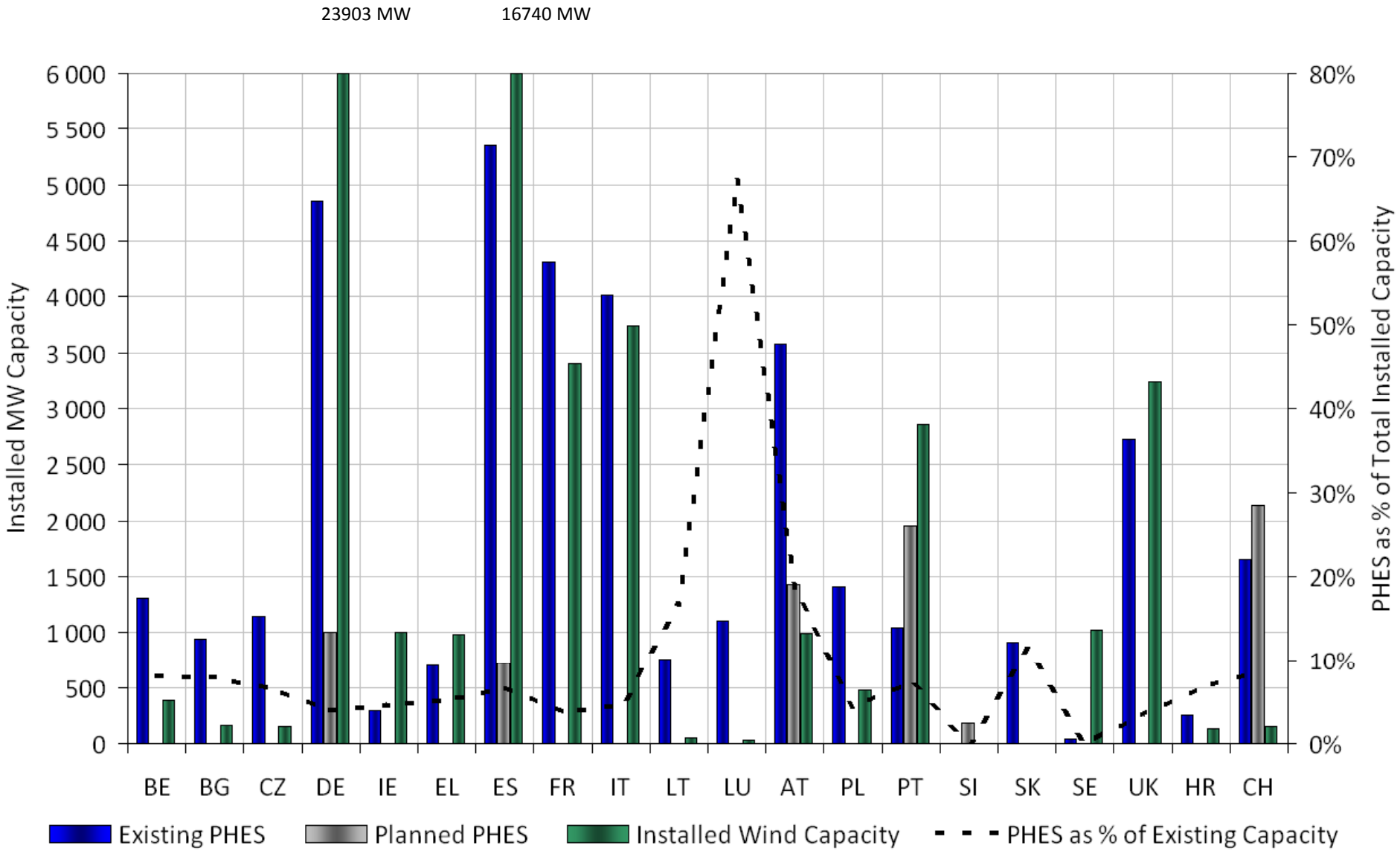
Development of PHES in Europe



Major Owners of PHES in Europe

PHES in Europe



Source: Planned PHES: Individual Company Websites and Eurostat “European Energy handbook 2009”

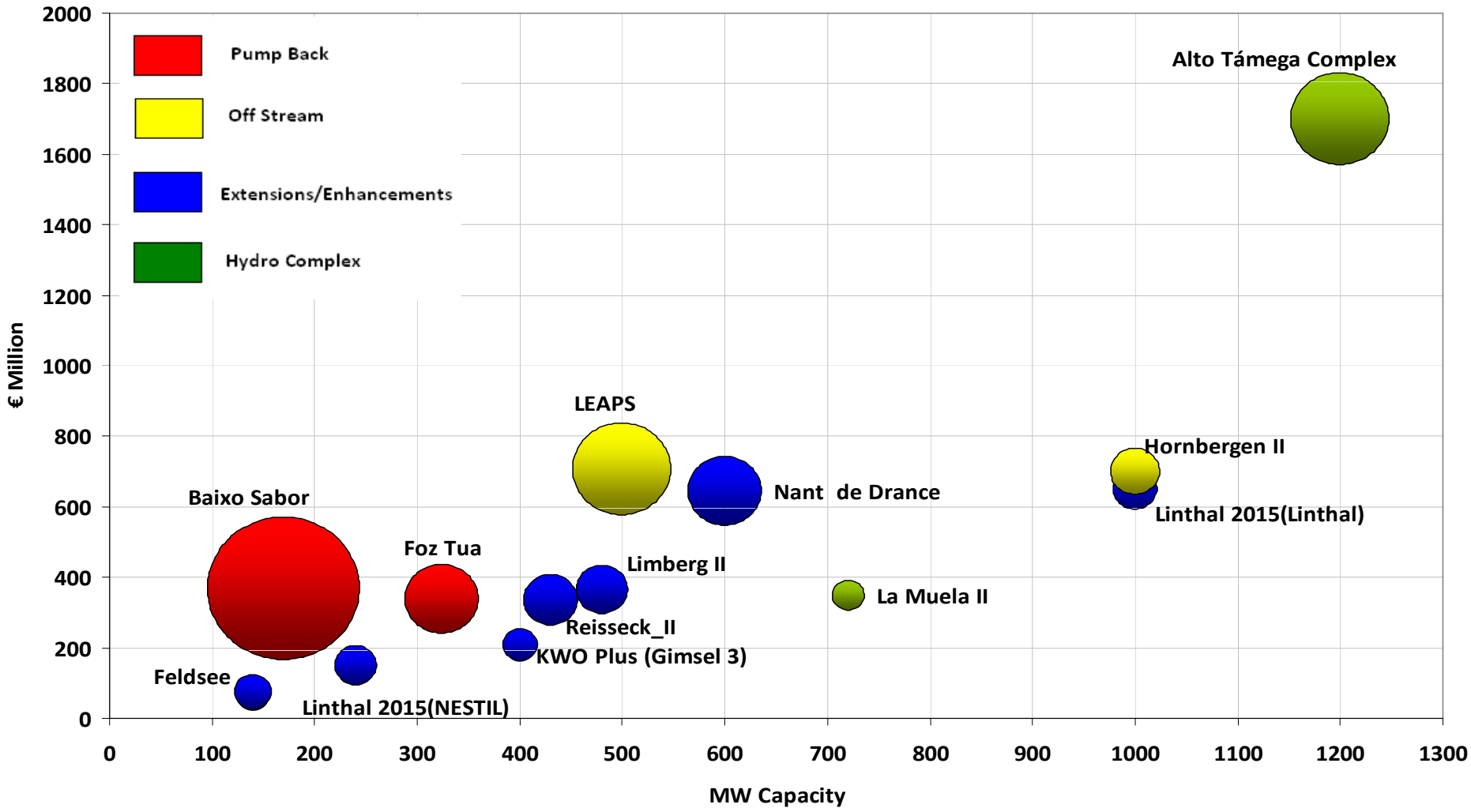
Plant	MW Capacity	Published Cost (€million)	€m/MW	Type of PHES	Developer
Linthal 2015(NESTIL)	140	65.16	0.47	Addition to existing Hydro Complex (Linth Limmer)	
Linthal 2015(Linthal)	1000	651.58	0.65	Addition to existing Hydro Complex (Linth Limmer)	
Nant de Drance	600	645.06	1.08	Using existing reservoirs	
KWO Plus (Gimsel 3)	400	208.51	0.52	Addition to existing Hydro Complex	
Reisseck_II	430	335	0.78	Addition to existing Hydro Complex (Malta)	
Limberg II	480	365	0.76	Addition to existing Hydro Complex (Kaprun)	
Feldsee	140	75	0.54	Addition to existing Hydro Complex (Fragant)	
Hornbergen II	1000	700	0.70	Off stream PHES (combined)	
LEAPS	500	707	1.41	Off stream PHES	
Alto Támega Complex	1200	1700	1.42	Hydro Complex: 4 Dams	
Baixo Sabor	170	369	2.17	Pump Back: 2 Dams	
Foz Tua	324	340	1.05	Pump Back	
Alqeueva II	240	150	0.63	Expansion of existing project	
La Muela II	720	350	0.49	Hydro Complex	

Range 0.47 to 2.17 €m/MW

Total	7344 MW	€m6,661

All cost are from developers published on their web sites

Proposed PHES Costs



Conclusion

- Over 7GW of New PHES proposed in Europe
- Most Plant are utilizing exiting resources or are Pump Back type
- Wide range of costs 0.47-2.17 €m/MW. Very Site/Project Specific.

Acknowledgements

- Dr Paul Leahy, UCC

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Thank You

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