

Developing Renewable Technologies-Cost and Performance Characteristics

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Description of NREL

- Only Department of Energy national laboratory dedicated to renewable energy
- Deep expertise in many renewable technologies
- Deep expertise in renewable resource assessments
- Extensive analysis capabilities
- Ongoing research: technology cost and performance projections

Motivation

- Planning scenarios require projections of conditions in the future
- Projections of technology cost and performance values can vary widely
- A range of values can provide appropriate boundaries for scenarios

Overview of NREL Contribution

- Comparisons of future projections of renewable energy cost and performance characteristics
 - Capital costs
 - Fixed and variable O&M
 - Capacity factor
 - Plant lifetime
 - Heat rate (biomass)
- Database format
 - Harmonized dollar years
 - Readily available charts/visualizations

Datasets

- Energy Economic Models Datasets
 - EIA
 - EPA
 - EPRI
 - GCAM
 - NREL 20% National RPS Study
 - REF Study
- Other Published Data sources

Technologies Overview

- Renewable Technology Categories
 - Wind
 - PV
 - CSP
 - Dedicated Biomass
 - Geothermal
 - Hydrokinetic
 - Storage technologies

Technologies-Wind

Technology								
		AEO 2009	GPRA FY10	NREL-SEAC 2008	MiniCAM	REF	EPA IPM	MERGE
Wind								
Onshore	Generic Technology	X			X		X	X
	Specific Wind Classes		X	X		X		
Offshore	Generic Technology	X						
	Deep-Generic Technology							
	Deep-Specific Wind Classes			X		X		
	Shallow-Generic Technology							
	Shallow-Specific Wind Classes		X	X		X		

5 different wind-based technologies

Technologies-Solar

Technology								
		AEO 2009	GPRA FY10	NREL-SEAC 2008	MiniCAM	REF	EPA IPM	MERGE
Solar								
PV	Generic Utility-Scale	X	X	X	X	X	X	X
	Generic Commercial			X		X		
	Generic Residential			X		X		
	Specific Technology Type (a-Si, m-Si, CdTe, etc.)							
	Solar Resource-Specific Values			X		X		
Concentrating Solar Power (CSP)	Generic Technology- no storage	X		X			X	
	Generic Technology- with storage		X		X	X		
	Specific Technology Type (trough, power tower, etc.)							X
	Solar Resource-Specific Values			X		X		

8 different solar-based technologies

Technologies-Biomass

Technology								
		AEO 2009	GPRA FY10	NREL-SEAC 2008	MiniCAM	REF	EPA IPM	MERGE
Biomass								
MSW-Landfill Gas	Generic Technology Type	X		X		X	X	
	Specific Technology Type							
Dedicated Biomass	Generic Technology Type	X		X	X	X	X	X
	Specific Technology Type							

2 different biomass-based technologies

Technologies-Geothermal

Technology								
		AEO 2009	GPRA FY10	NREL-SEAC 2008	MiniCAM	REF	EPA IPM	MERGE
Geothermal								
Generic Geothermal	Generic Technology							
Hydrothermal	Generic Technology							
	Specific Technology Type (Flash and Binary)		X					
	Resource Specific Values	X	X	X	X	X	X	
EGS	Generic Technology		X					
	Resource Specific Values			X		X		
EHS	Generic Technology							
	Resource Specific Values					X		

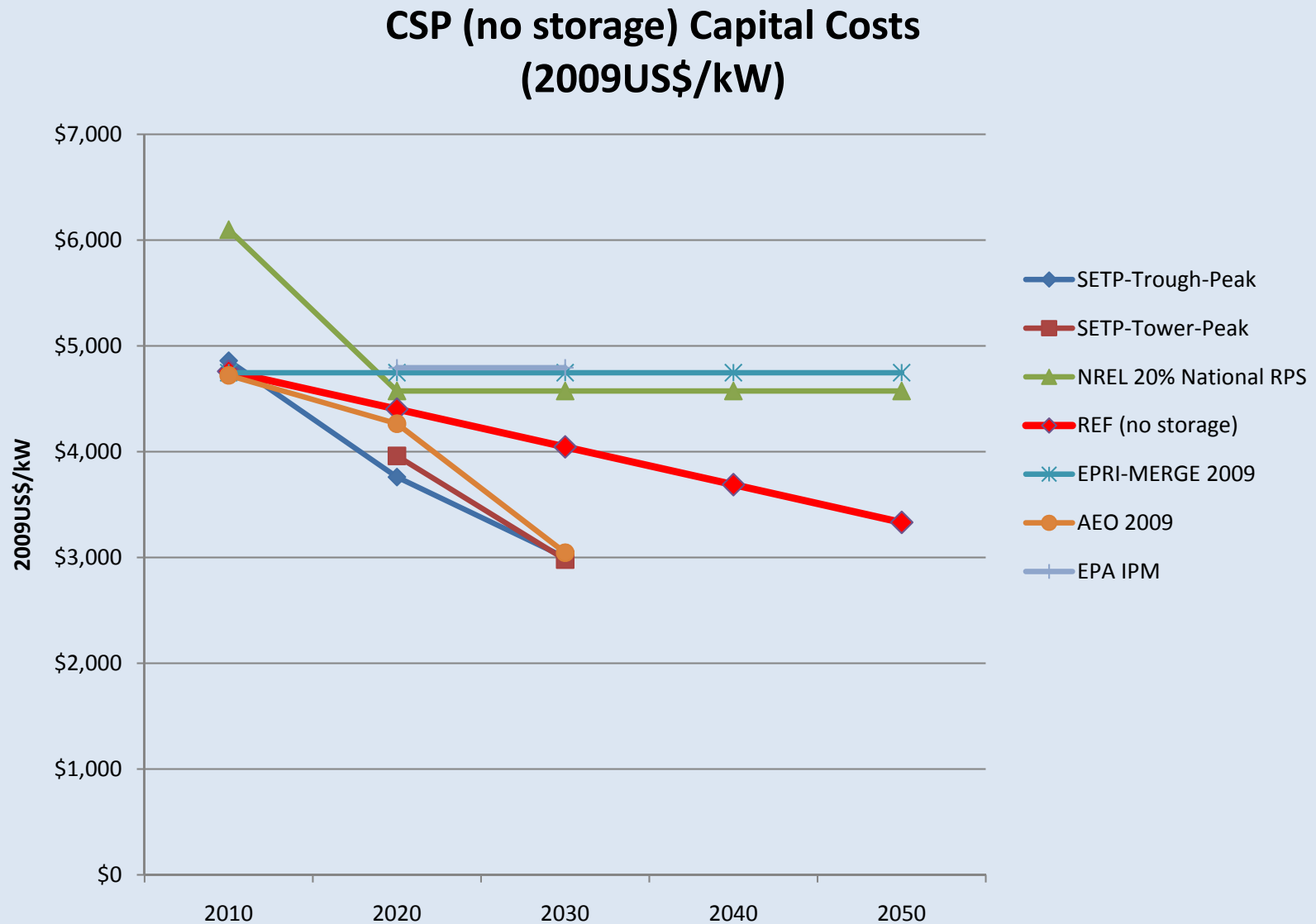
7 different geothermal-based technologies

Technologies-Hydrokinetic, Hydro, Storage

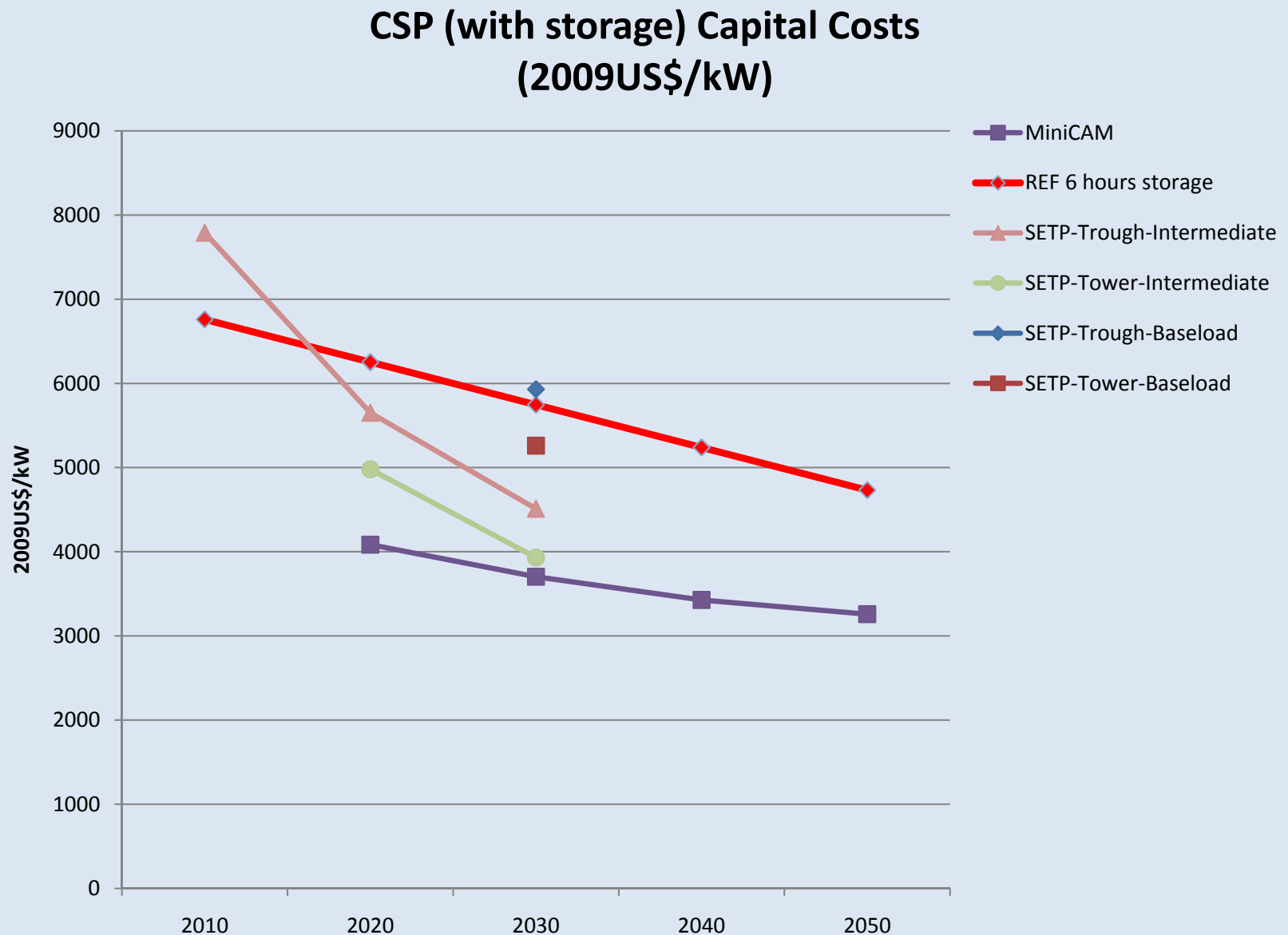
Technology							
	AEO 2009	GPRA FY10	NREL-SEAC 2008	MiniCAM	REF	EPA IPM	MERGE
Hydrokinetic							
Wave					X		
Current					X		
Hydro (generic)	X		X		X		
Energy Storage							
Battery			X		X		
Compressed air energy storage (CAES)			X		X		
ICE Storage			X		X		
Pumped Hydro			X		X		

- 2 hydrokinetic technologies
- 1 generic hydro technology
- 4 energy storage technologies

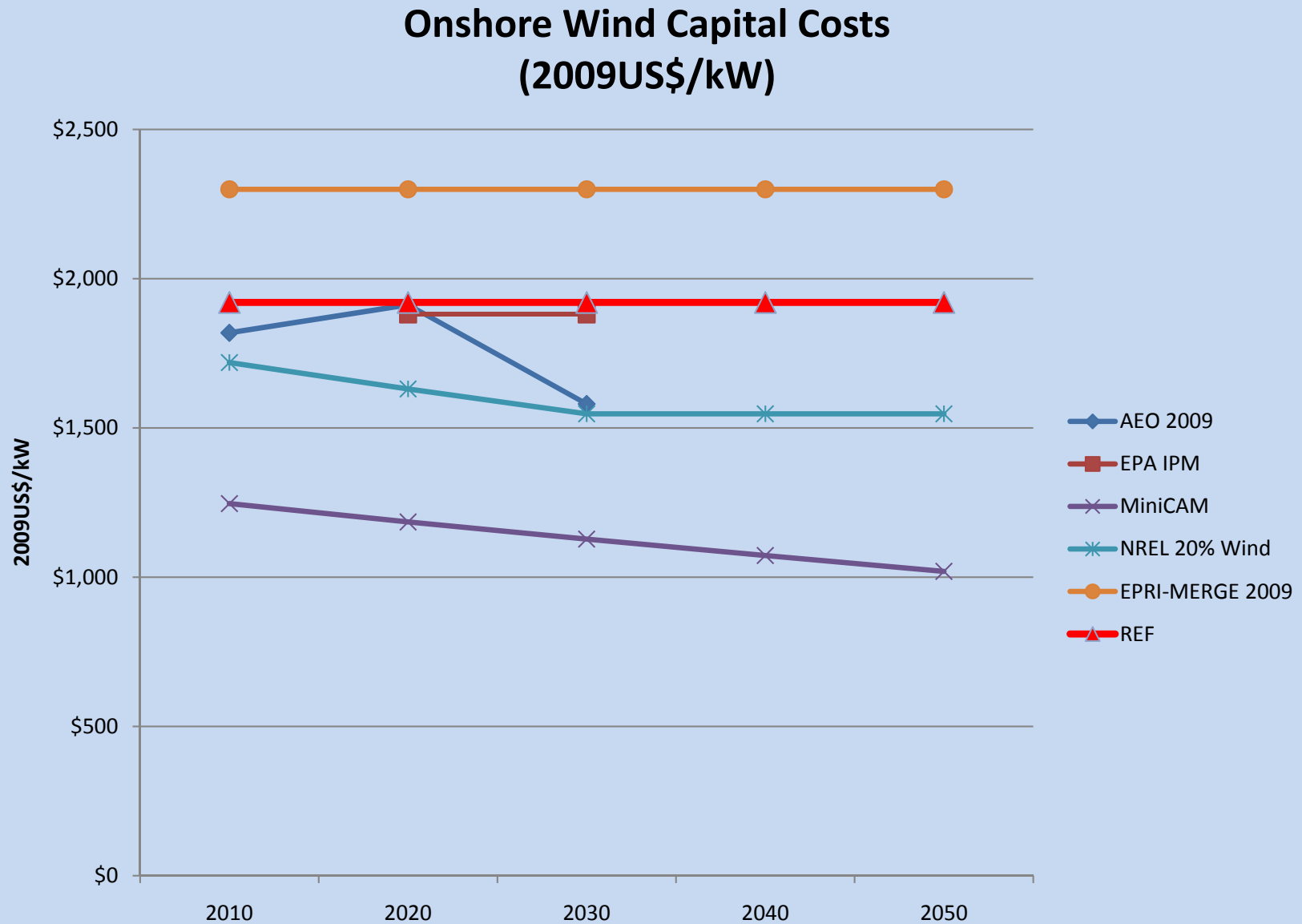
CSP technologies-no storage Capital Cost Comparisons (2010-2050)



CSP technologies-with storage Capital Cost Comparisons (2010-2050)



Onshore wind technologies Capital Cost Comparisons (2010-2050)



Capacity Factor Comparisons

Technology	Data Set						Standard Deviation	Coefficient of Variation
	AEO	GPRA	NREL-SEAC	MiniCAM	EPA	MERGE		
Coal	85%	---	85%	80%	85%	80%	0.027	3%
IGCC	85%	---	81%	80%	85%	80%	0.026	3%
Combustion Turbine	92%	---	80%	10%	92%	---	0.394	58%
Combined Cycle	87%	---	85%	80%	87%	80%	0.035	4%
Nuclear	90%	---	90%	90%	89%	90%	0.003	0%
Biomass	83%	---	84%	80%	83%	85%	0.019	2%
Geothermal (hydrothermal)	90%	95%	85%	90%	87%	---	0.039	4%
Wind (onshore)	40%	47%	46%	46%	39%	42%	0.035	8%
Wind (offshore)	40%	45%	48%	---	---	---	0.038	9%
Solar Thermal	31%	74%	32%	73%	36%	22%	0.229	51%
PV	22%	32%	21%	25%	24%	26%	0.037	15%

Heat Rate Comparisons

Technology	Data Set						Standard Deviation	Coefficient of Variation
	AEO	GPRA	NREL-SEAC	MiniCAM	EPA	MERGE		
Coal	9,200	---	9,470	9,319	9,200	8,979	180	2%
IGCC	8,765	---	9,000	8,005	8,765	8,979	406	5%
Combustion Turbine	9,289	---	11,560	8,877	9,289	---	1,220	13%
Combined Cycle	6,752	---	6,870	6,164	6,752	7,260	393	6%
Nuclear	10,434	---	10,400	10,339	10,434	10,339	48	0%
Biomass	9,646	---	14,500	12,133	9,646	12,186	2,042	18%

Other factors to consider

- Year of publication of data
- Vintage year of data
- Degree of learning considered in dataset
- Boundary definitions of capital costs
- Relationship of technology costs within each dataset

Potential Future Work

- **Online Dynamic Platform**
 - Updated by dataset providers
 - User-friendly interface
- **More Detailed Data**
 - Commodity Price Effects
 - Component Level Data
- **Expansion of Project Scope**
 - Other Technologies
 - Other Sectors

Thank You

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