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Energy  
**REPUBLIC OF SOUTH AFRICA**

DRAFT INTEGRATED ENERGY PLANNING REPORT



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# DRAFT IEP REPORT MODELLING RESULTS



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  - DOE objectives and indicators
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  - Technologies
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  - Primary energy mix

# PURPOSE OF MODELLING



In the context of the following policy options:

- Emissions limits
- Minimum renewable energy target
- Carbon pricing

Quantify indicators for DoE objectives:

- Energy requirements and technology investments
  - Energy security and security of supply
- System costs
  - Affordability - minimise energy costs
- Carbon dioxide emissions and water consumption
  - Environmentally friendly energy supply
- Energy mix
  - Diversity - energy security



# PURPOSE OF MODELLING

Case Study Objective	Base Case	Emissions Limited Cases		RE Target	Carbon Tax	Low Oil Price	High Oil Price
		Peak Plateau Decline	PPD + No Nuclear				
Energy and technology	Determine energy requirements and technology investments based on demand						
Costs	Minimise and quantify						
						<b>Externality costs of Carbon emissions included</b>	Sensitivity analysis of crude oil prices
Emissions	Quantify						
			<b>Constrain emissions</b>				
Water	Quantify						
Energy Mix	Quantify						
				<b>Specify Minimum RE target</b>			



# SUMMARY OF RESULTS

Case Study Objective \	Base Case	Emissions Limited Cases		RE Target	Carbon Tax	Low Oil Price	High Oil Price
		Peak Plateau Decline	PPD + No Nuclear				
Total discounted cost R bn (2010)	2 484	2 701	2 705	2 570	2 644	1 779	2 977
Additional cost from Base Case		8.8 %	8.9 %	3.5 %	6.4 %	-28.4%	19.9%
Total emissions (Mt)	22 101	16 811	16 807	20 418	19833	22 393	22 425
Average annual CO <sub>2</sub> emissions (Mt/a)	539	410	409	510	498	546	546
Total Water (Mt)	12 538	9 630	9 845	11 800	12 043	13 019	11 048
Total Primary Energy (PJ)	289 912	249 197	249 359	282 741	262 348	292 907	297 956
Meets emissions limits for electricity & liquid fuels sectors	✗	✓	✓	✗	✗	✗	✗
Meets RE target	✗	✓	✓	✓	✓	✗	✗



# TRANSPORT AND REFINING

Case Study Technology	Base Case	Emissions Limited Cases		RE Target	Carbon Tax	Low Oil Price	High Oil Price
		Peak Plateau Decline	PPD + No Nuclear				
Electric vehicles	✓	✓	✓	✓	✓	✓	✓
Hybrid vehicles	✗	✗	✗	✗	✗	✗	✓
Petroleum product imports	High <2020	High	High	High <2020	High <2020	Low	Medium
New refining capacity	✓	✓	✓	✓	✓	✓	✗
New CTL	✓	✗	✗	✓	✓	✓	✓
New GTL	✗	✗	✗	✗	✗	✗	✓
Notes							Assumes crude oil and natural gas prices are not linked

Emissions limits remove new coal to liquids as an option viable

# ELECTRICITY GENERATION



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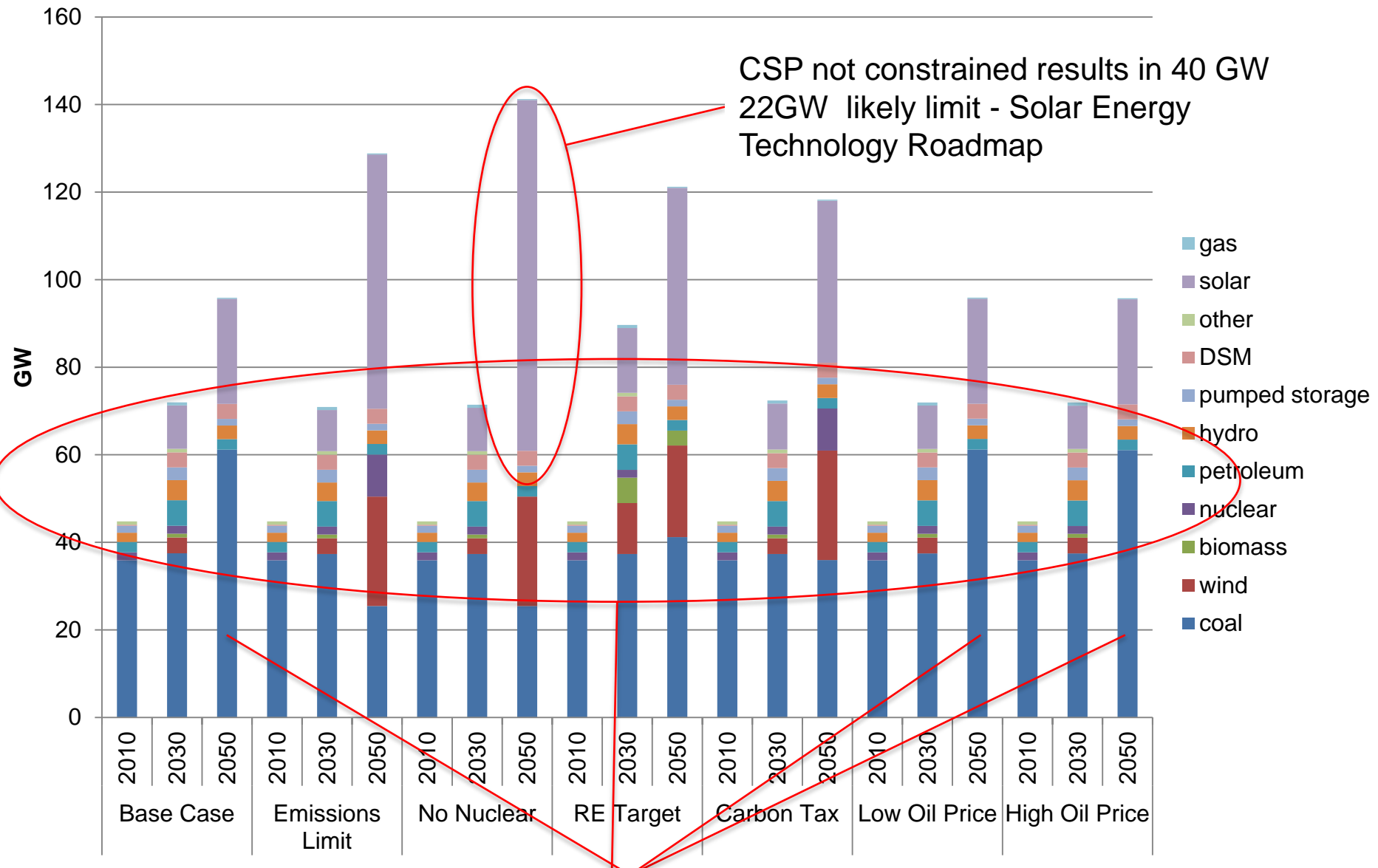
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Case Study Share of energy mix into generation	Base Case	Emissions Limited Cases		RE Target	Carbon Tax	Low Oil Price	High Oil Price	
		Peak Plateau Decline	PPD + No Nuclear					
2010	Coal	95.6%						
	Nuclear	2.4%						
	Hydro	2.0%						
	Solar	0.0%						
	Petroleum product	0.0%						
2030	Coal	88.2%	88.8%	88.6%	70.9%	88.0%	88.1%	88.4%
	Hydro	3.1%	3.0%	3.0%	3.4%	3.1%	3.1%	3.1%
	Solar	2.7%	2.8%	2.9%	4.6%	2.9%	2.7%	2.8%
	Nuclear	1.9%	2.0%	2.0%	2.1%	1.9%	1.9%	1.9%
	Biomass	1.9%	2.0%	2.0%	13.5%	1.9%	1.9%	1.9%
	Petroleum product	1.3%	0.5%	0.5%	1.4%	1.3%	1.3%	1.0%
	Wind	0.9%	1.0%	1.0%	4.0%	0.9%	0.9%	0.9%
2050	Coal	95.0%	60.7%	60.7%	76.8%	74.1%	95.0%	95.1%
	Solar	3.6%	20.1%	29.4%	11.1%	9.4%	3.6%	3.6%
	Hydro	1.0%	1.6%	1.6%	1.2%	1.4%	1.0%	1.0%
	Petroleum product	0.3%	0.4%	0.4%	0.4%	0.4%	0.3%	0.2%
	Wind	0.0%	8.0%	8.0%	5.2%	6.8%	0.0%	0.0%
	Biomass	0.0%	0.0%	0.0%	5.3%	0.0%	0.0%	0.0%
	Nuclear	0.0%	9.2%	0.0%	0.0%	7.9%	0.0%	0.0%

RE target more effective in short term – more  
Carbon tax more effective in long term  
Emissions limits most effective in long term



# Generation Capacity 2010, 2030, 2050



2050 Base Case, Low Oil Price Case and High Oil Price Case are similar – no constraints or costs to emissions



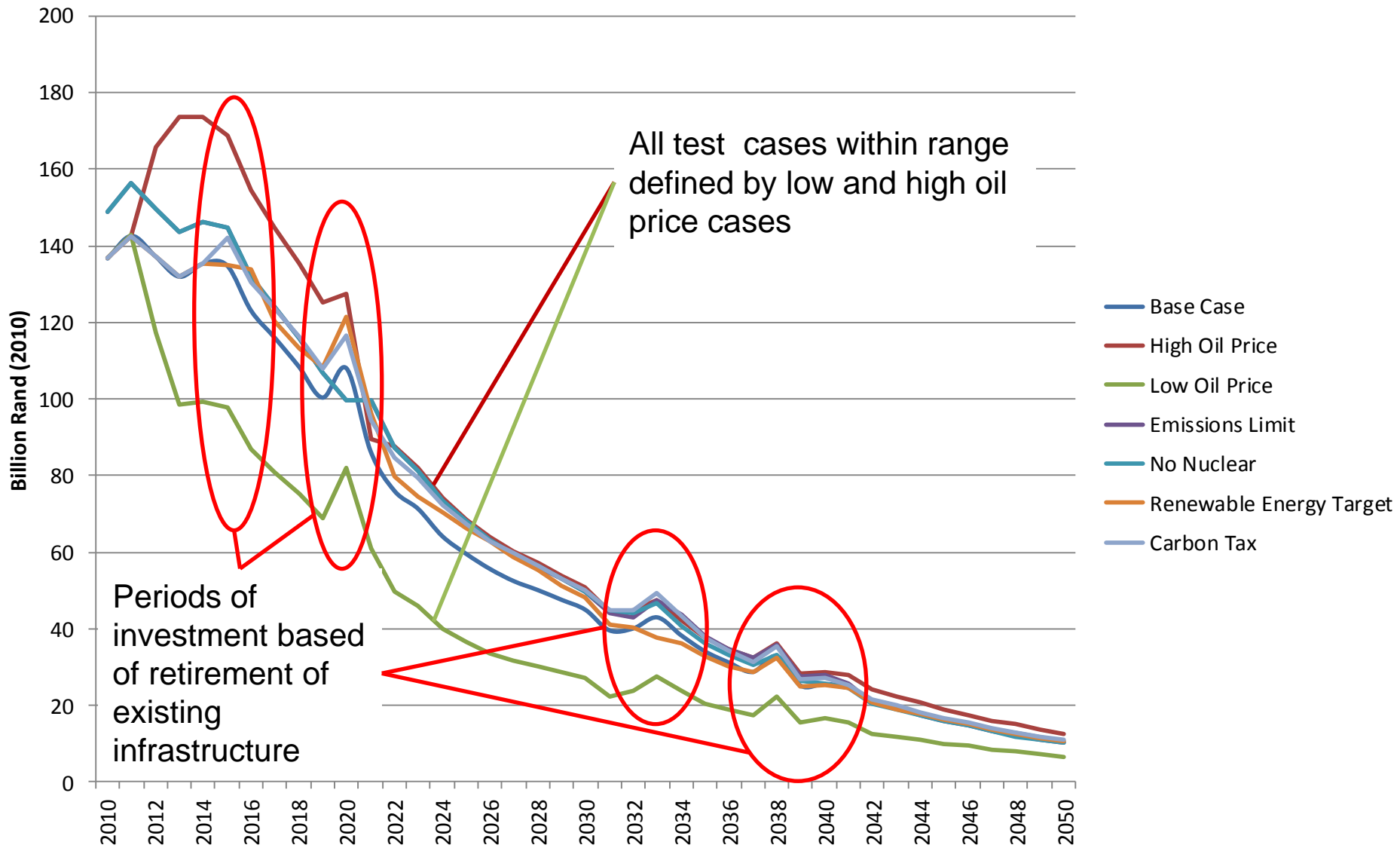
# SYSTEM COSTS

Component	Base Case		Emissions Limit		PPD No Nuclear		RE Target		Carbon Tax		Low Oil Price		High Oil Price	
	R'b 2010	%	R'b 2010	%	R'b 2010	%	R'b 2010	%	R'b 2010	%	R'b 2010	%	R'b 2010	%
<b>Total</b>	<b>2484</b>	100	<b>2701</b>	100	<b>2705</b>	100	<b>2570</b>	100	<b>2644</b>	100	<b>1779</b>	100	<b>2977</b>	100
Imports	1922	77.4	2187	81.0	2187	80.8	1922	74.8	1923	72.7	1209	68.0	2363	79.4
Extraction/ Production	208	8.4	188	7.0	188	7.0	187	7.3	197	7.4	207	11.6	207	7.0
Electricity generation infrastructure	189	7.6	199	7.4	203	7.5	297	11.5	310	11.7	189	10.6	189	6.3
Liquid fuels production infrastructure	129	5.2	92	3.4	92	3.4	129	5.0	179	6.8	138	7.8	183	6.2
Storage, Transport and Distribution	35	1.4	35	1.3	35	1.3	35	1.4	35	1.3	36	2.0	35	1.2

Additional costs due to greater imports due to no mining of coal for CTL

Additional costs due in part to carbon tax

# Discounted costs





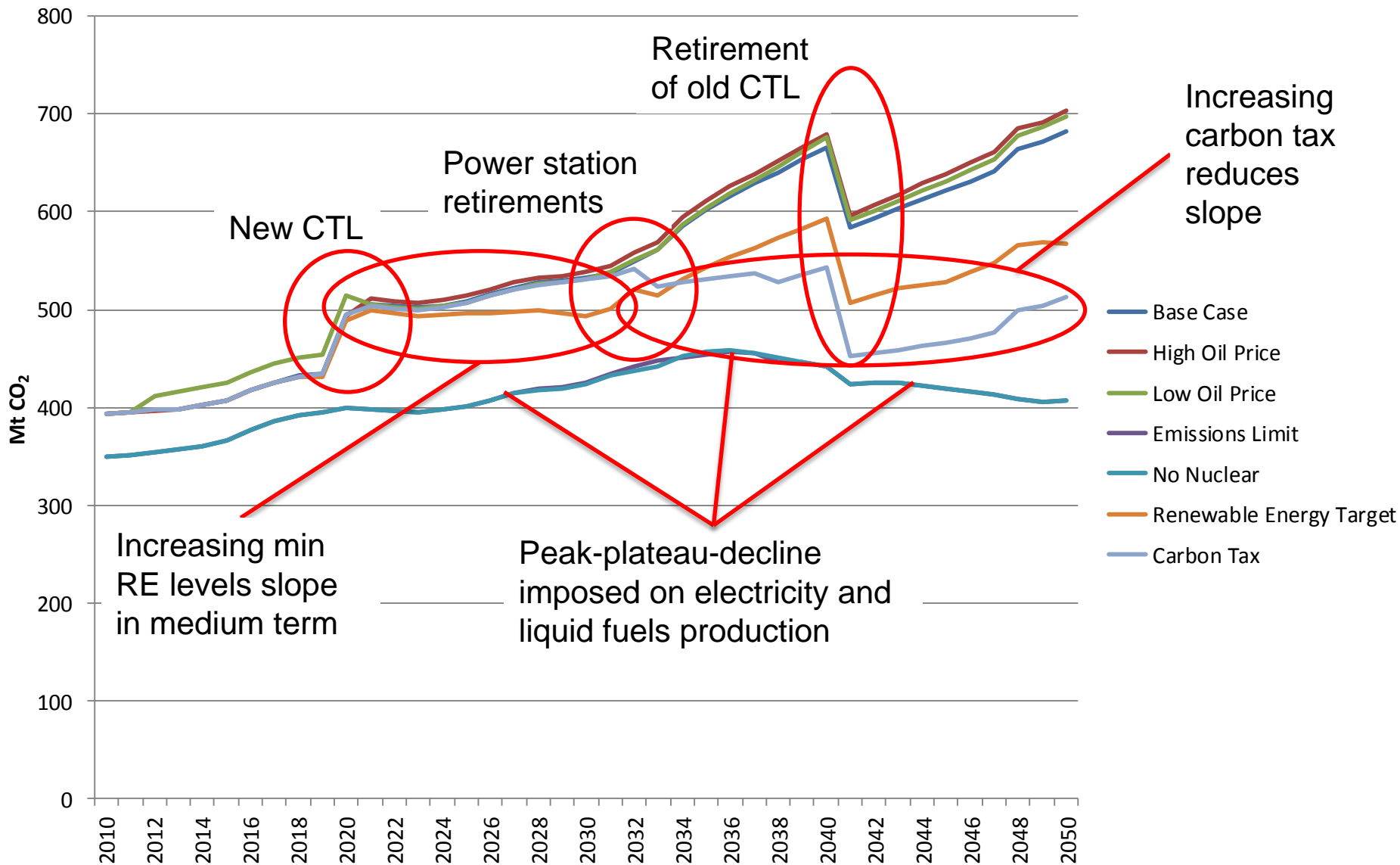
# EMISSIONS

	Base Case	Emissions Limit	PPD No Nuclear	RE Target	Carbon Tax	Low Oil Price	High Oil Price
Total Discounted Cost	2 484	2 701	2 705	2 570	2 644	1 779	2 977
Difference in cost from Base Case (Rb)		218	222	87	160	-705	494
Difference in cost from Base Case (%)		8.8%	8.9%	3.5%	6.4%	-28.4%	19.9%
Model Period Emissions 2010-2050 (Mt)	22 101	16 811	16 808	20 419	19 833	22 393	22 425
Difference in emissions from Base Case (Mt)		-5 290	-5 293	-1 682	-2 268	292	324
Average cost difference per tCO <sub>2</sub> from Base Case (R/t)		41	42	52	71	2 411	

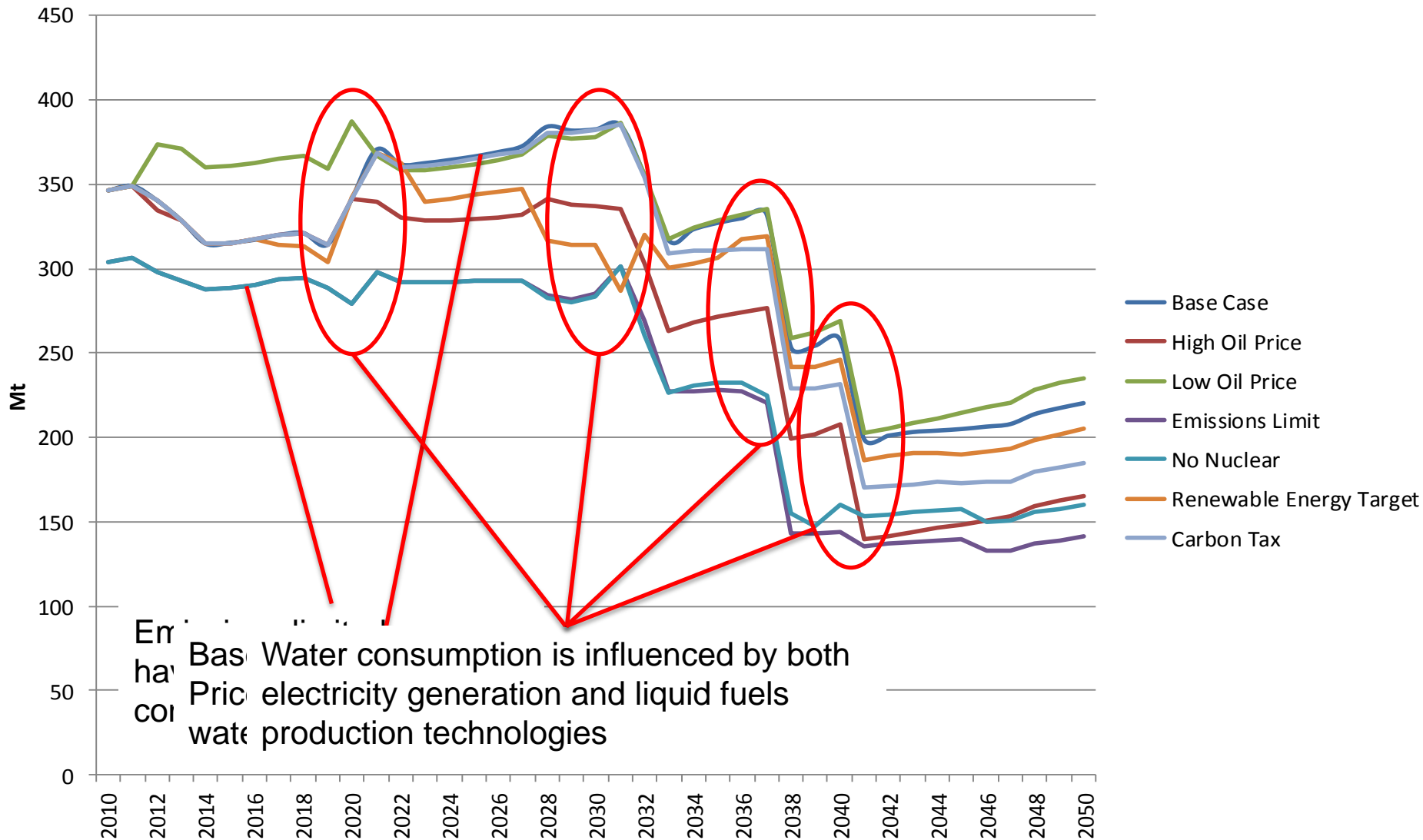
Carbon Tax Case - prices all carbon including final consumption

Emissions limited cases - applied to electricity and liquid fuels production

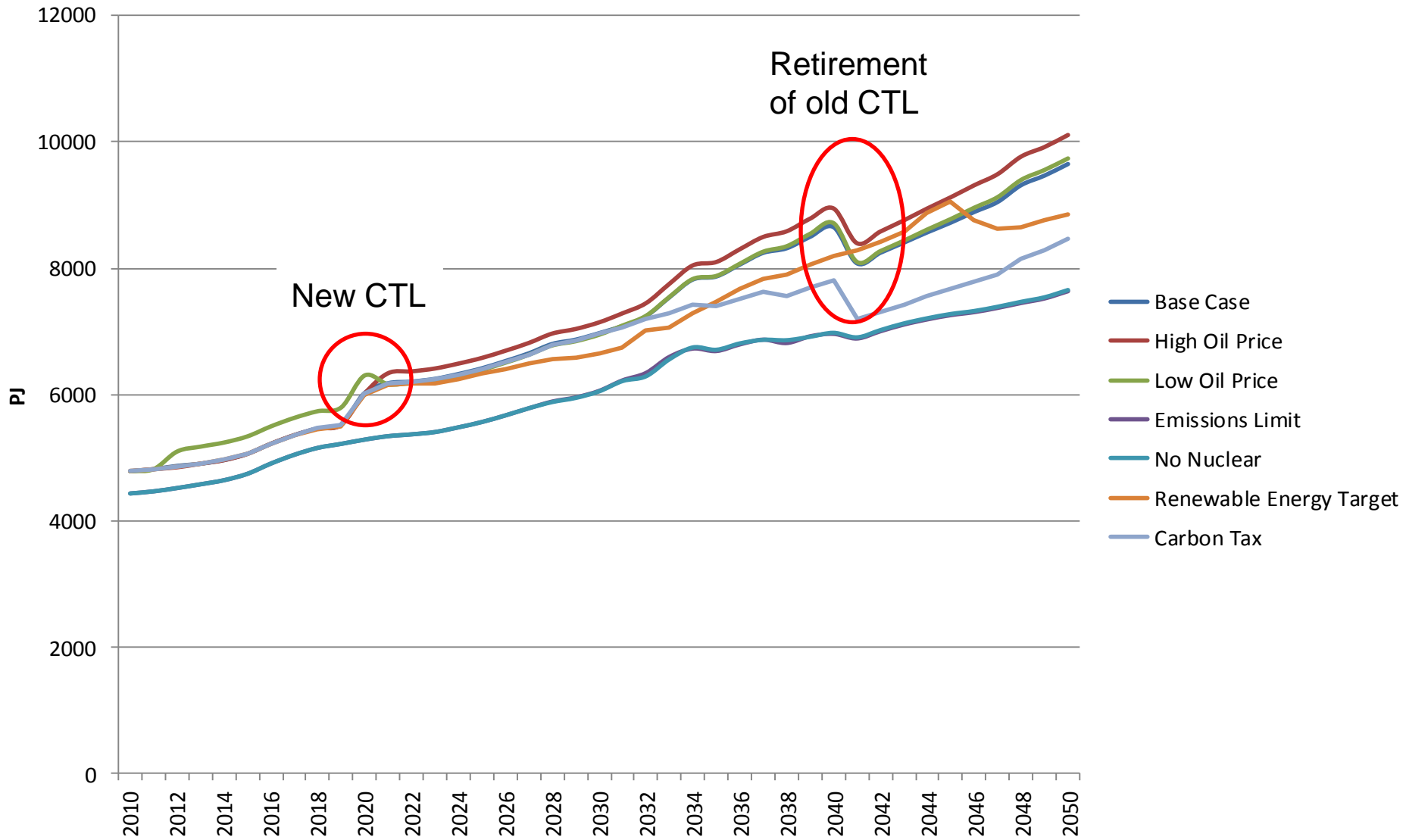
# CO<sub>2</sub> Emissions for Test Cases



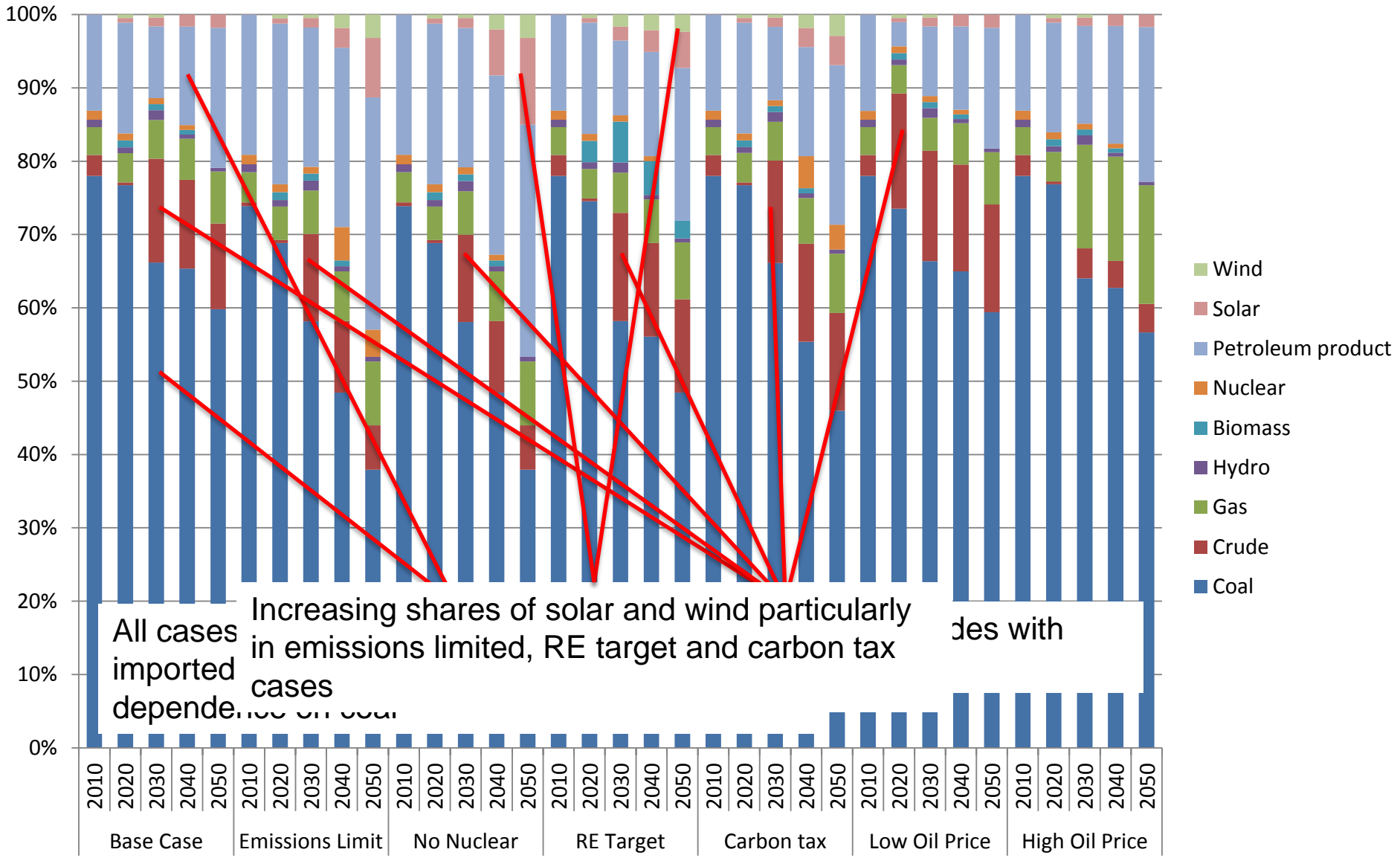
# Water use for Test Cases



# Primary Energy Use

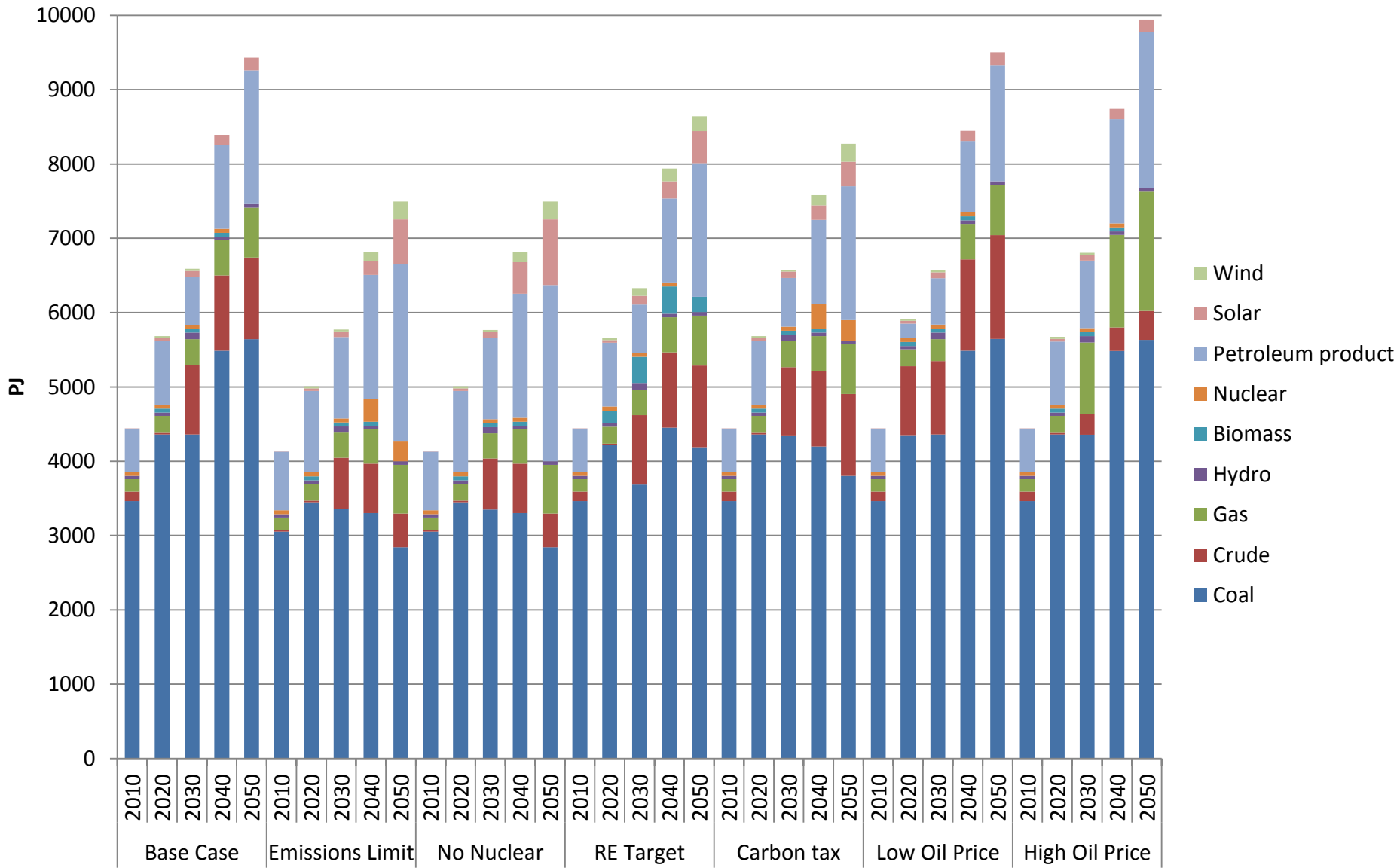


# Primary Energy Use

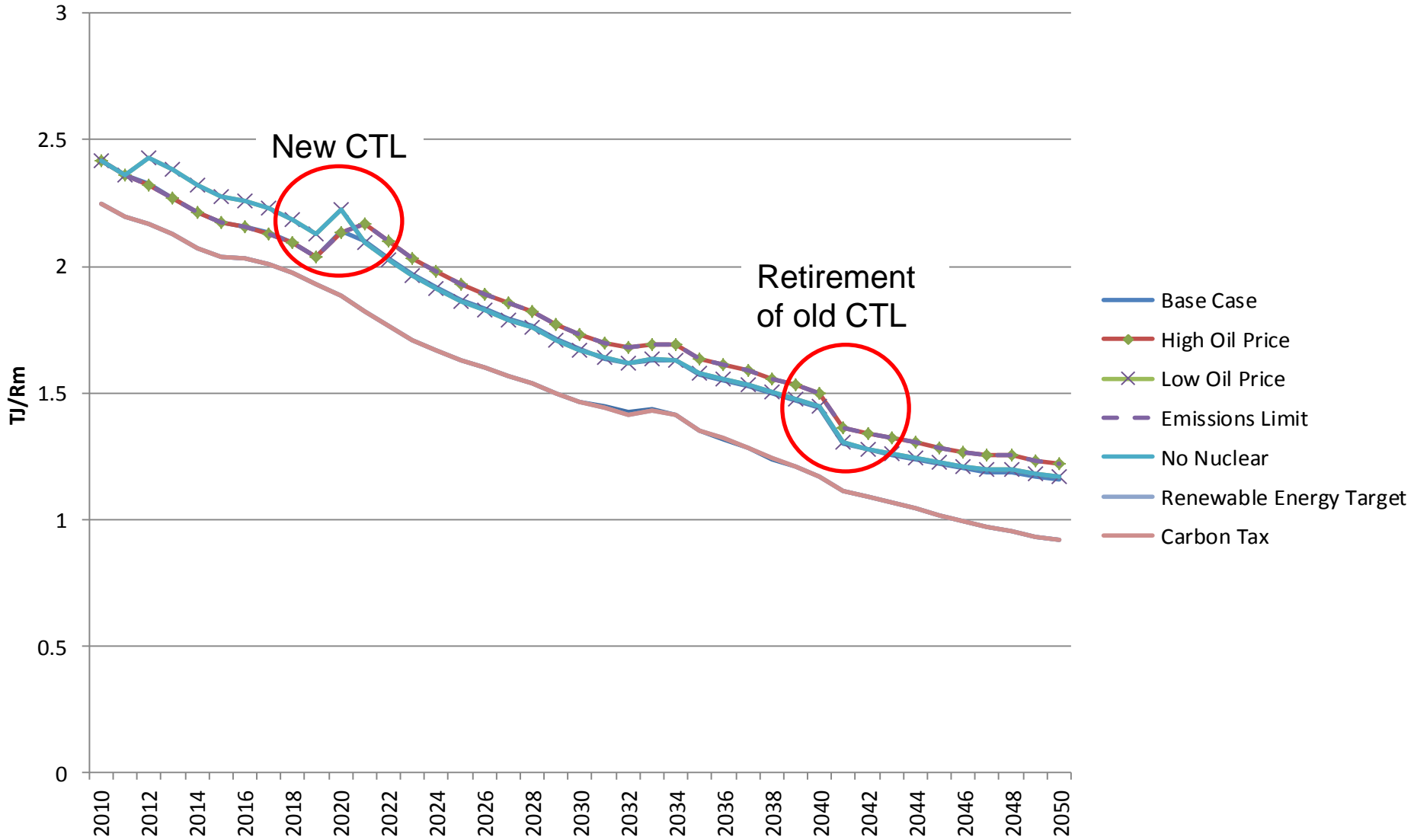




# Primary Energy Use



# Energy Intensities for Test Cases





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