California ISO
Shaping a Renewed Future

Operational Challenges to Integrate 33% Renewable Generation

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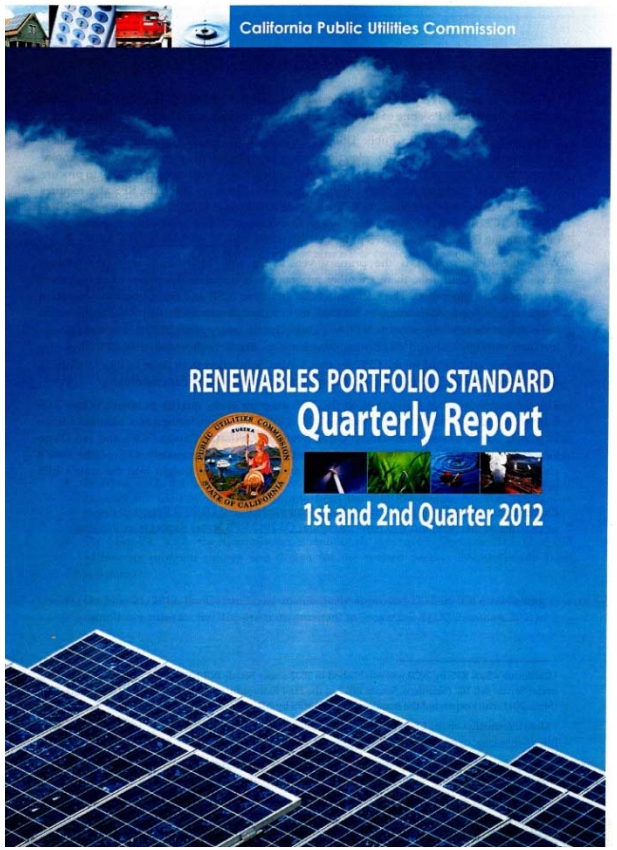
Renewable Portfolio Standard compliance phase-in



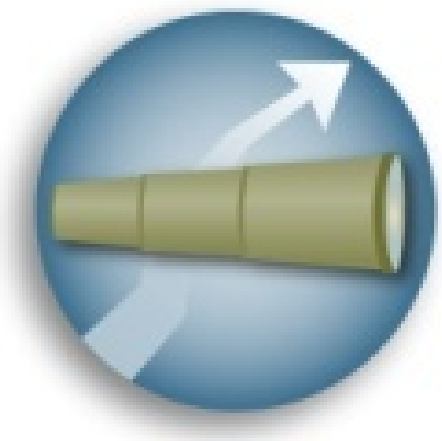
"2011 showed the greatest year-to-year increase in the capacity of renewable generation achieving commercial operation since the beginning of the program, and 2012 is already on track to far surpass 2011"

20%	+5%	25%	+8%	33%
2011-2013		2014-2016		2017-2020

"In 2012, 2,500 MW is scheduled to come on line before the end of the year. That compares with 2,871 MW of new renewables capacity to come on line since the RPS program started in 2003."

Operational challenges … over the next 10 years

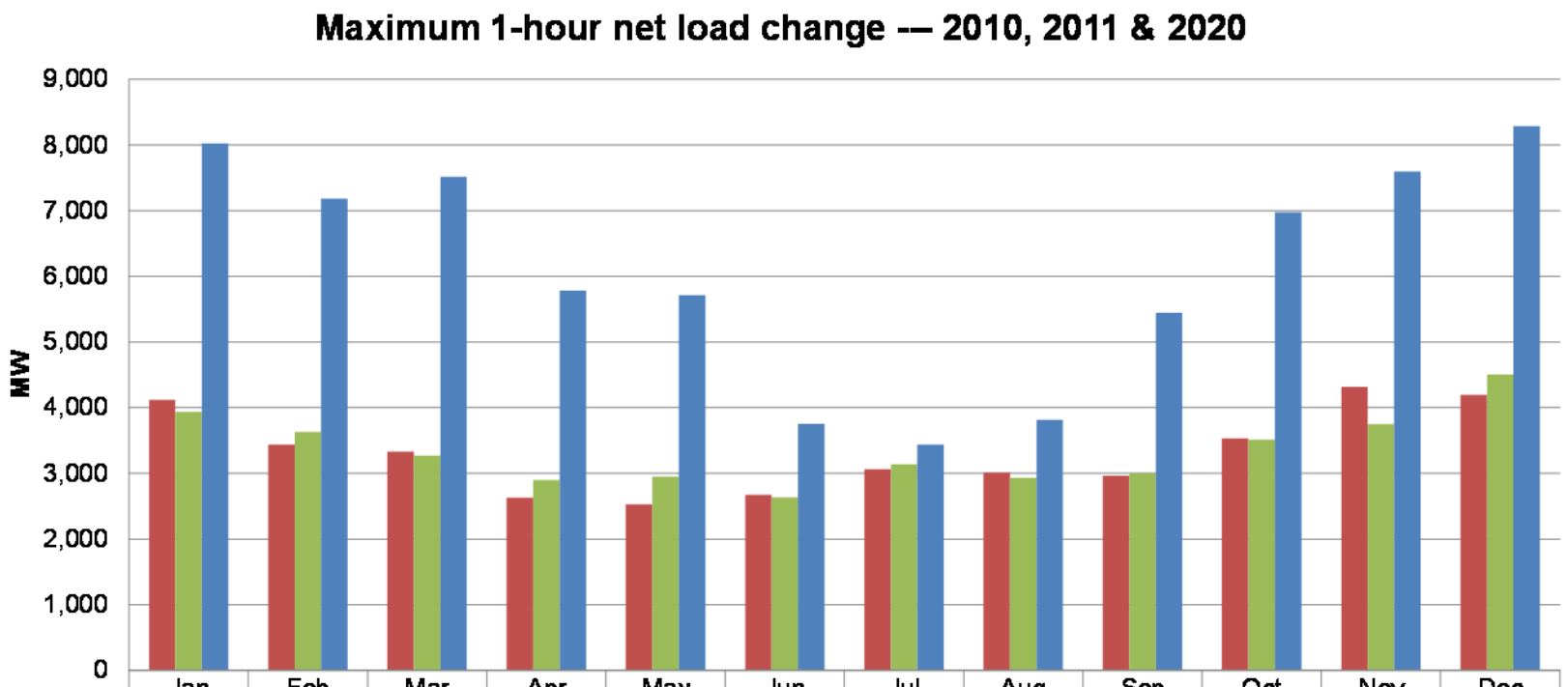
- Increased supply volatility - Over 20,000 MW of wind and solar capacity
- Uncertainty surrounding thermal resources - About 12,000 MW of OTC thermal generation will be repowered or retired
- Less predictable load patterns – Changes in load patterns due to DER and PEV
- Changing revenue patterns - Decreasing marginal prices and changes in resource operational pattern



DER – Distributed Energy Resources
PEV – Plug in Electric Vehicle

Maximum 1-hour net-load change comparison - actual 2010 & 2011 and simulated 2020

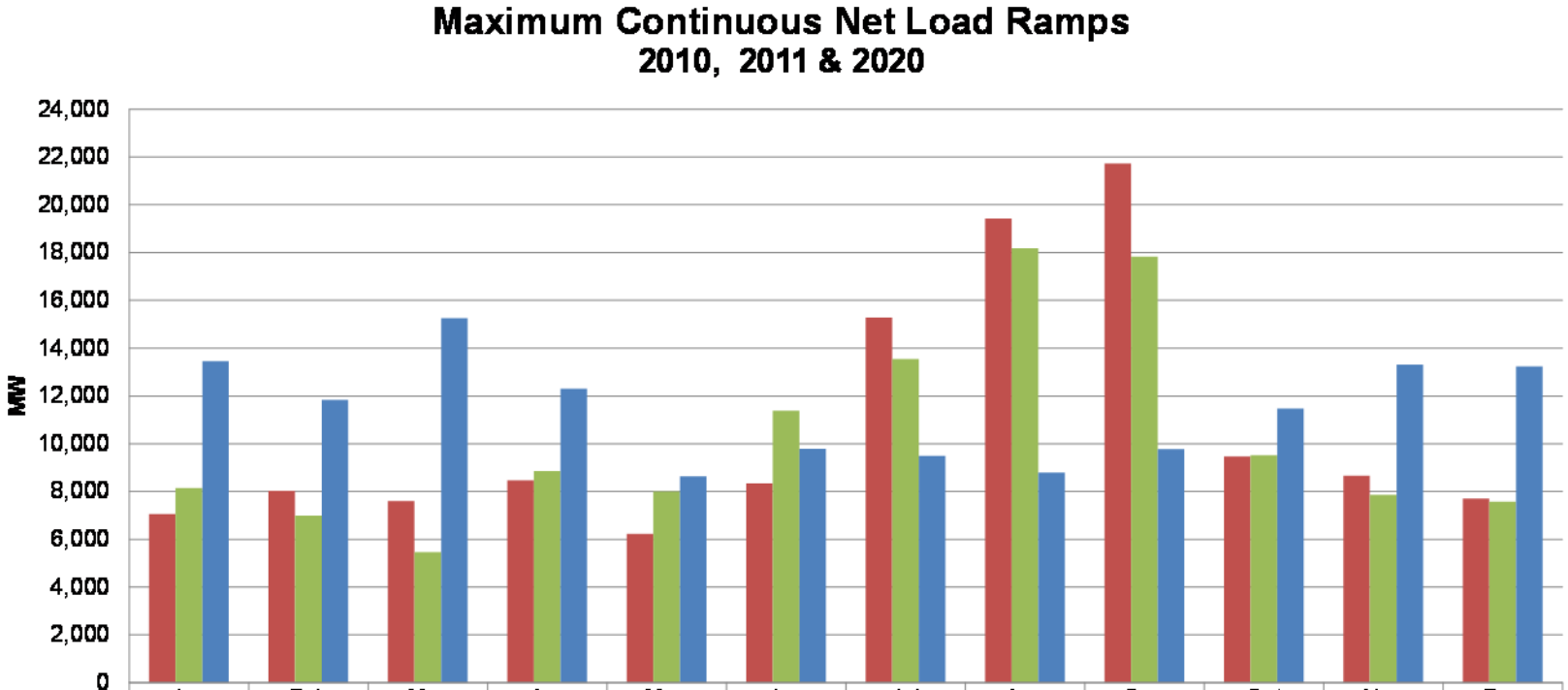
Observation: Hourly changes increases in 2020 in non-summer months



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	4,120	3,440	3,329	2,629	2,527	2,675	3,061	3,010	2,963	3,531	4,321	4,198
2011	3,935	3,630	3,271	2,897	2,951	2,637	3,137	2,933	3,004	3,514	3,746	4,506
2020	8,022	7,186	7,516	5,783	5,714	3,753	3,439	3,811	5,443	6,979	7,597	8,286

Maximum continuous net load ramps (trough to peak) - actual 2010 & 2011 and simulated 2020

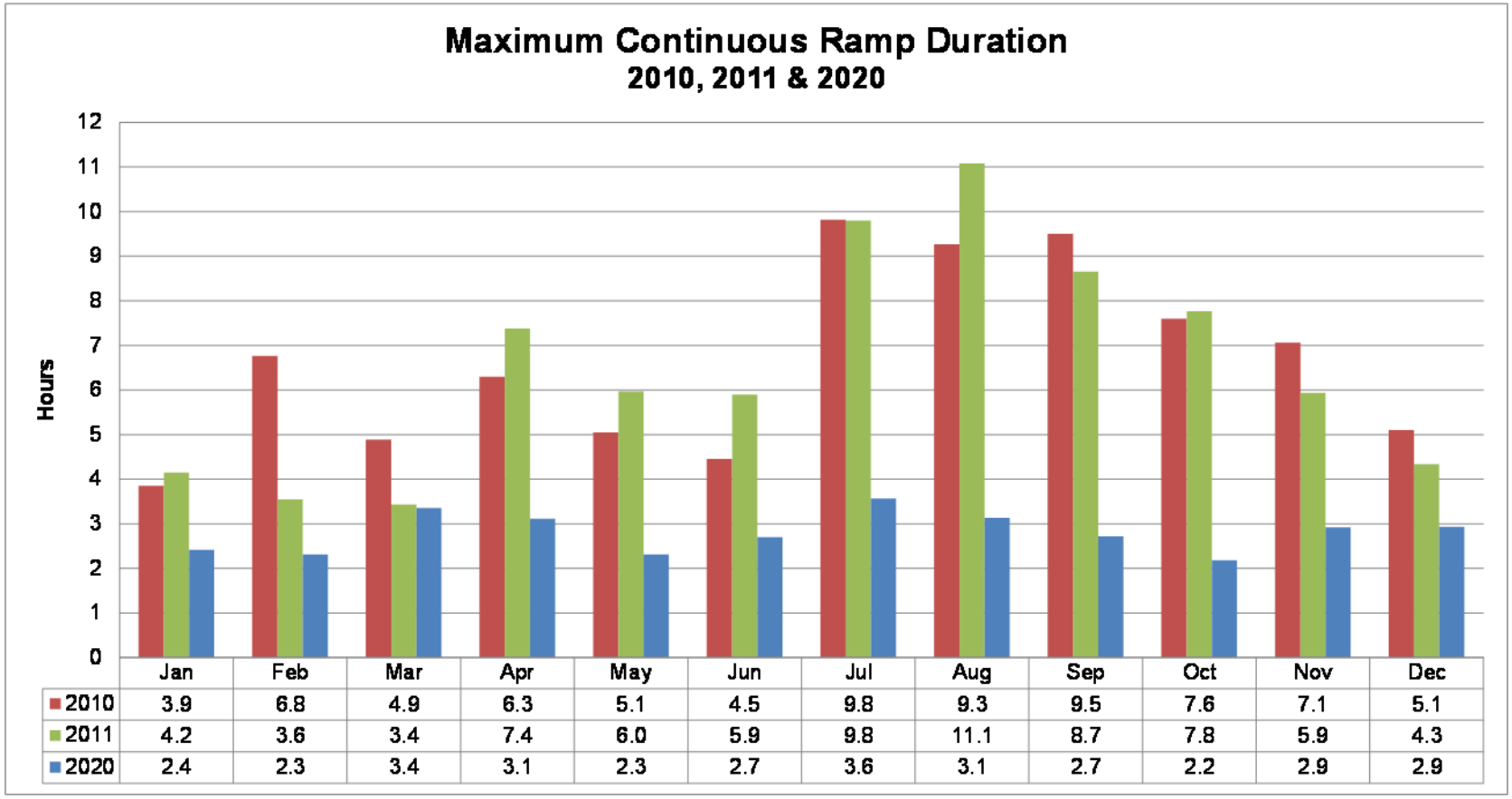
Observation: Range of continuous ramp decreases in summer months



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	7,057	8,022	7,594	8,465	6,217	8,337	15,275	19,432	21,732	9,464	8,667	7,706
2011	8,133	6,982	5,453	8,859	8,000	11,382	13,544	18,181	17,824	9,510	7,855	7,577
2020	13,459	11,825	15,254	12,298	8,630	9,782	9,496	8,785	9,777	11,483	13,308	13,234

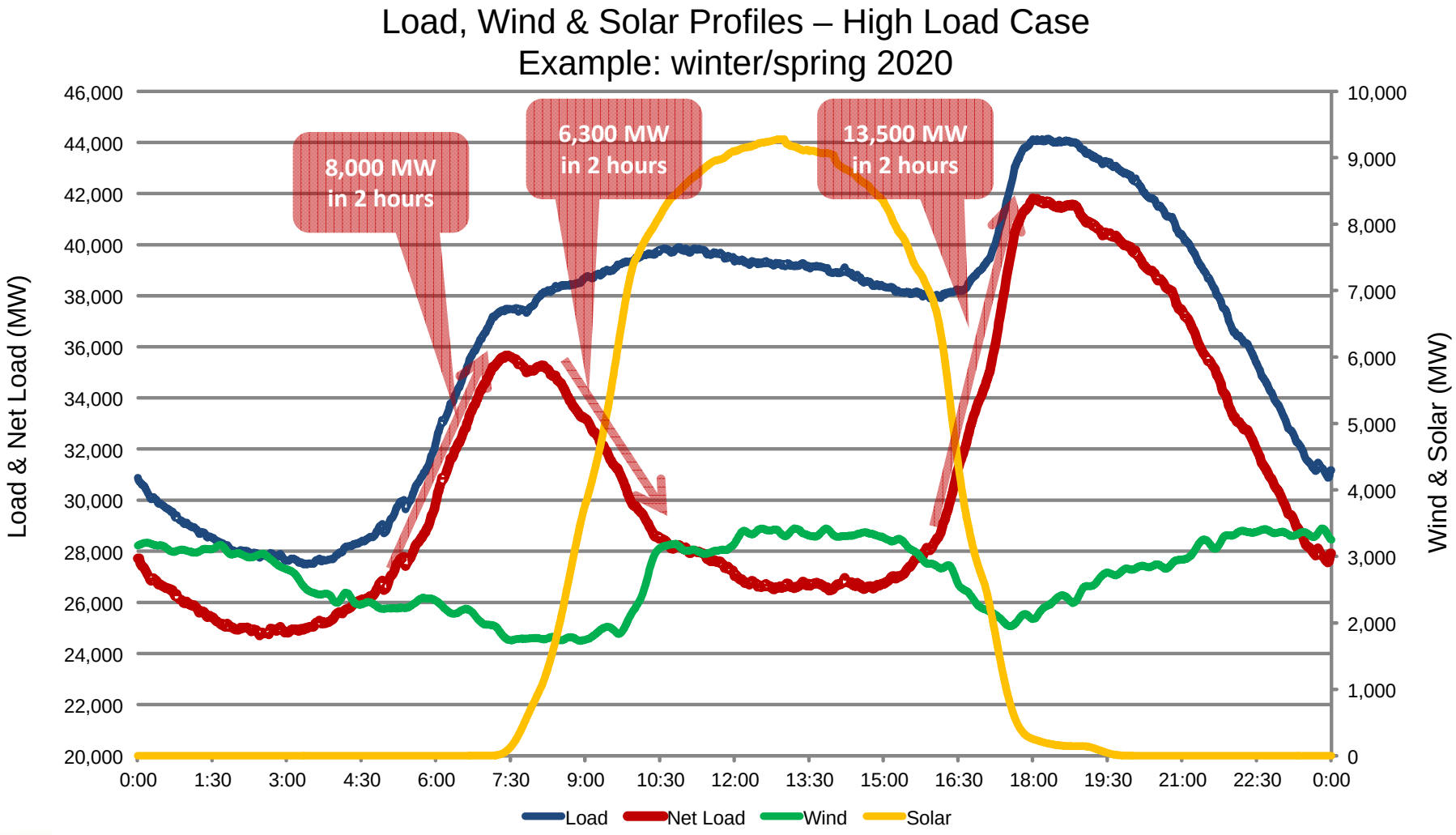
Maximum continuous ramp duration based on net load - actual 2010 & 2011 and simulated 2020

Observation: Continuous ramp duration decreases to 2-3 hours in 2020

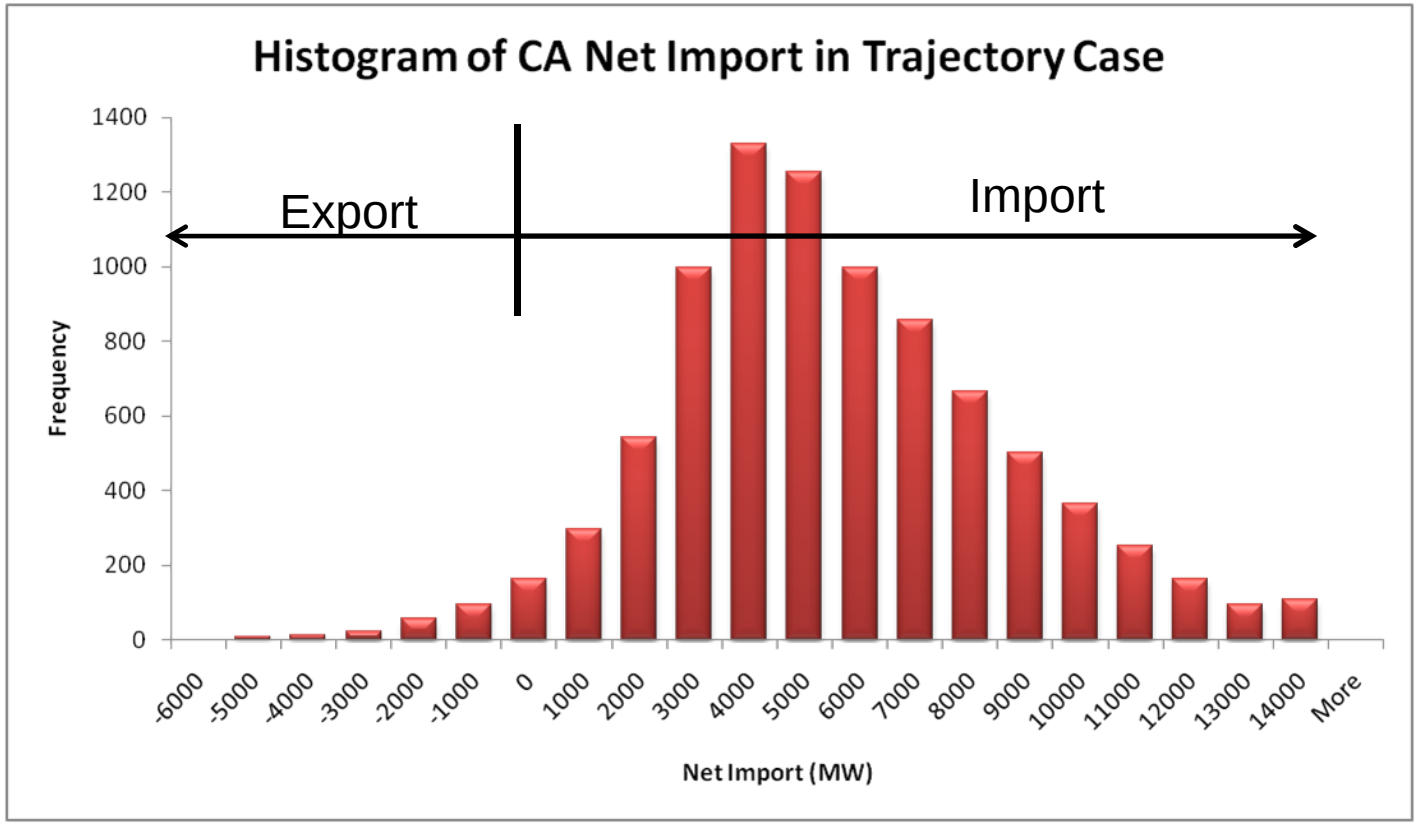
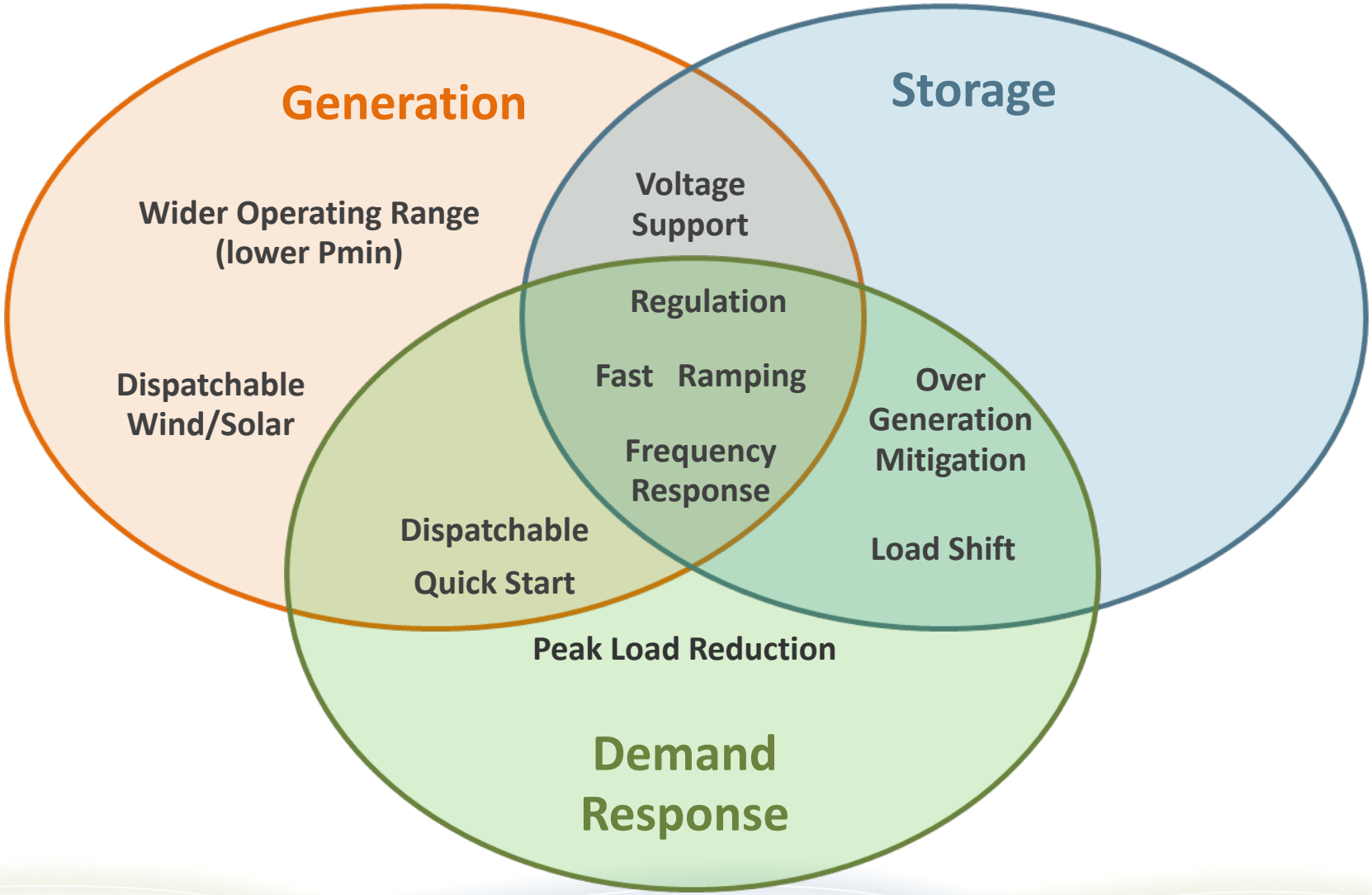


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	3.9	6.8	4.9	6.3	5.1	4.5	9.8	9.3	9.5	7.6	7.1	5.1
2011	4.2	3.6	3.4	7.4	6.0	5.9	9.8	11.1	8.7	7.8	5.9	4.3
2020	2.4	2.3	3.4	3.1	2.3	2.7	3.6	3.1	2.7	2.2	2.9	2.9

Conventional resources will be dispatched to the net load demand curve – High Load Case



Large quantity of net export observed in the cases need to be reviewed.



Meeting the operational challenges beyond 20% RPS