Consortium for Energy Sustainability and Advanced Management

CESAM NEW MEXICO

NMT

Panel: Solar, Wind, Energy Storage and Distribution

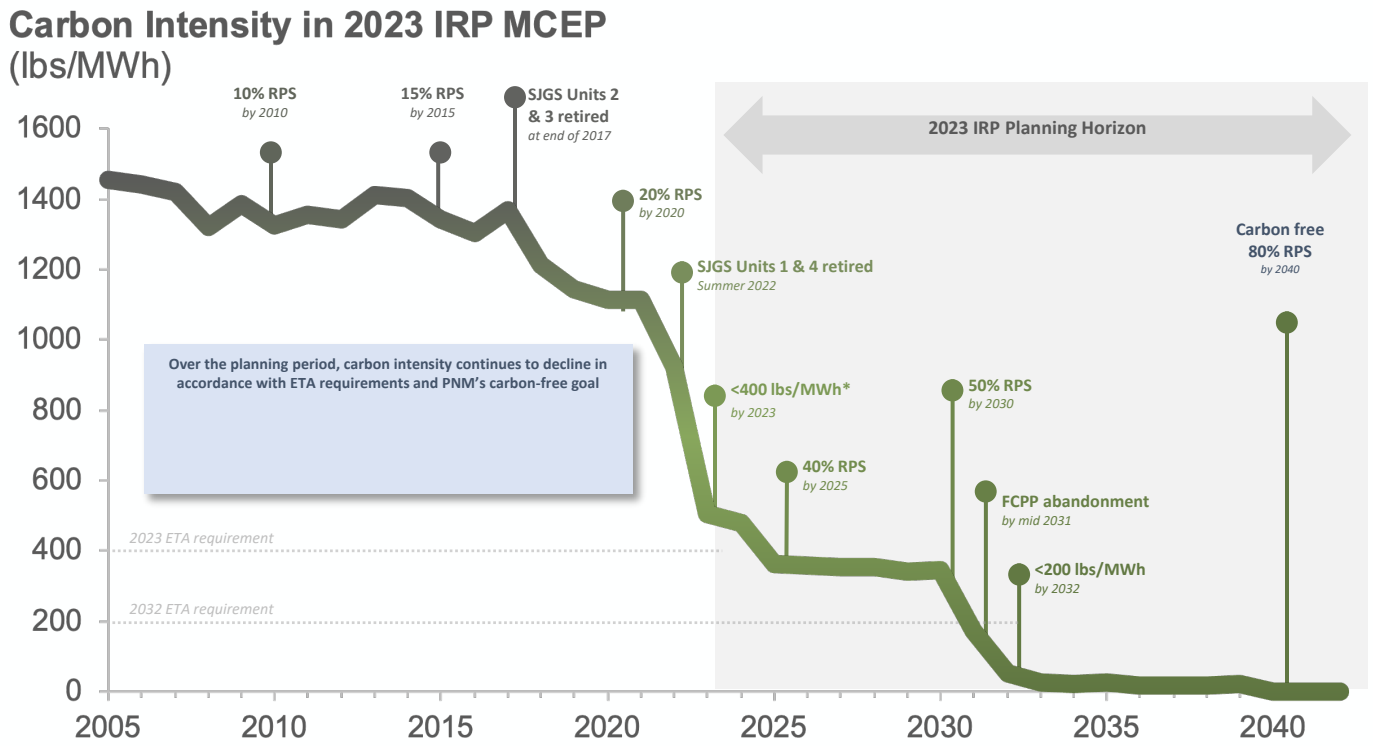
November 7, 2024

PNM®

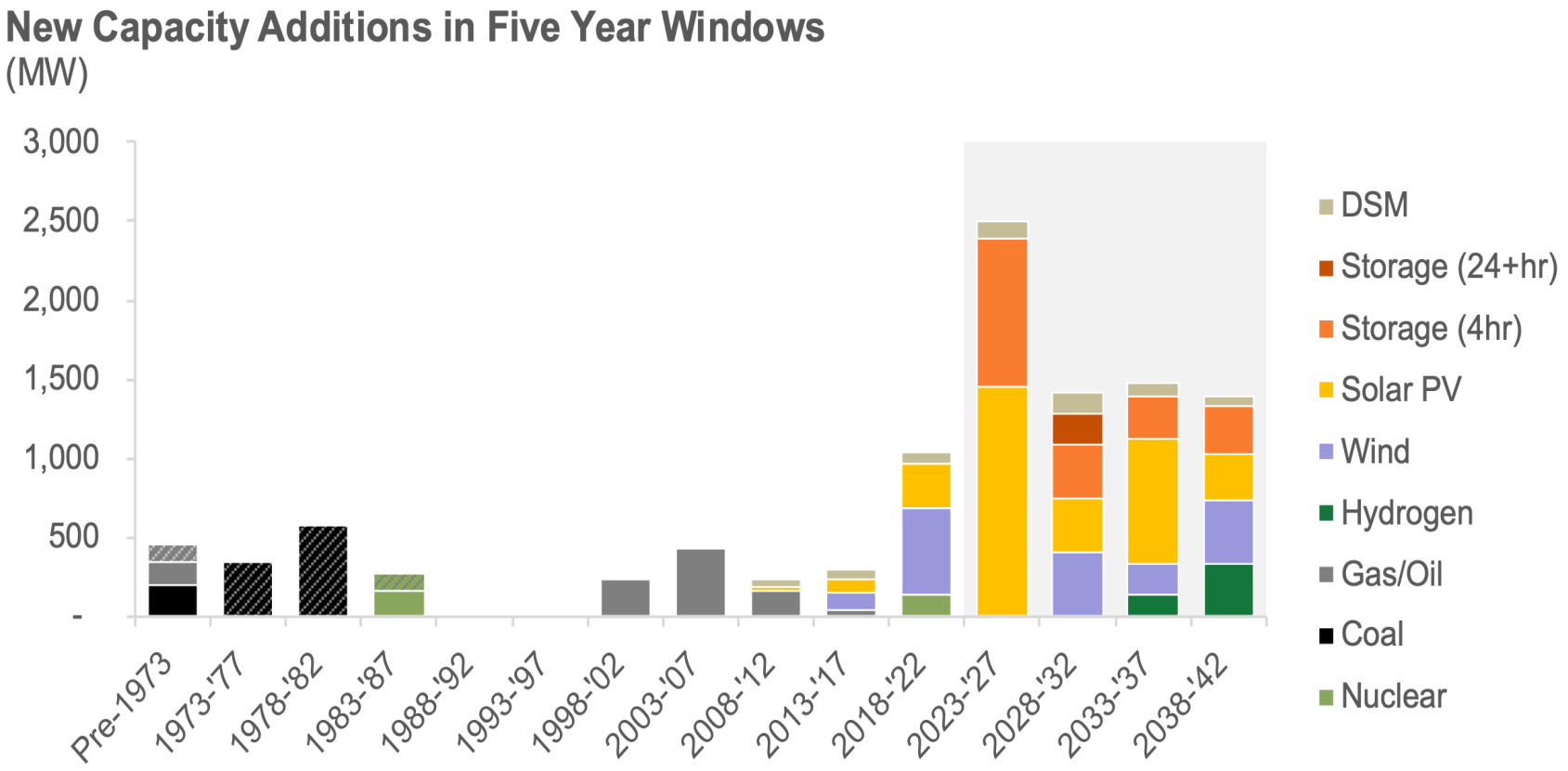
Industry Overview

- Renewable resources
- Reducing/eliminating carbon emitting resources
  - NM Requirements:
    - Carbon Free 2045 (PNM Targeting 2040)
    - Renewable 80%: Non-renewable technologies not defined.
- Economics and sustainability
- Onshoring and data centers (including AI)

Industry Overview: Carbon Intensity

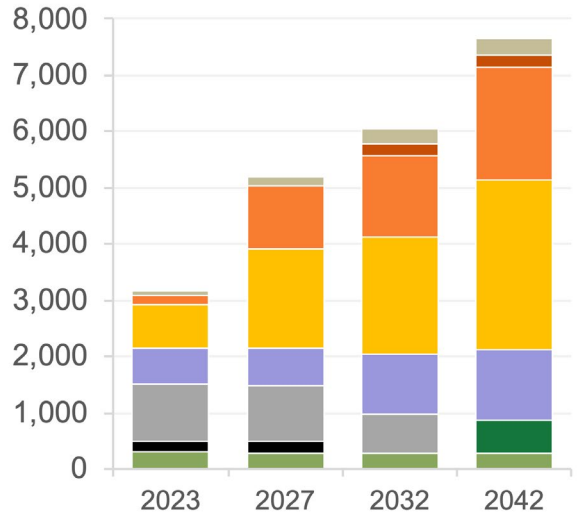


Technology Integration

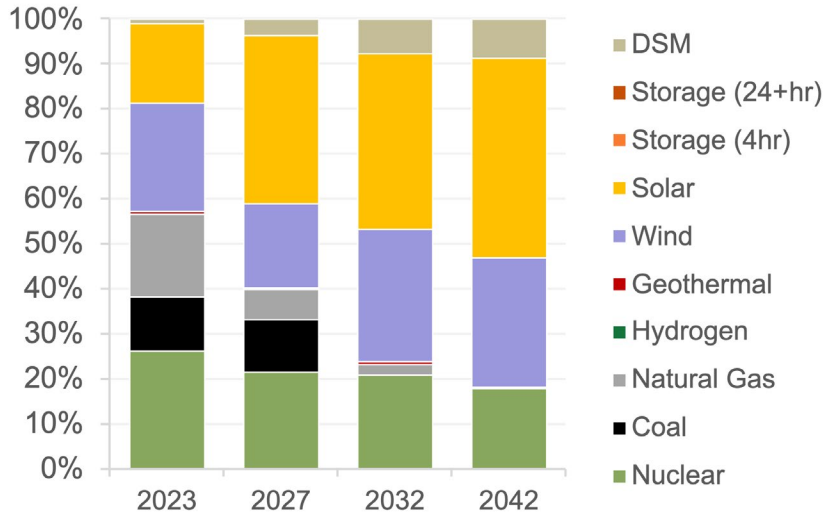


Technology Integration:
Future Electric Resource Additions

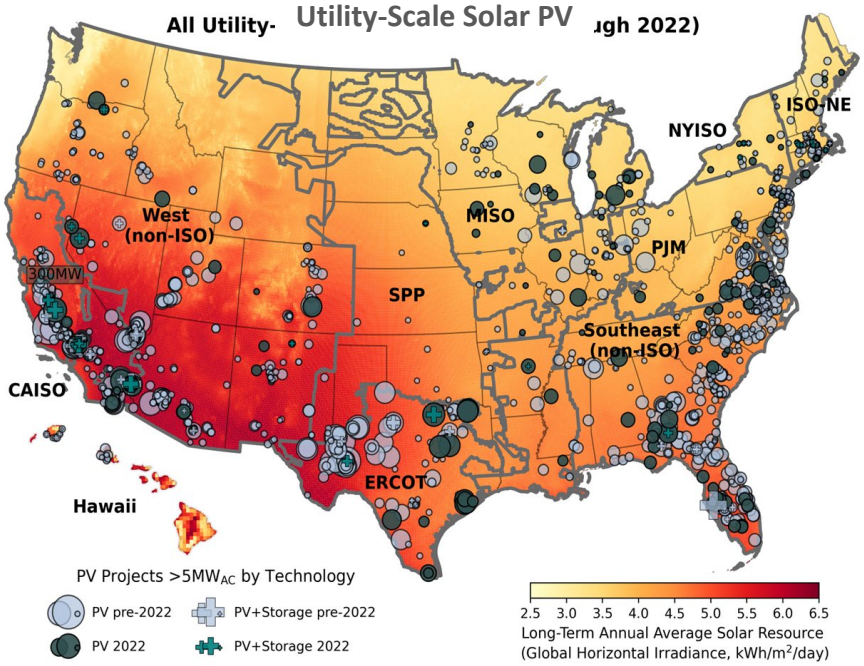
Total Installed Capacity, MCEP
(MW)

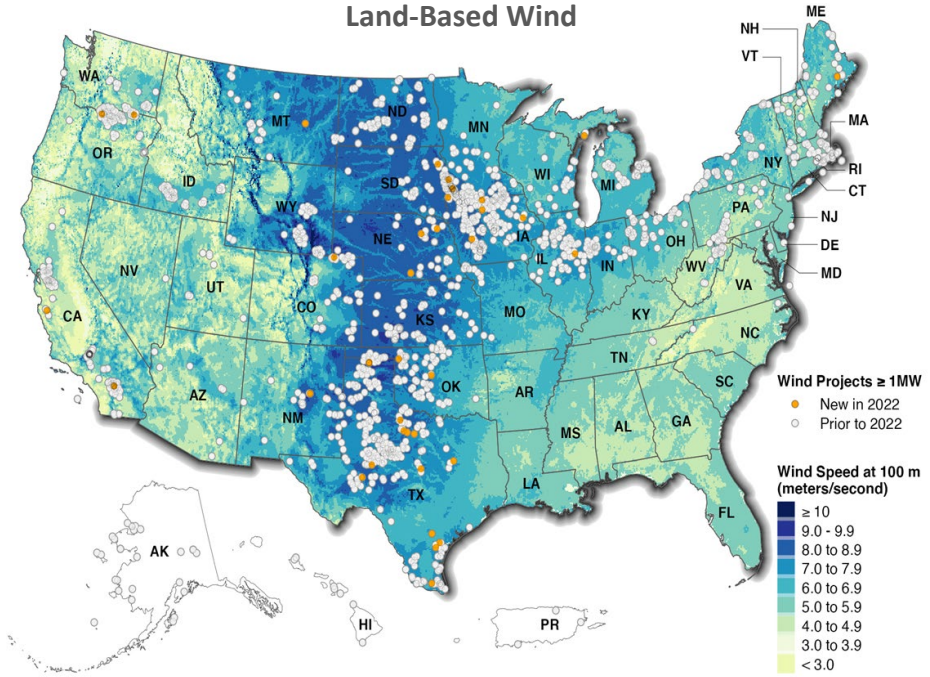


Annual Generation Mix, MCEP
(% of Annual Generation)



Technology Integration:
Solar, Wind and New Mexico





Storage Solutions

NON-EXHAUSTIVE – HYDROGEN AND HYBRID LONG DURATION STORAGE EXCLUDE

Faces geologic constraints[4] | Not enough public datapoints to obtain a reliable value | Less Desirable → More Desirable

Inter-day | Can function as both | Multi-day/week

Duration	Energy storage form	Technology	Nominal duration, hrs	LCOS[5], $/MWh	Min. deployment size, MW	Average RTE, %	TRL
Inter-day	Mechanical	Traditional pumped hydro (PSH)	0–15	70–170	200 – 400	70–80	9
		Novel pumped hydro (PSH)	0–15	70–170	10–100	50–80	5-8
		Gravity-based	0–15	90–120	20–1,000	70–90	6-8
		Compressed air (CAES)	6–24	80–150	200–500	40–70	7-9
		Liquid air (LAES)[1]	10–25	175–300	50–100	40–70	6-9
		Liquid CO2[1]	4–24	50–60	10–500	70–80	4-6
Multi-day / week	Thermal	Sensible heat (e.g., molten salts, rock material, concrete)[2]	10-200[2]	300	10–500	55–90	6-9
		Latent heat (e.g., aluminum alloy)	25–100	300	10–100	20–50	3-5
		Thermochemical heat (e.g., zeolites, silica gel)	XX	XX	XX	XX	XX
	Electrochemical	Aqueous electrolyte flow batteries	25–100	100-140	10–100	50–80	4-9
		Metal anode batteries	50–200	100	10–100	40–70	4-9
		Hybrid flow battery, with liquid electrolyte and metal anode (some are Inter-day)[2,3]	8–50[2]	XX	>100	55–75	4-9

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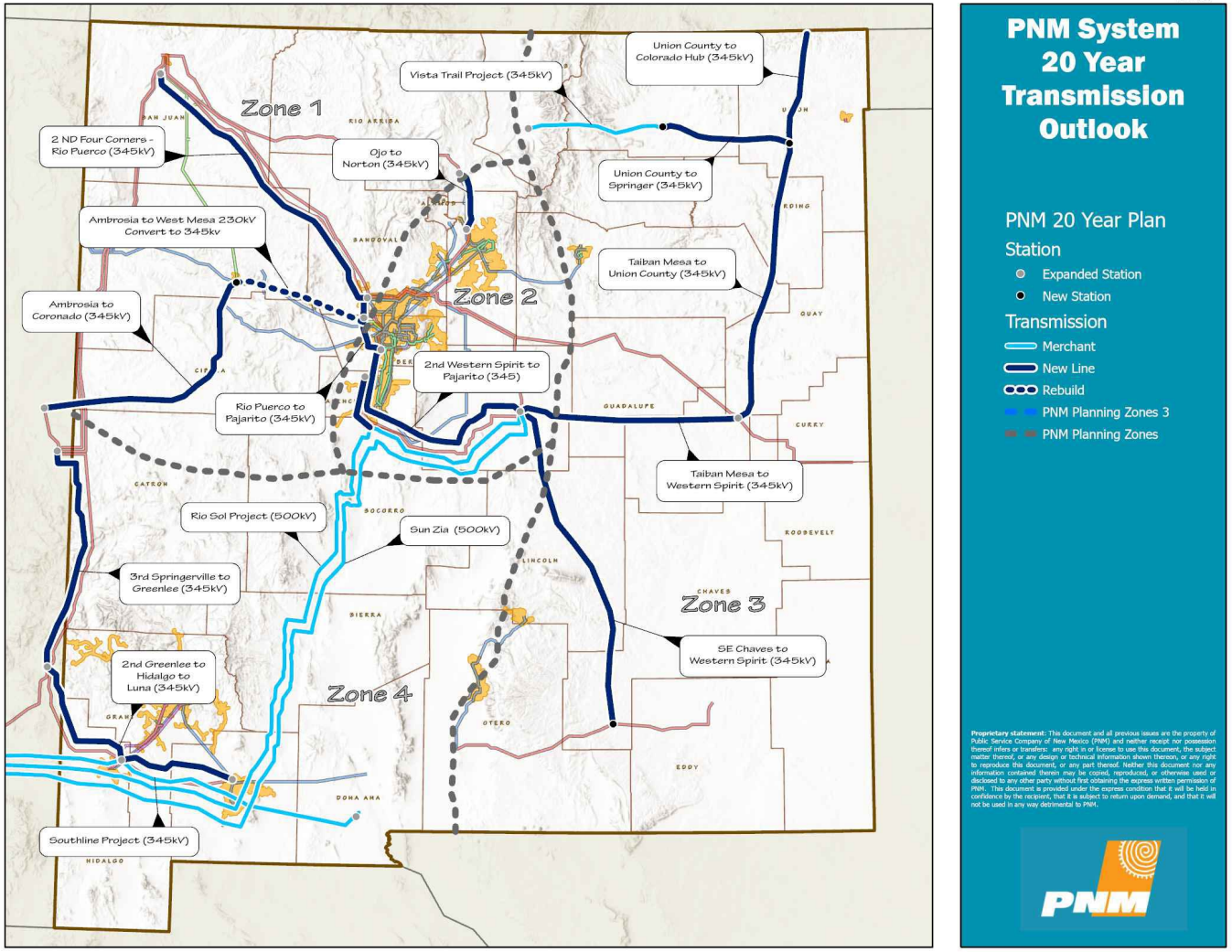
Grid Challenges

- Aligning Transmission Plans with Optimal Resource Technologies
- Achieve Renewable Integration
- Achieve Market Economics and Reliability Support
- Benefits of Diversity



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Distribution Challenges

- Legacy construction – Today's distribution systems were largely built for one way flow to load.
  - Numerous feeders are experiencing two way flows due to distribution resources (primarily solar)
- Data centers and manufacturing loads are large in comparison to capacity of typical feeders
- EV charging:
  - Commercial loads can be large also
  - Home charging may be during peak stress hours
- Generation hosting capacity, virtual power plants
- Modernization needed for operation of distribution system with these challenges:
  - Grid Modernization approved: Can result in combined automation of voltage control devices, resources, and consumer rate incentives to influence usage.