PACIFICORP:
PRIVATE GENERATION RESOURCE ASSESSMENT FOR LONG TERM PLANNING

JULY 30, 2021

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INTRODUCTION

INTRODUCTION

- Navigant prepared this Long-term Private Generation Resource Assessment on behalf of PacifiCorp.
- The purpose of this study is to support PacifiCorp's 2021 Integrated Resource Plan (IRP) by projecting the level of private generation resources PacifiCorp's customers might install over the next twenty years under base, low, and high penetration scenarios.
- This study builds on Navigant's previous assessment which supported PacifiCorp's 2015, 2017, and 2019 IRP, incorporating updated load forecasts, market data, technology cost and performance projections.
- The study includes projections for PacifiCorp's six state territories: UT, OR, ID, WY, CA, WA.
- Navigant evaluated five private generation resources in detail in this report:
    1. Photovoltaic Solar
    2. Small Scale Wind
    3. Small Scale Hydro
    4. Combined Heat and Power Reciprocating Engines
    5. Combined Heat and Power Micro-turbines

PRIVATE GENERATION TECHNOLOGIES: RESOURCE COST ASSUMPTIONS

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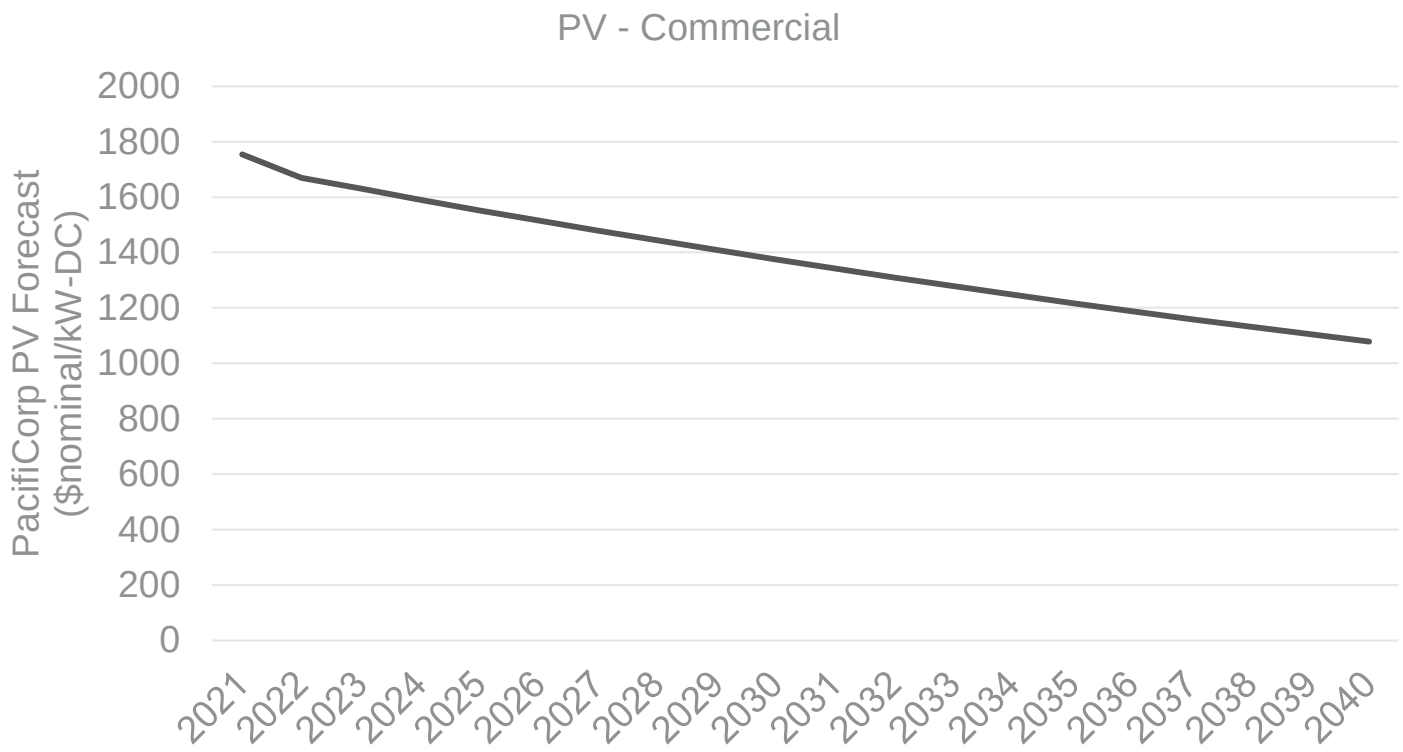
PRIVATE GENERATION TECHNOLOGIES

Resource Cost and Performance	Solar PV	Small-scale Wind	Small-scale Hydro	Micro-Turbines	Reciprocating Engines
Installed Cost – Res ($/kW 2021)*	UT: $2,300/kW-DC Other: $2,500/kW-DC	$7,200	NA	NA	NA
Installed Cost – Non-Res ($/kW 2021)*	All Markets: $1,750/kW-DC	$6,000	$4,000	$2,685	$2,970
Average Change in Annual Installed Cost (2021-2040) (%)	-2.8% (Res) -2.5% (Non-Res)	0.0%	0.0%	-0.3%	0.4%
Fixed O&M – Res ($/kW-yr.)	$25	$40	NA	NA	NA
Fixed O&M – Non-Res ($/kW-yr.)	$23	$40	$52	NA	NA
Variable O&M	NA	NA	NA	$23	$20
Change in Annual O&M Cost (%)	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%
Capacity Factor (%)	12.4%-16.8%	24%	50% ±5%	85%	85%
Fuel Cost	NA	NA	NA	PacifiCorp Gas Forecast	PacifiCorp Gas Forecast
Electric Heat Rate (HHV) (Btu/kWh)	NA	NA	NA	15,535	12,637
DC to AC Derate Factor	0.85	NA	NA	NA	NA

* Installed costs for solar PV are in $/W-DC; all other technologies are in $/W-AC

NON-RESIDENTIAL SOLAR SYSTEM COSTS, 2021-2040



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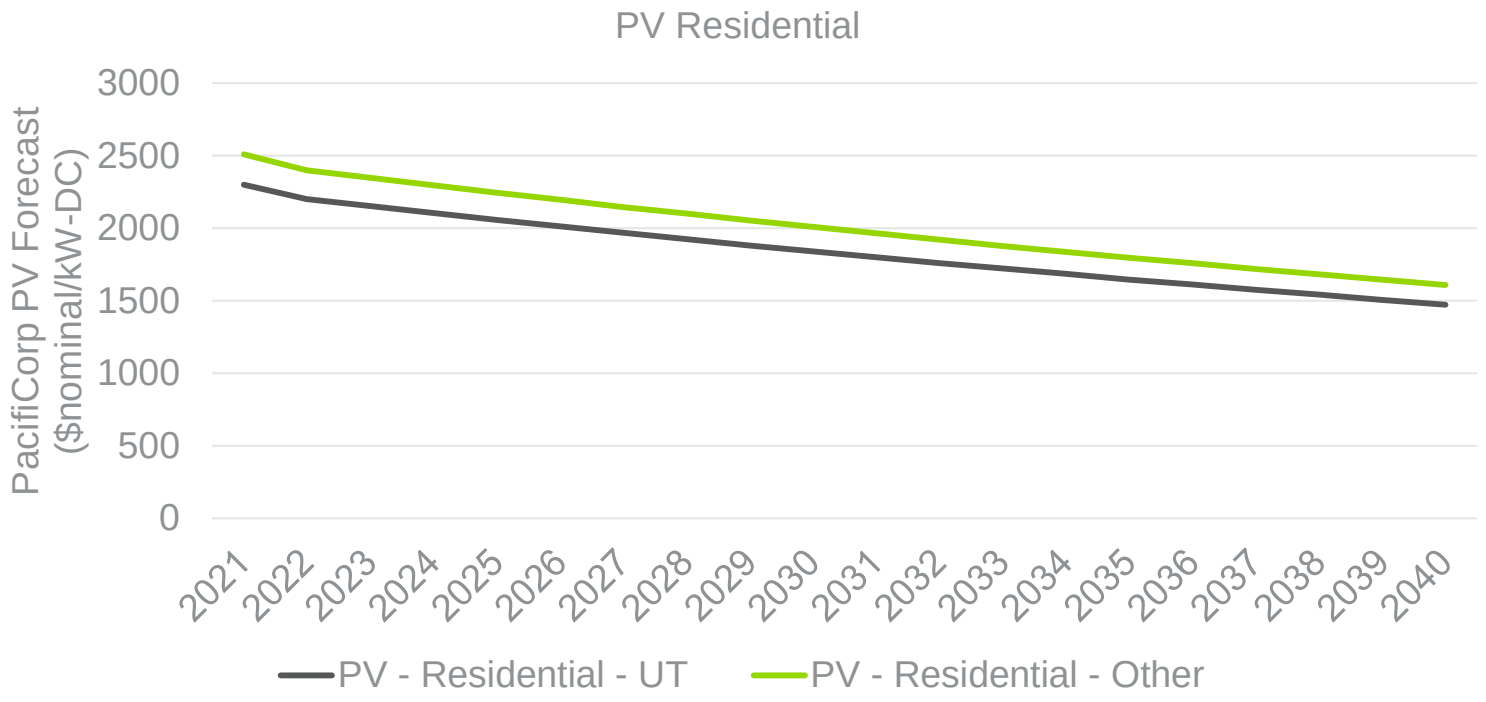
RESIDENTIAL SOLAR SYSTEM COSTS, 2021-2040



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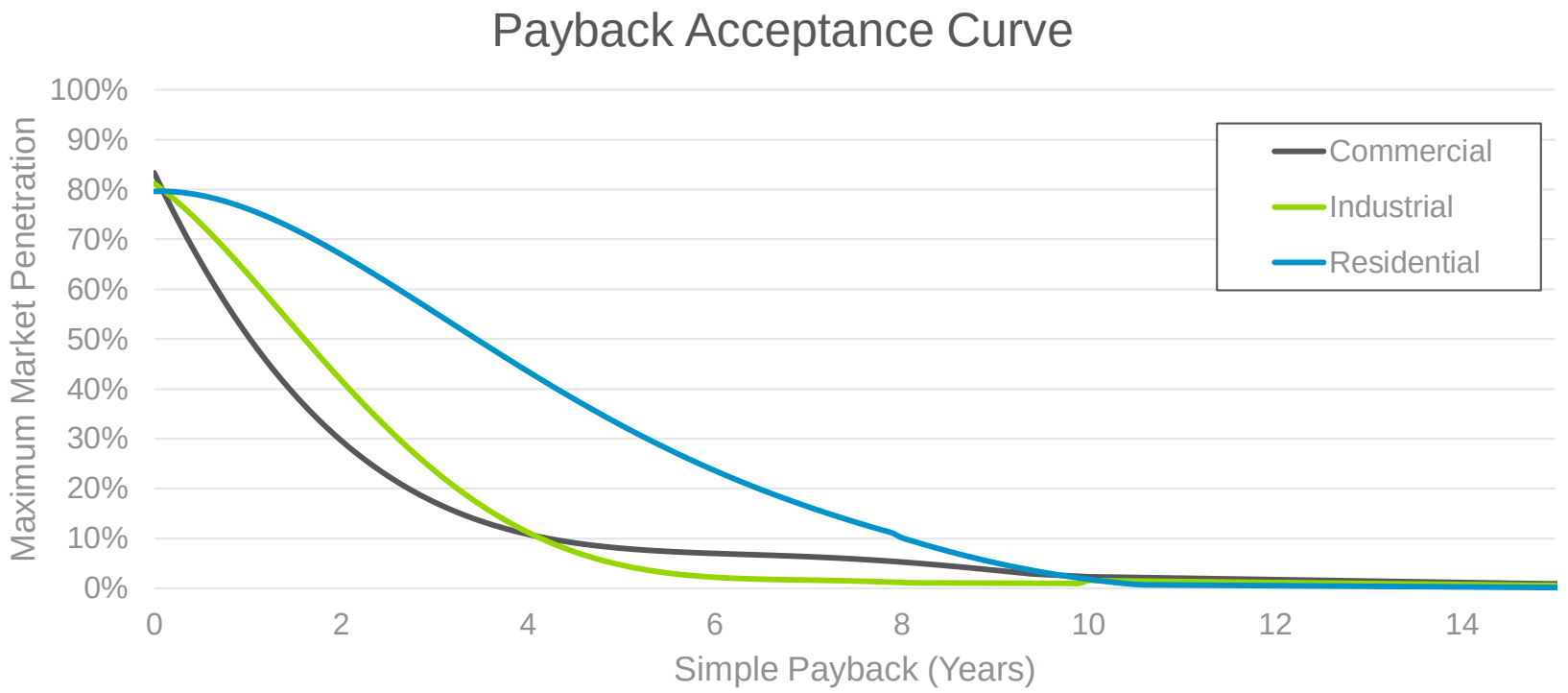
METHODOLOGY

METHODOLOGY

1. **Assess a Technology's Technical Potential:** Technical potential is the amount of a technology that can physically be installed without taking economics into account.
2. **Calculate First Year Simple Payback Period for Each Year of Analysis:** From past work projecting the penetration of new technologies, Navigant found that Simple Payback Period is the best indicator of uptake. Another possible metric is Return on Investment (ROI). Navigant found that most customers, especially in the residential sector, do not do sophisticated enough calculations to warrant an ROI analysis.
3. **Project Ultimate Adoption Using Payback Acceptance Curves:** Payback Acceptance Curves estimate what percentage of a market will ultimately adopt a technology. Payback Acceptance Curves do not factor in how long adoption will take.
4. **Project Actual Market Penetration Using Market Penetration Curves:** Market penetration curves factor in market and technology characteristics to project how long adoption will take.
5. **Project Market Penetration Under Different Scenarios:** Penetration can vary depending on different market scenarios.

PAYBACK ACCEPTANCE

For private generation sources, Navigant used the following payback acceptance curves to model market penetration from the retail customer perspective.



Source: NCI based upon work for various utilities, federal government organizations, and state/local organizations. The curves were developed from customer surveys, mining of historical program data, and industry interviews.

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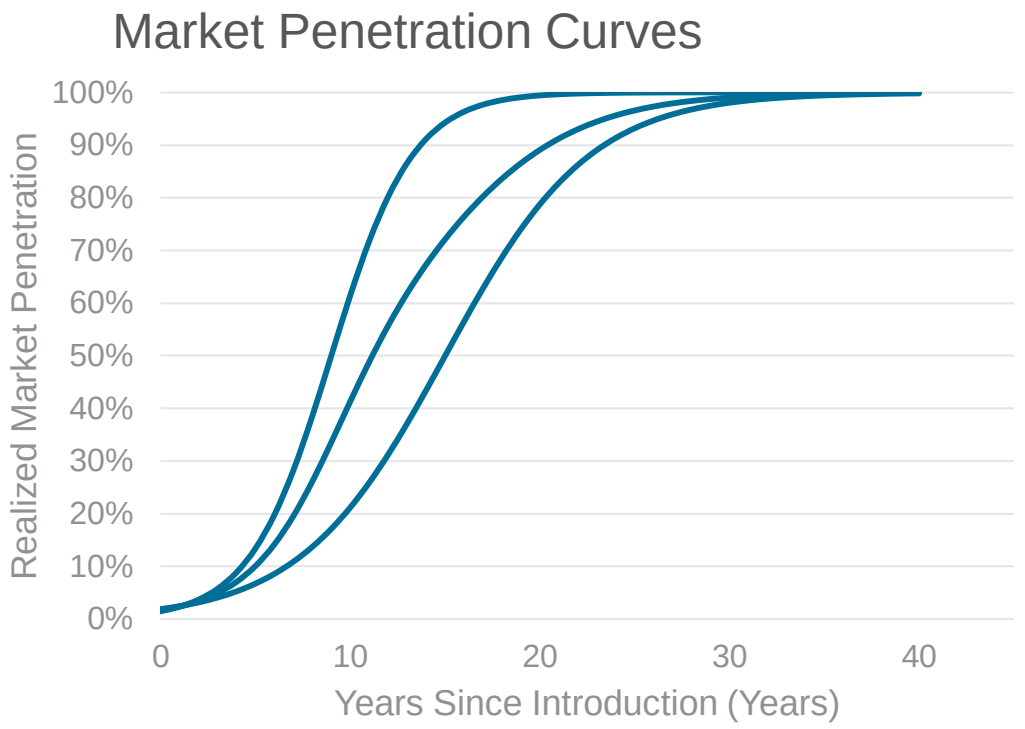
MARKET PENETRATION

Navigant uses market penetration curves to assess how a technology is adopted over time.

- Market penetration curves (sometimes called S-curves) are well established tools for estimating diffusion or penetration of technologies into the market.
- A market penetration curve provides the rate of adoption of technologies, as a function of the technology's characteristics and market conditions.
- Navigant Consulting has gathered market data on the adoption of technologies over the past 120 years and fit the data using Fisher-Pry curves.*
- The Fisher-Pry technology substitution model predicts market adoption rate for an existing market of known size.
- A key parameter when using market penetration curves is the assumed year of introduction.
  - For this study, NCI assumed the first year introduction occurred when the simple payback period was less than 25 years (per the payback acceptance curves used, this is the highest payback period that has any adoption).



*Source: Navigant Consulting, Inc., November 2008 as taken from Fisher, J.C. and R.H. Pry, A Simple Substitution Model of Technological Change, *Technological Forecasting and Social Change*, Vol 3, Pages 75 – 99, 1971 .

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RESULTS

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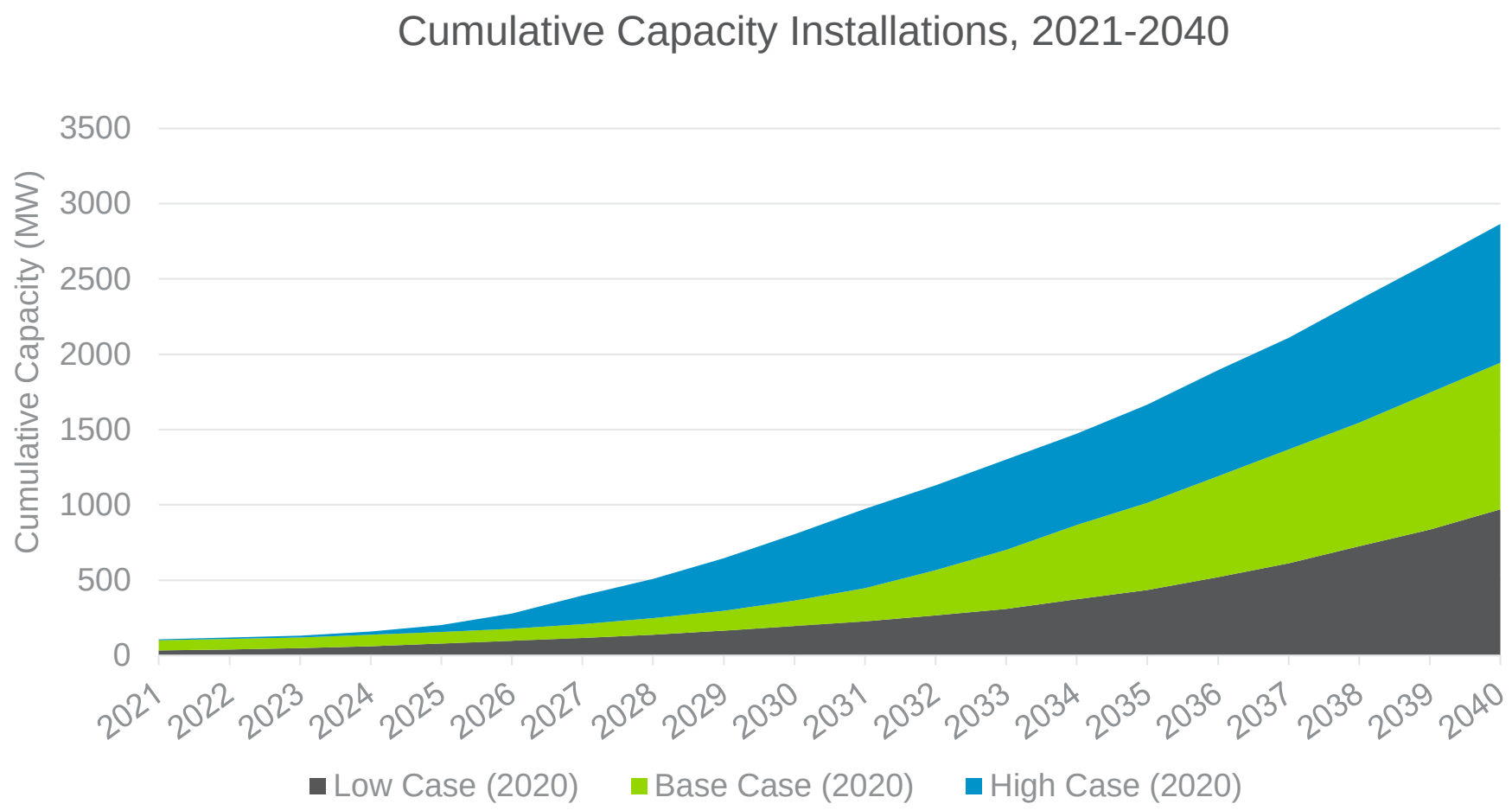
PRIVATE GENERATION – ALL CASES AND STATES



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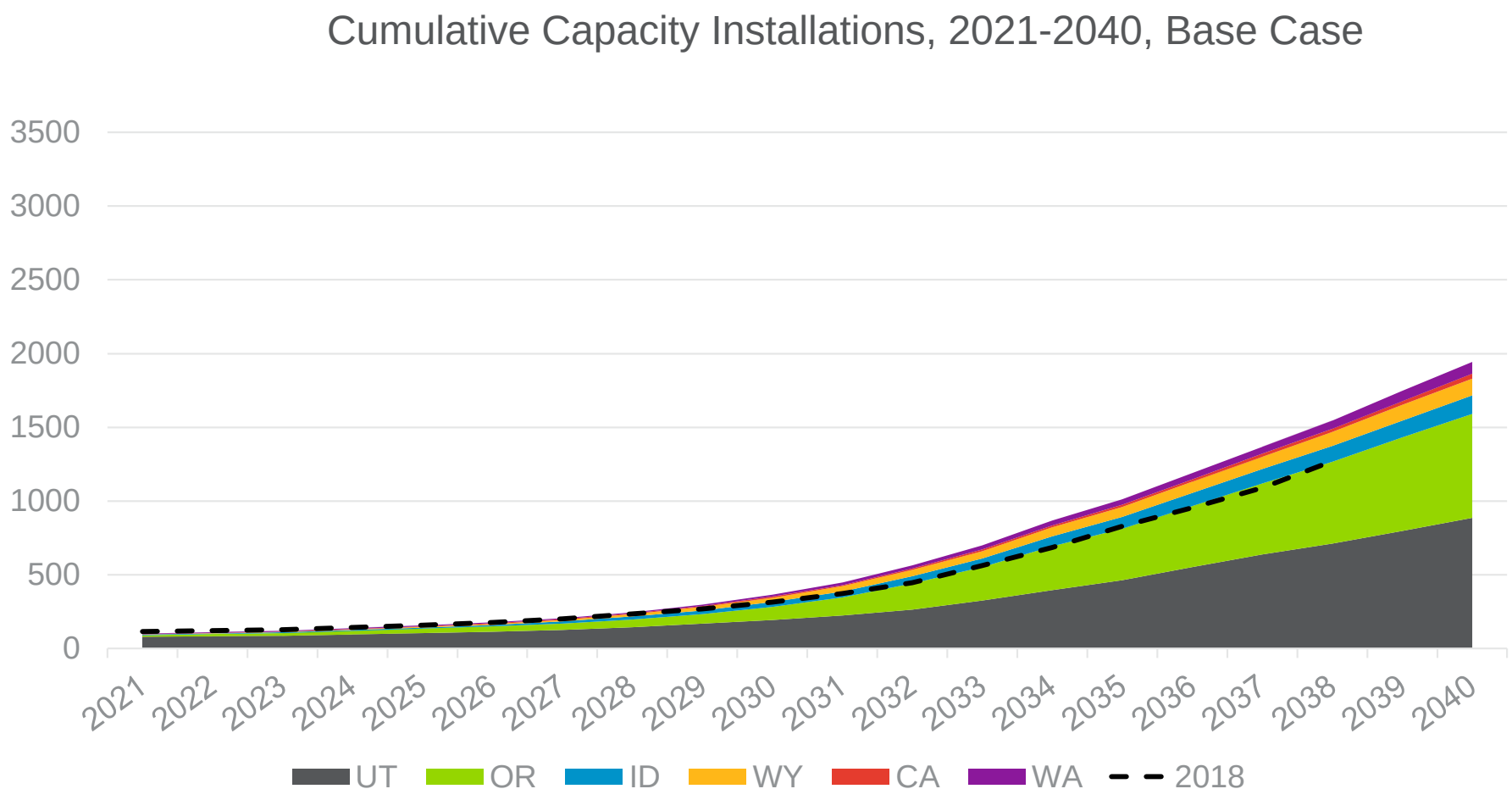
PRIVATE GENERATION – BASE CASE



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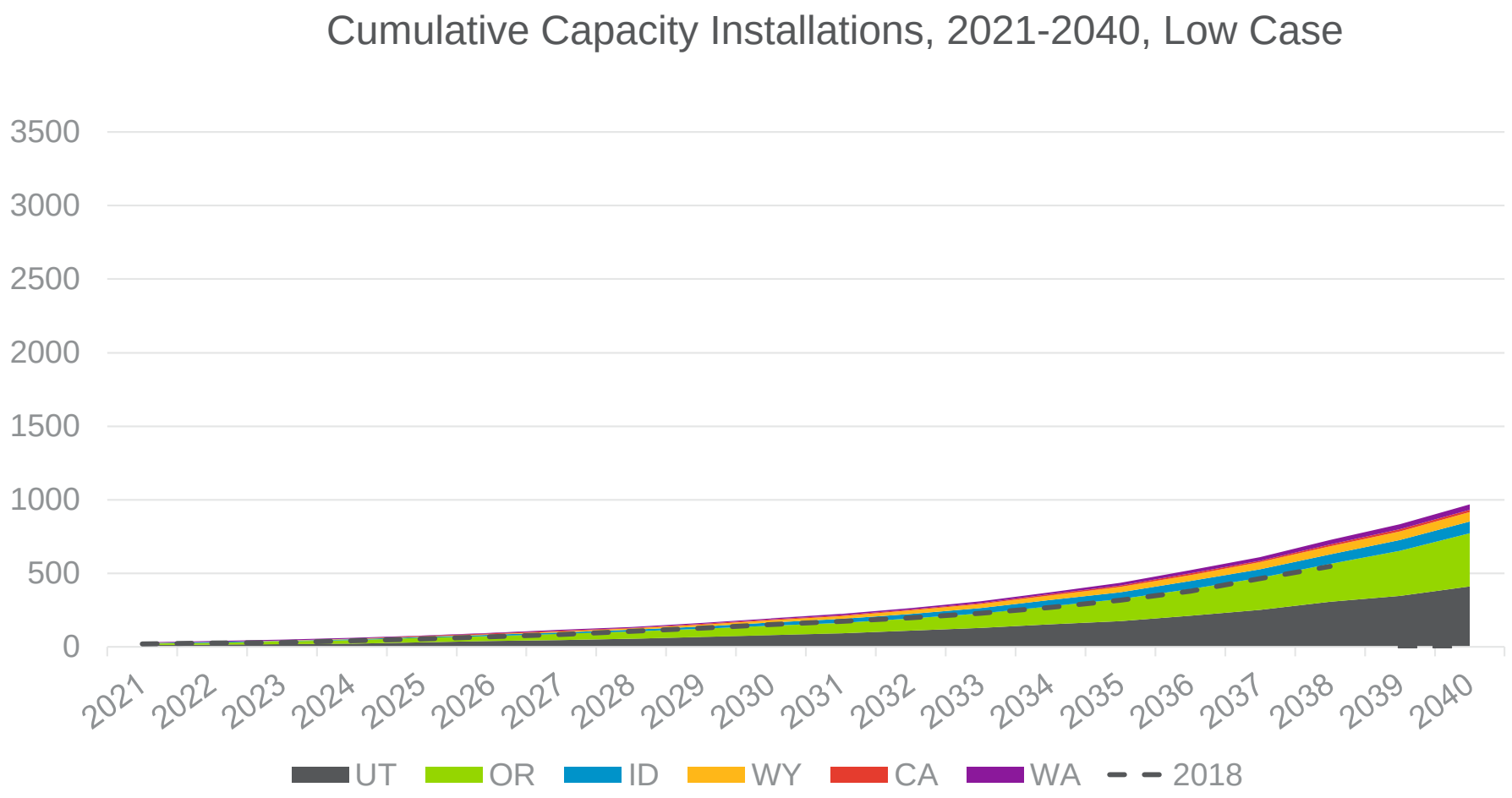
PRIVATE GENERATION – LOW CASE



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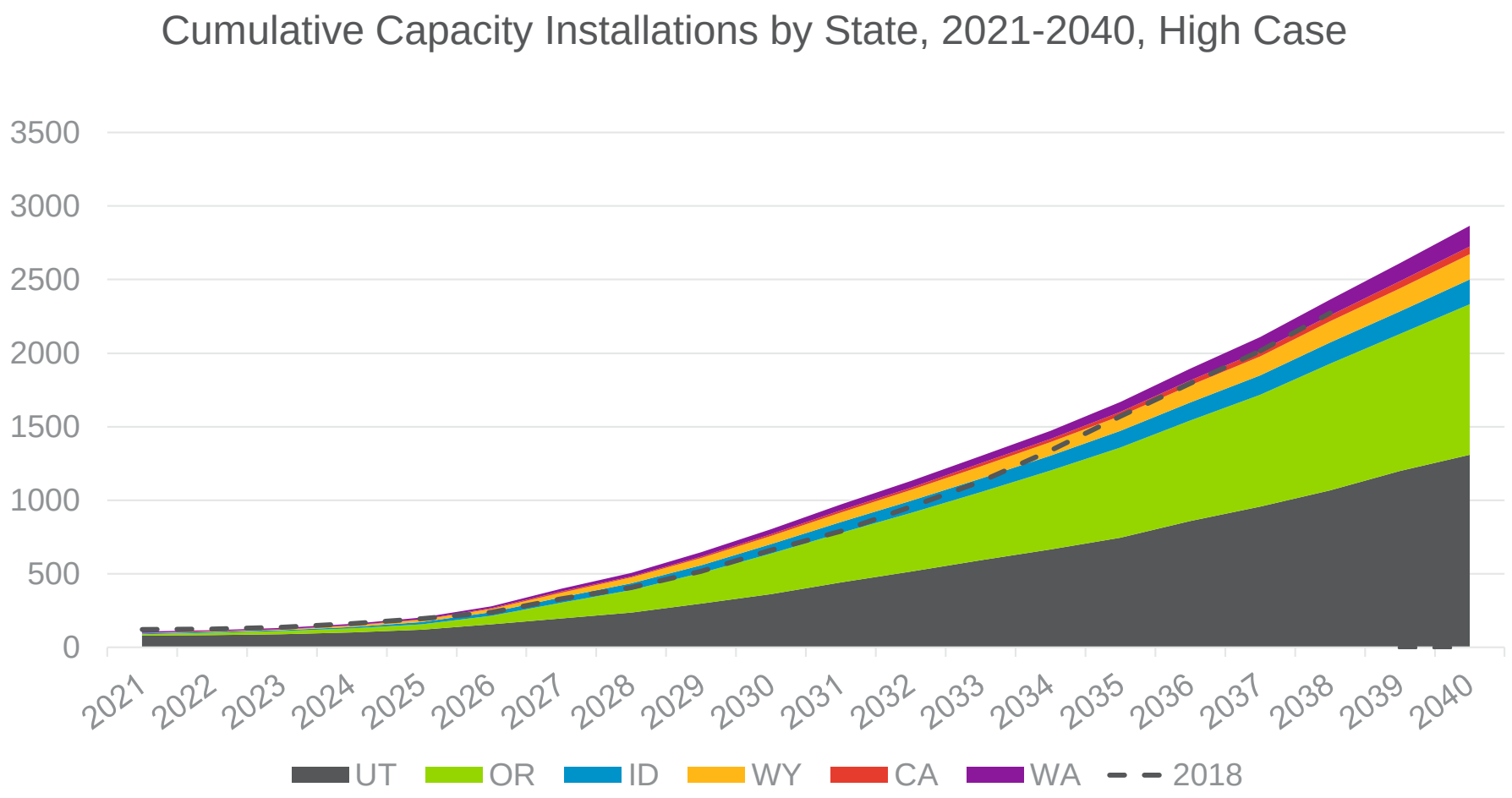
PRIVATE GENERATION – HIGH CASE



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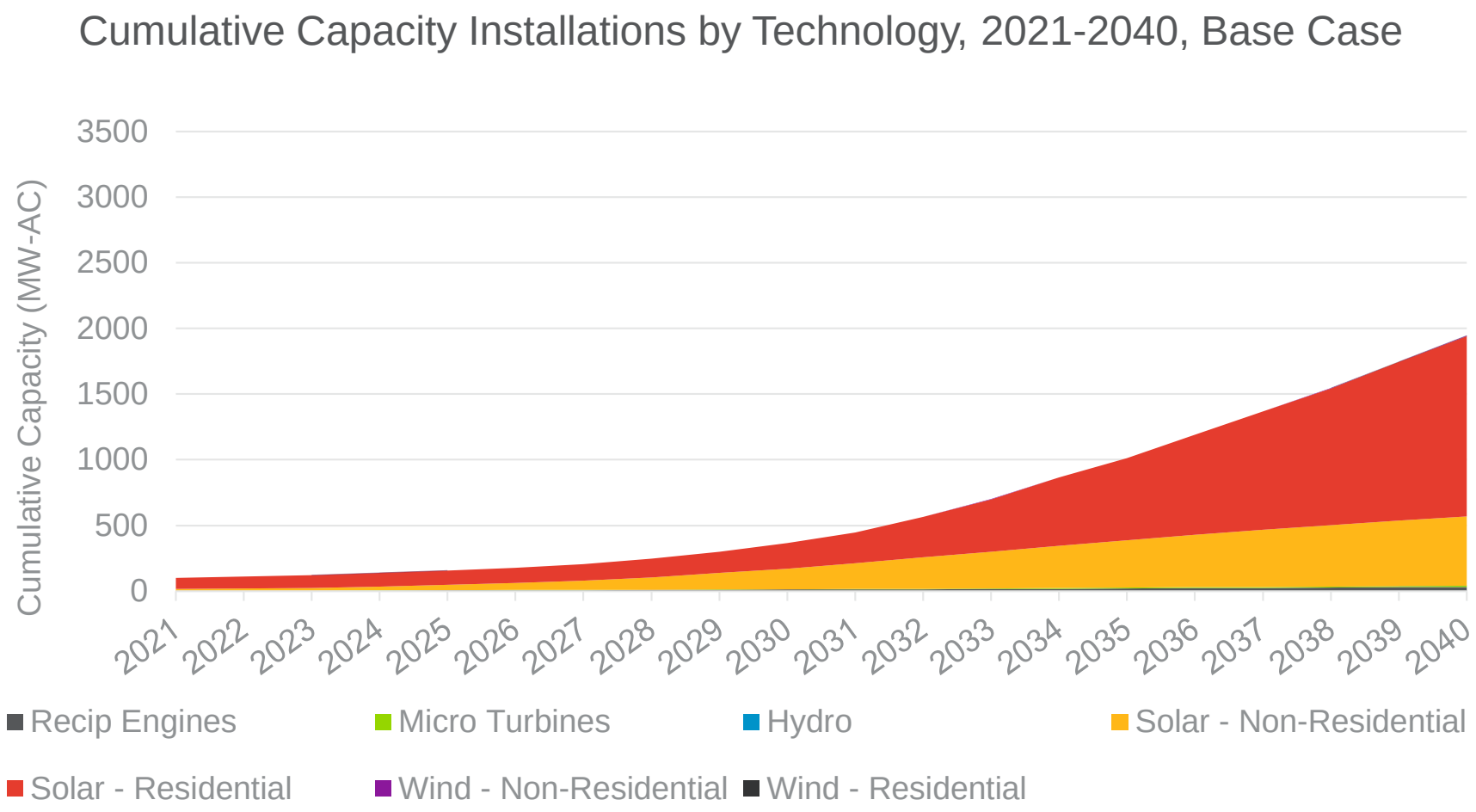
PRIVATE GENERATION – BASE CASE



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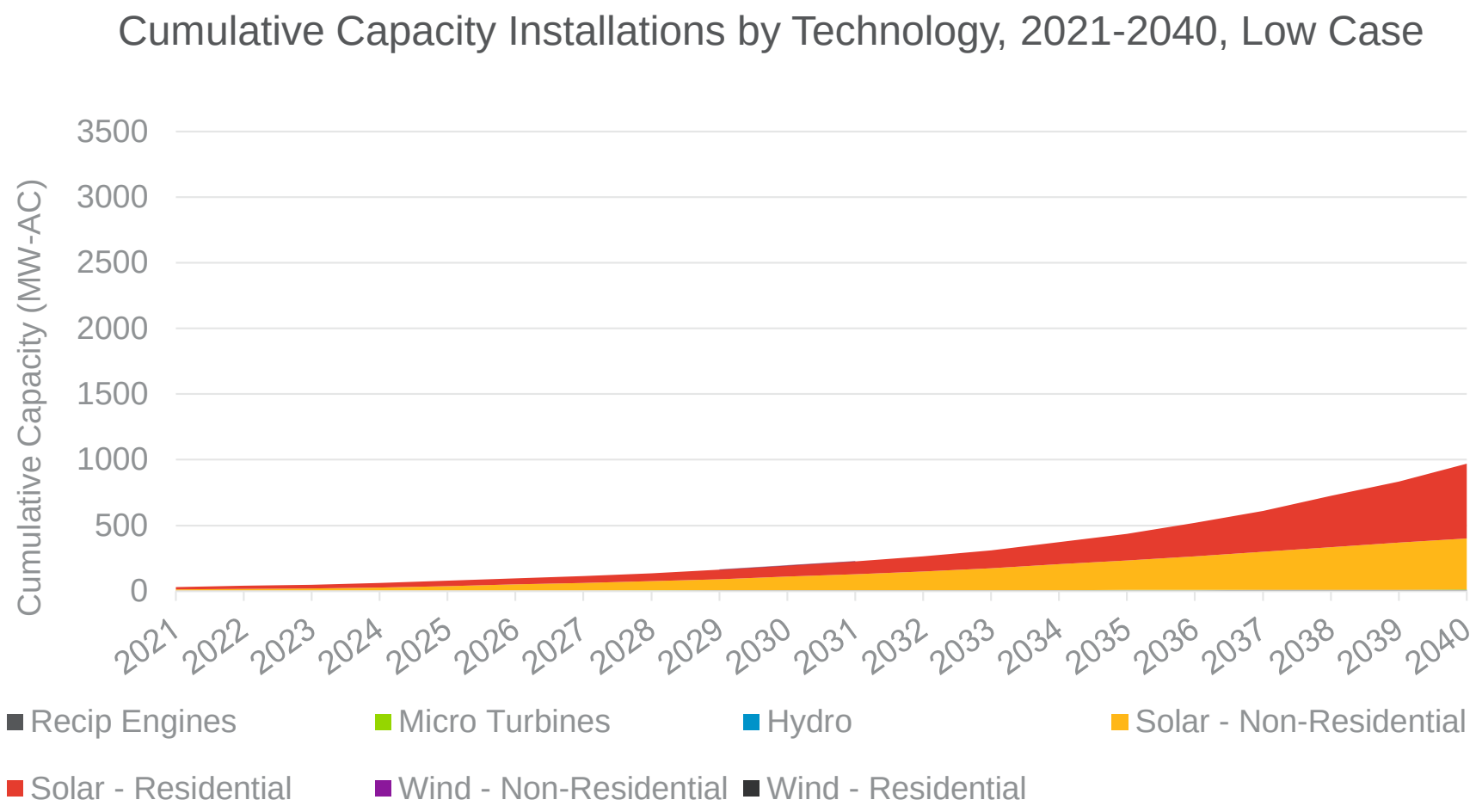
PRIVATE GENERATION – LOW CASE



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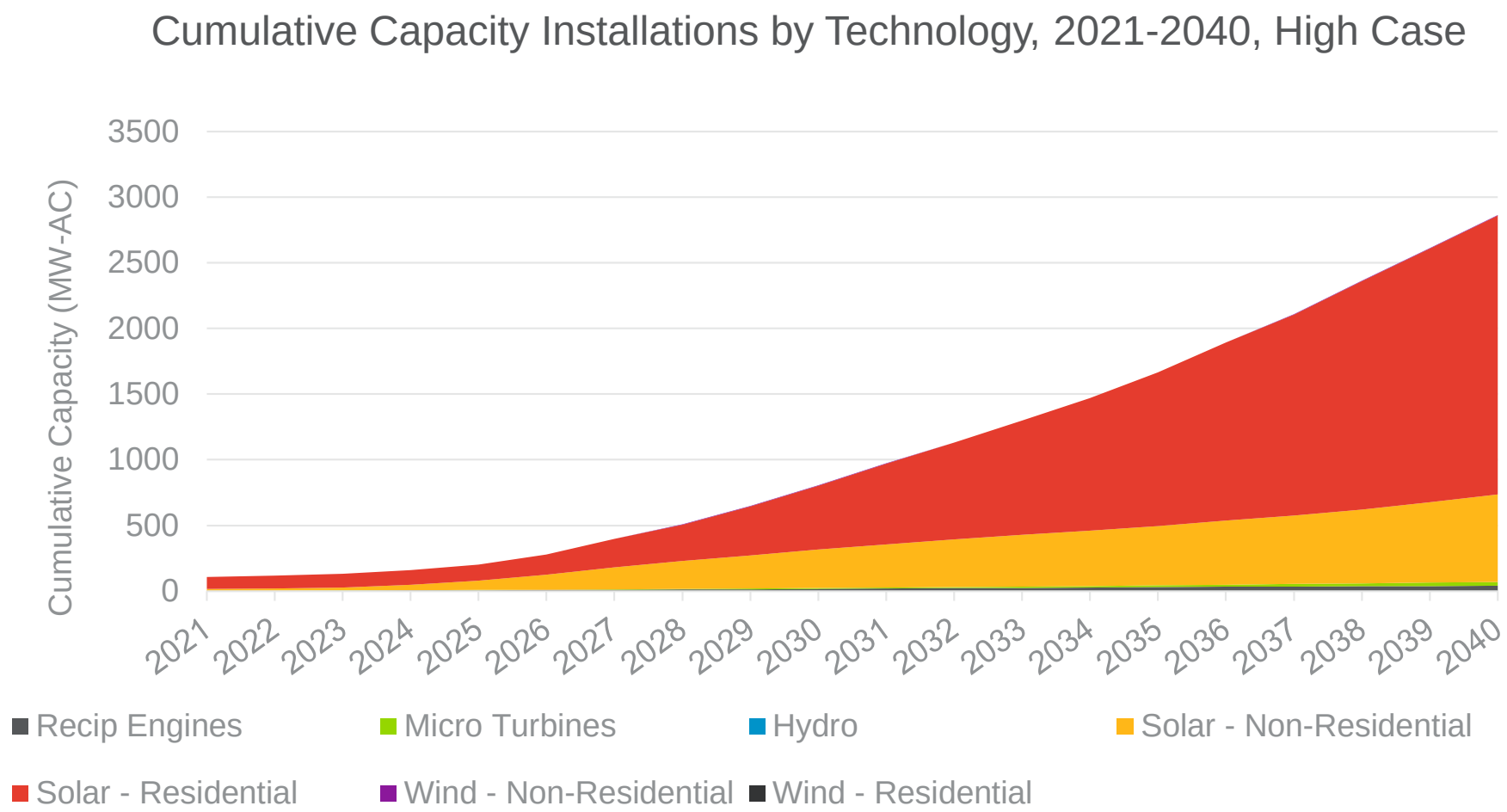
PRIVATE GENERATION – HIGH CASE



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COMPARISON WITH PAST STUDY RESULTS

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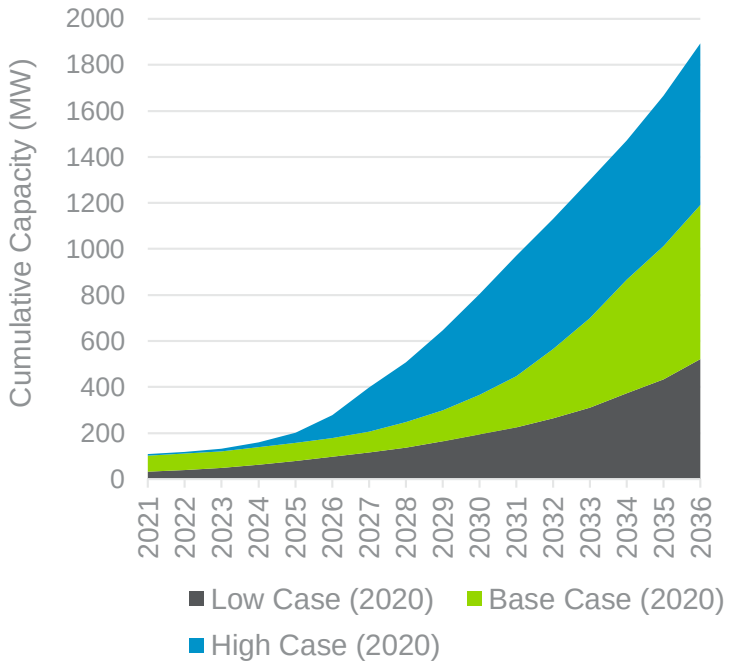
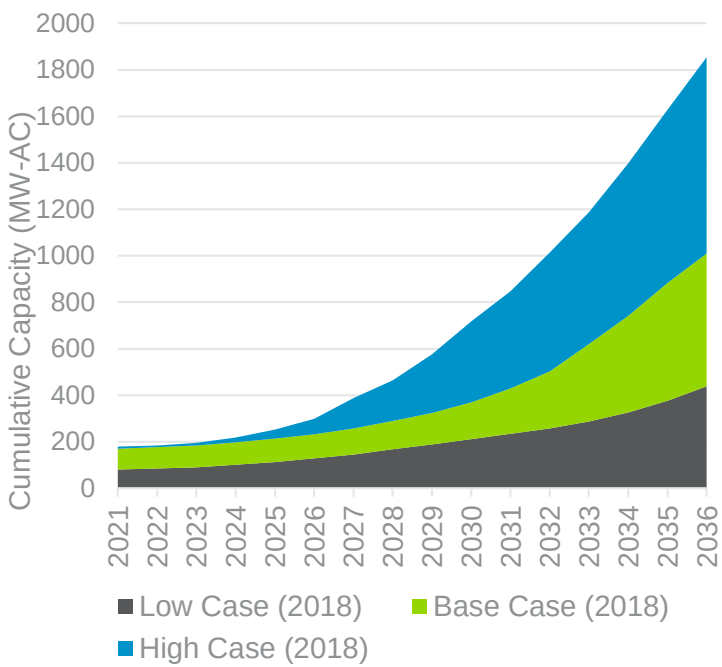
COMPARISON TO 2016 AND 2018 STUDY RESULTS

Since the 2018 study, projected PV capacity is expected to grow at a slower rate in the early years and at a faster rate towards the end of the forecast period reaching similar overall adoption. The main reasons include policy changes and costs declines, especially for solar PV.

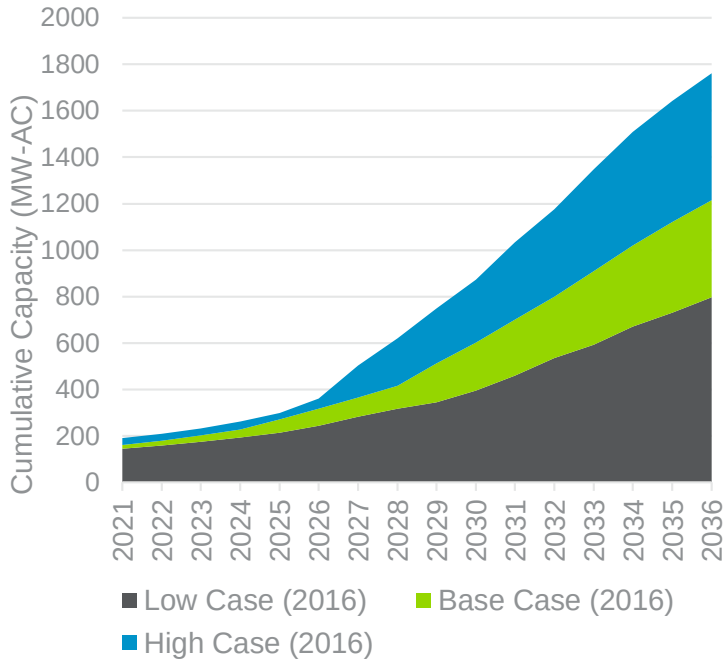
Cumulative Market Penetration Results by Scenario (MW-AC), 2020 – 2036, Base Case (2020 Study)



Cumulative Market Penetration Results by Scenario (MW-AC), 2019 – 2036, Base Case (2018 Study)



Cumulative Market Penetration Results by Scenario (MW-AC), 2019 – 2036, Base Case (2016 Study)



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COMPARISON TO 2018 STUDY RESULTS

State	Estimated Adoption Change	Key Adoption Drivers
CA	**2038** – Market decreased from 48 MW to 22 MW	• Rates: Decrease (residential significantly, commercial and industrial marginally) • Solar PV Cost: Declines in the later years are more sustained • Policy: Change to net billing framework (captured in the offset rates) • Customer Count: increased 3%
ID	**2038** – Market remained consistent	• Rates: Decrease (residential, commercial, industrial) • Solar PV Cost: Declines in the later years are more sustained • Policy: No change • Customer Count: increased 10%
OR	**2038** – Market increased from 435 MW to 554 MW, with adoption shifting to later years which seems reasonable given incentive declines offset by cost declines in future years	• Rates: Decrease (commercial, industrial) • Solar PV Cost: Declines in the later years are more sustained • Policy: No change from Energy Trust incentives previously included. • Customer Count: increased 7.5%
UT	**2038** – Market increased from 560 MW to 646 MW. Key drivers include customer count increase, manual adjustment for 2021, and increase in commercial offset rates.	• Rates: Decrease (Residential, Industrial), Increase (Commercial); NEM reduction to around 90% of full rates • Solar PV Cost: Declines in the later years are more sustained • Policy: Incentive for residential solar PV declines to $400 in 2024 and $0 beyond; • The report reflects the regulatory modifications to the PG program in Utah, as included in Schedule 136 (Utah Docket 14-035-114) • Customer Count: increased 12%
WA	**2038** – Market increased from 60 MW to 76 MW	• Rates: Decrease (commercial, industrial) • Solar PV Cost: Declines in the later years are more sustained • Policy: Solar and wind FiT reduced rate for an 8 year period • Customer Count: increased 5.5%
WY	**2038** – Market decreased from 114 MW to 96 MW	• Rate: Small changes only • Solar PV Cost: Declines in the later years are more sustained • Policy: None • Customer Count: increased 2%

APPENDIX

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FEDERAL INCENTIVES

Technology	2019	2020	2021	2022	2023	>2023
Recip. Engines	10%	10%	10%	0%	0%	0%
Micro Turbines	10%	10%	10%	0%	0%	0%
Small Hydro	0%	0%	0%	0%	0%	0%
PV - Com	30%	26%	22%	10%	10%	10%
PV - Res	30%	26%	22%	0%	0%	0%
Wind - Com	12%	0%	0%	0%	0%	0%
Wind - Res	30%	26%	22%	22%	0%	0%

Federal Investment Tax credit, http://energy.gov/savings/business-energy-investment-tax-credit-itc

STATE INCENTIVES - UT

Technology	2019	2020	2021	2022	2023	2023	>2024
Recip. Engines (%)	10	10	10	10	10	10	10
Micro Turbines (%)	10	10	10	10	10	10	10
Small Hydro (%)	10	10	10	10	10	10	10
PV – Com (%)	10	10	10	10	10	10	10
PV – Res ($)*	$1,600	$1,600	$1,600	$1,200	$800	$400	$0
Wind – Com (%)	10	10	10	10	10	10	10
Wind – Res ($)*	$1,200	$800	$400	$0	$0	$0	$0

*Renewable Energy Systems Tax Credit, Program Cap: Residential cap = $2,000; commercial systems <660kW, no limit

NEM Policy: 90% of offset rates

STATE INCENTIVES - CA

Technology	2019	2020	2021	2022	2023	>2023
Recip. Engines	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0
PV - Com	0	0	0	0	0	0
PV - Res	0	0	0	0	0	0
Wind - Com	0	0	0	0	0	0
Wind - Res	0	0	0	0	0	0

NEM Policy: Full retail rates

STATE INCENTIVES - OR

Technology	2019	2020	2021	2022	2023	>2023
Recip. Engines	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0
PV – Com ($/W)	$0.50-$0.20/W	$0.50-$0.20/W	$0.50-$0.20/W	$0.50-$0.20/W	$0.50-$0.20/W	$0.50-$0.20/W
PV – Res ($/W)	$0.55/W	$0.55/W	$0.55/W	$0.55/W	$0.55/W	$0.55/W
Wind – Com ($/kWh)	0	0	0	0	0	0
Wind – Res ($)	0	0	0	0	0	0

* Energy Trust of Oregon Solar Incentive (capped at $1.5M/year for residential)

Solar Residential: capped at $4,400/system.
NEM Policy: Full Retail

STATE INCENTIVES - WA

Technology	2019	2020	2021	2022	2023	>2023
Recip. Engines	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0
PV – Com ($/kWh)*	$0.04 (+$0.04)	$0.02 (+$0.03)	$0.02 (+$0.02)	0	0	0
PV – Res ($/kWh)*	$0.14 (+$0.04)	$0.12 (+$0.03)	$0.10 (+$0.02)	0	0	0
Wind – Com ($/kWh)*	$0.04 (+$0.04)	$0.02 (+$0.03)	$0.02 (+$0.02)	0	0	0
Wind – Res ($/kWh)*	$0.14 (+$0.04)	$0.12 (+$0.03)	$0.10 (+$0.02)	0	0	0

* Feed-in Tariff: $/kWh for all kWh generated through mid-2020; annually capped at $5,000/year, http://programs.dsireusa.org/system/program/detail/5698

NEM Policy: Full Retail

STATE INCENTIVES - WY

Technology	2019	2020	2021	2022	2023	>2023
Recip. Engines	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0
PV - Com	0	0	0	0	0	0
PV - Res	0	0	0	0	0	0
Wind - Com	0	0	0	0	0	0
Wind - Res	0	0	0	0	0	0

NEM Policy: Full retail rates

STATE INCENTIVES - ID

Technology	2019	2020	2021	2022	2023	>2023
Recip. Engines	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0
PV - Com	0	0	0	0	0	0
PV – Res (%)*	40,20,20,20	40,20,20,20	40,20,20,20	40,20,20,20	40,20,20,20	40,20,20,20
Wind – Com	0	0	0	0	0	0
Wind – Res (%)*	40,20,20,20	40,20,20,20	40,20,20,20	40,20,20,20	40,20,20,20	40,20,20,20

* Residential Alternative Energy Income Tax Deduction: 40% in the first year and 20% for the next three years, http://programs.dsireusa.org/system/program/detail/137

NEM Policy: Full retail rates

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