PACIFICORP 2017 IRP PUBLIC INPUT MEETING PRIVATE GENERATION PRESENTATION

AUGUST 25, 2016

PacifiCorp

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INTRODUCTION

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INTRODUCTION

- Navigant prepared this Long-term Private Generation Resource Assessment on behalf of PacifiCorp.
- The purpose of this study is to support PacifiCorp's 2017 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 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

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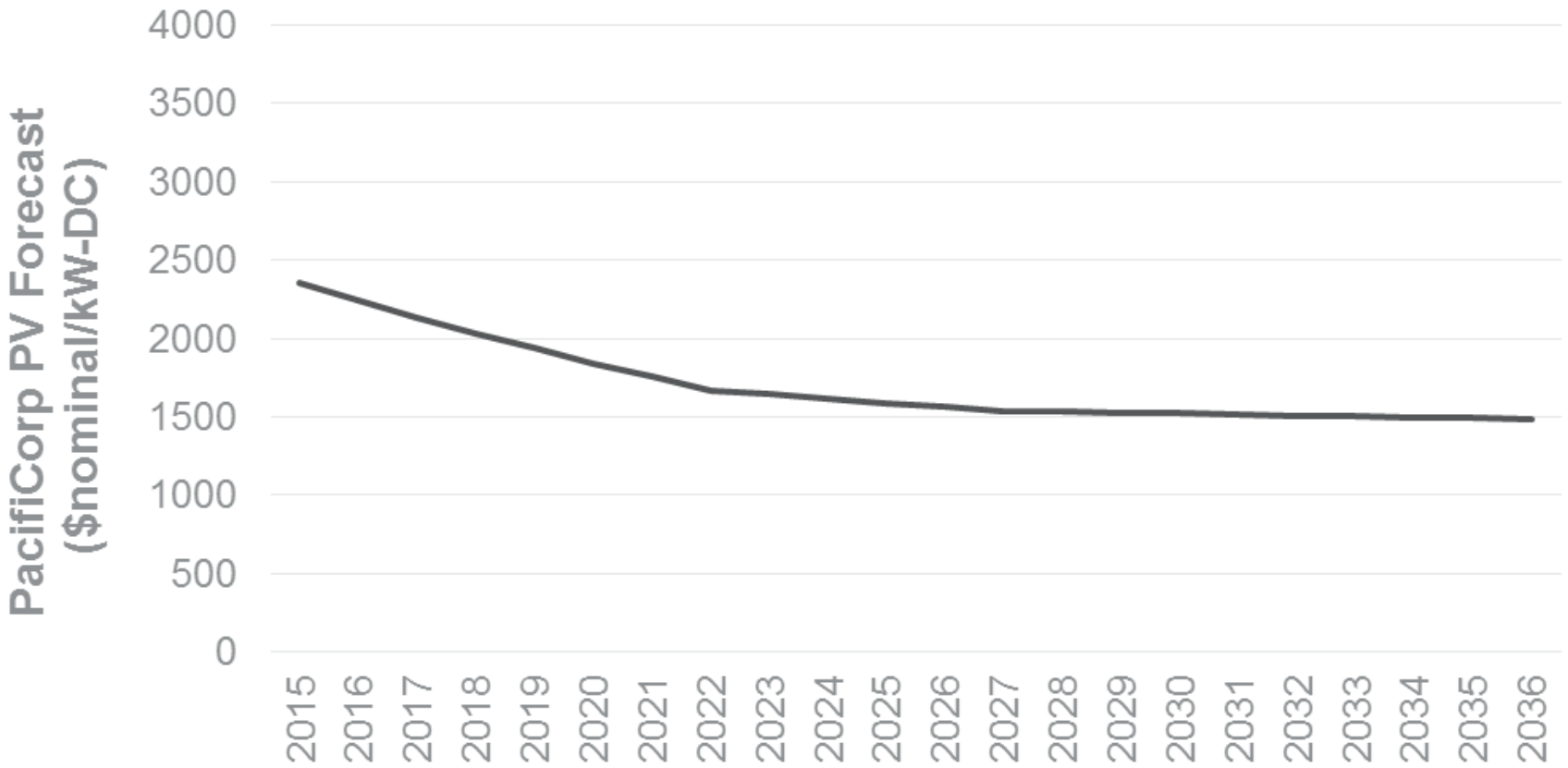
PRIVATE GENERATION TECHNOLOGIES

Resource Cost and Performance	Solar PV	Small-scale Wind	Small-scale Hydro	CHP- Micro-Turbines	CHP- Reciprocating Engines
2017 Installed Cost – Res ($/kW)	UT: $3,000 Other: $3,500	$7,200	NA	NA	NA
2017 Installed Cost – Non-Res ($/kW)	All Markets: $2,300	$6,000	$4,000	$2,690	$2,900
Average Change in Annual Installed Cost (2015-2034) (%)	-2.4% (Res) -2.2% (Non-Res)	0.0%	0.0%	-0.3%	0.4%
Fixed O&M – Res ($/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%	20% (2013) to 25% (2034)	50% ±5%	NA	NA
Fuel Cost	NA	NA	NA	PacifiCorp Gas Forecast	PacifiCorp Gas Forecast
Electric Heat Rate (HHV) (Btu/kWh)	NA	NA	NA	15,535	12,637

NON-RESIDENTIAL SOLAR SYSTEM COSTS, 2015-2036



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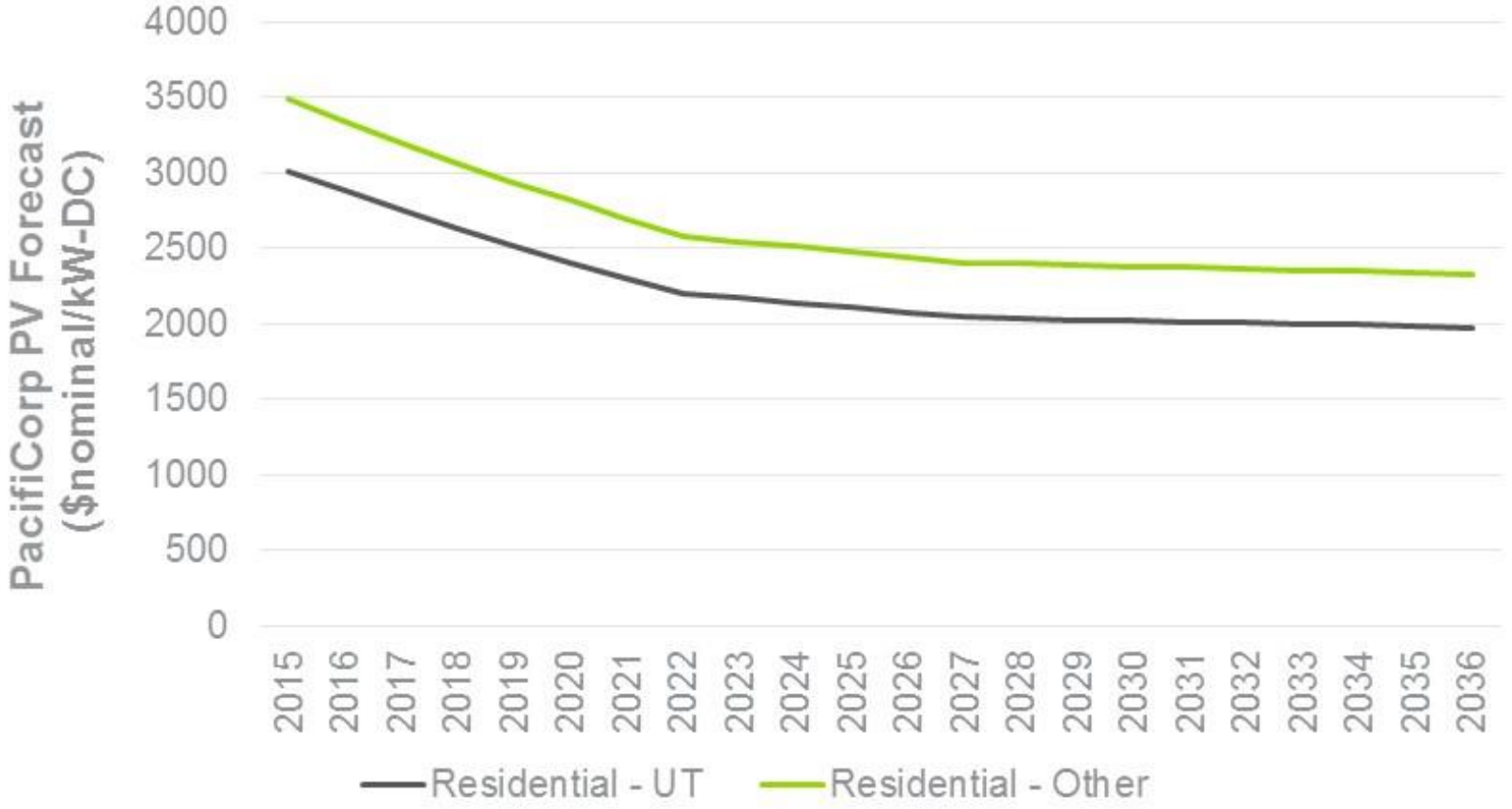
RESIDENTIAL SOLAR SYSTEM COSTS, 2015-2036



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METHODOLOGY

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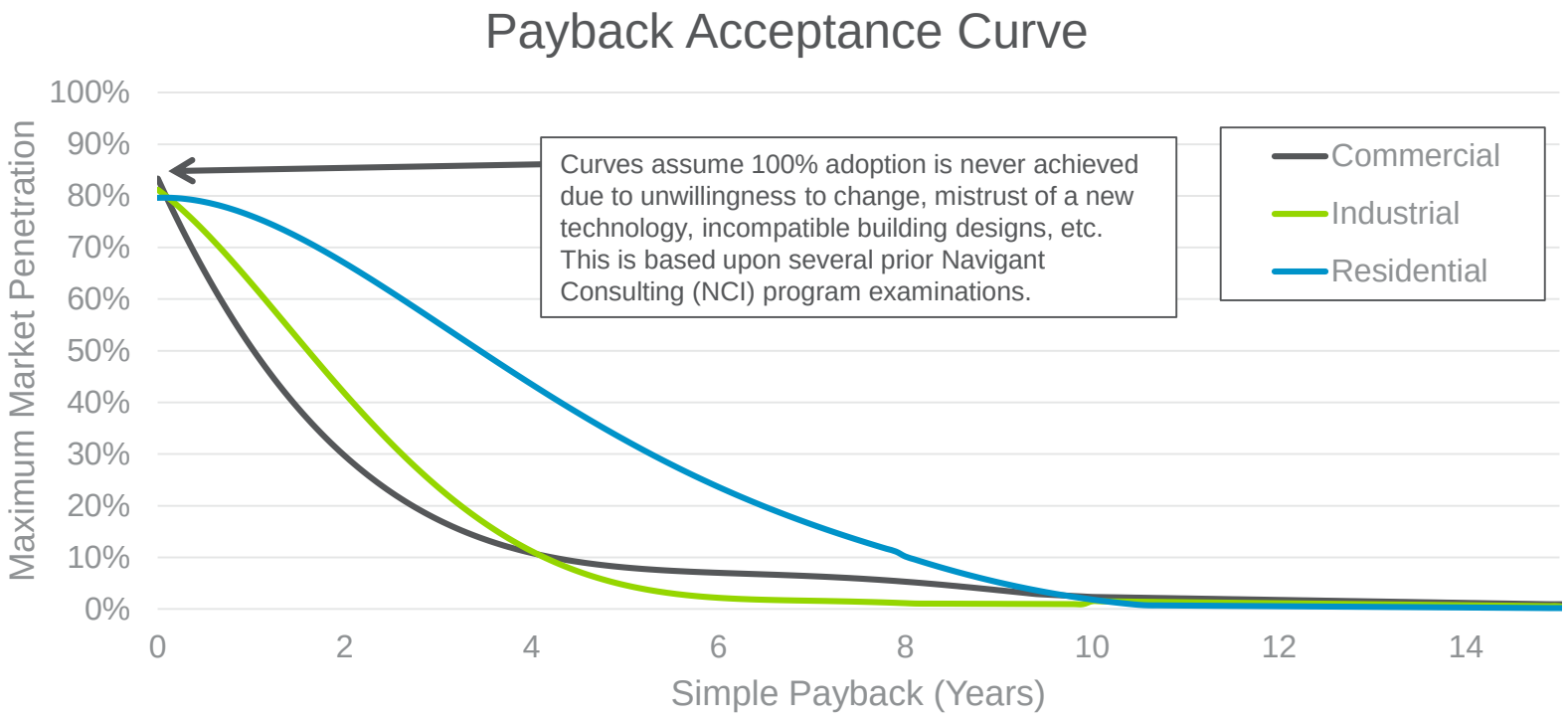
METHODOLOGY

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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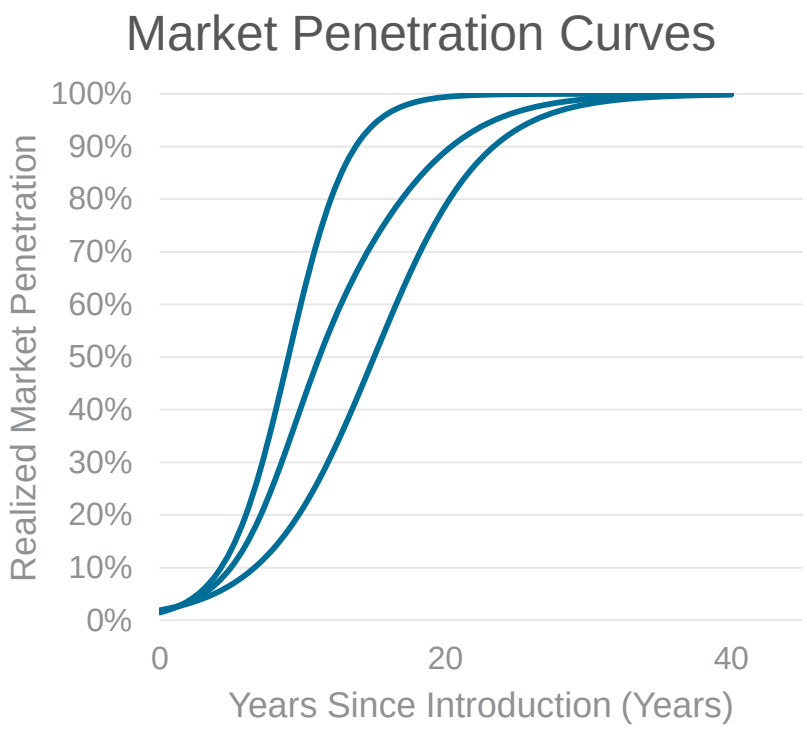
MARKET PENETRATION

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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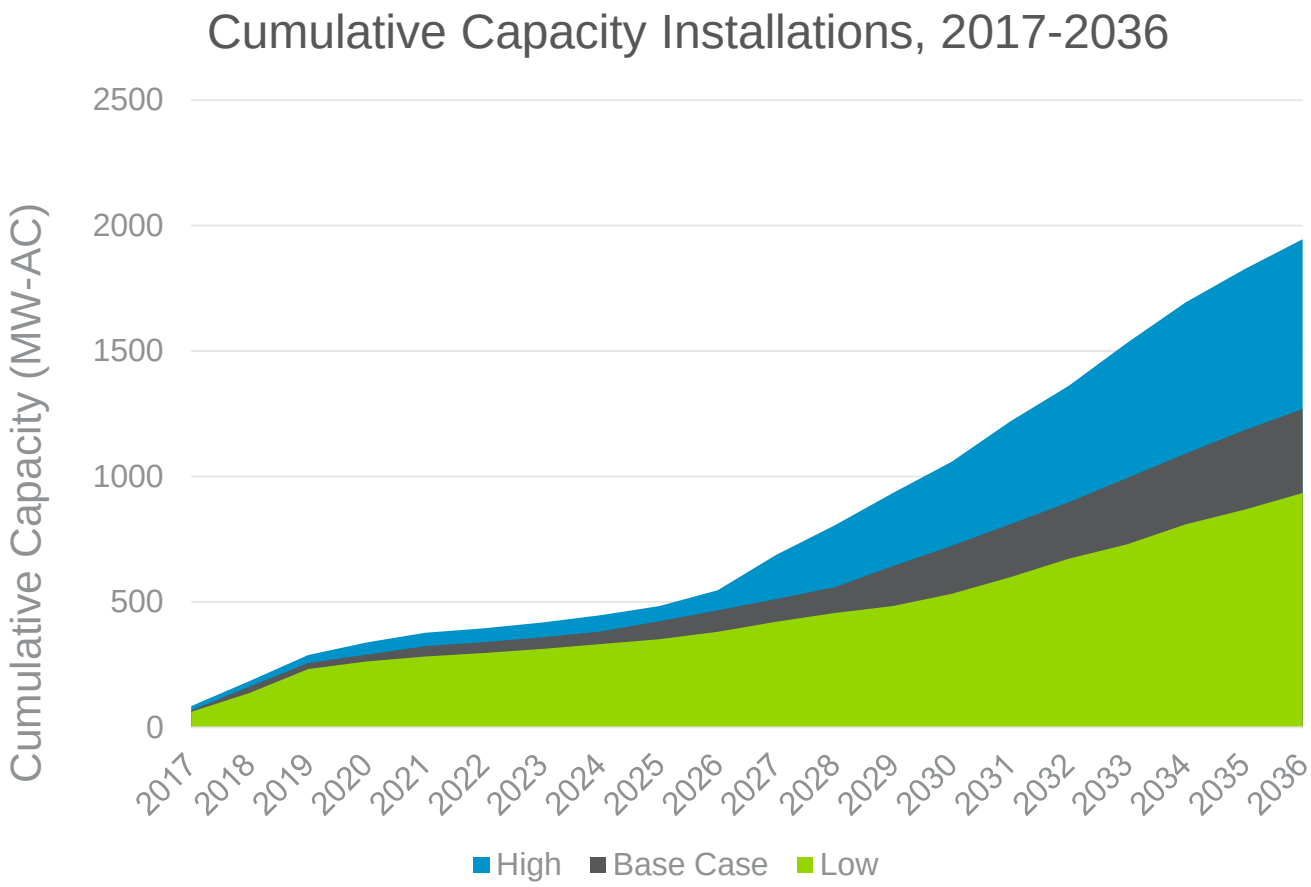
SCENARIO ASSUMPTIONS

Scenarios			
Cases	Technology Costs	Performance	Electricity Rates
Base Case	• See technology and cost section	• As modeled	• Increase at inflation rate, assumed at 1.9%
Low Penetration	• PV: Same as Base Case • Other: Mature technologies. Same as base case	• PV: Same as Base Case • Other: 5% worse	• -0.5%/year, relative to the base case
High Penetration	• PV: 2X steeper cost reduction/year • Other: Mature technologies. Same as base case	• Reciprocating Engines: 0.5% better (mature) • Micro-turbines: 2% better • Hydro: 5% better (reflecting wide performance distribution uncertainty) • PV/Wind: 1% better (relatively mature)	• +0.5%/year, relative to the base case

PRIVATE GENERATION – ALL CASES AND STATES



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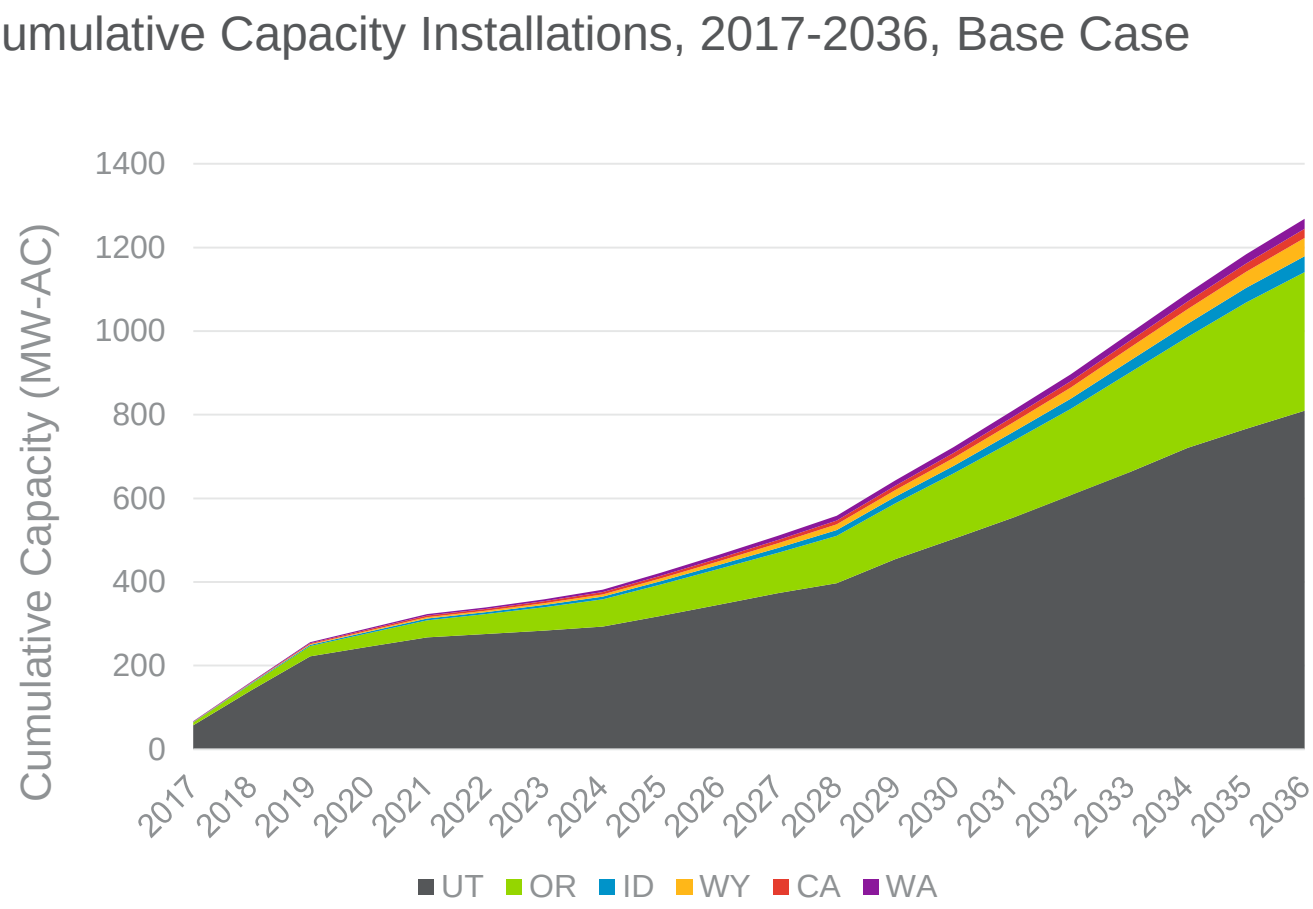
PRIVATE GENERATION – BASE CASE



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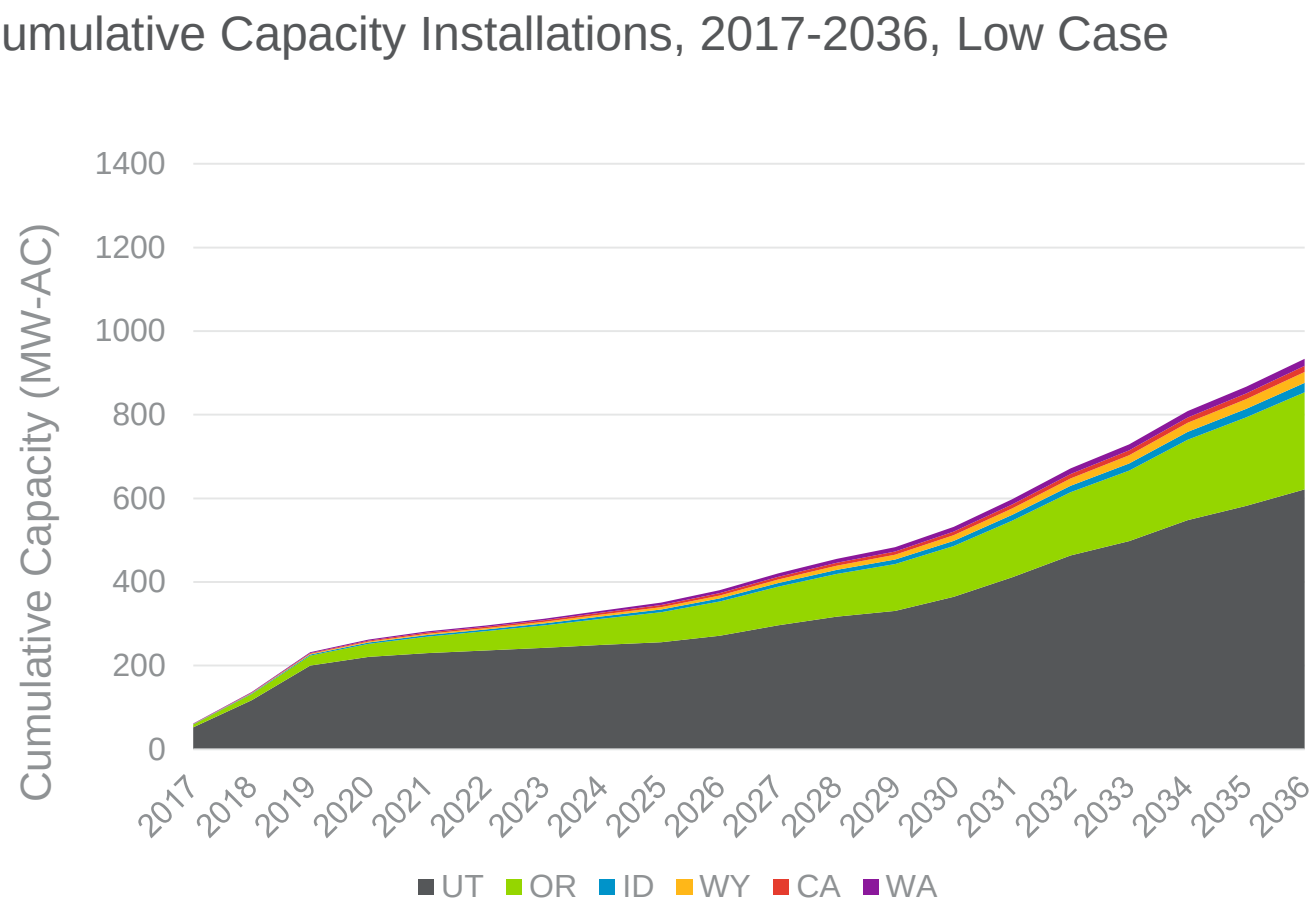
PRIVATE GENERATION – LOW CASE



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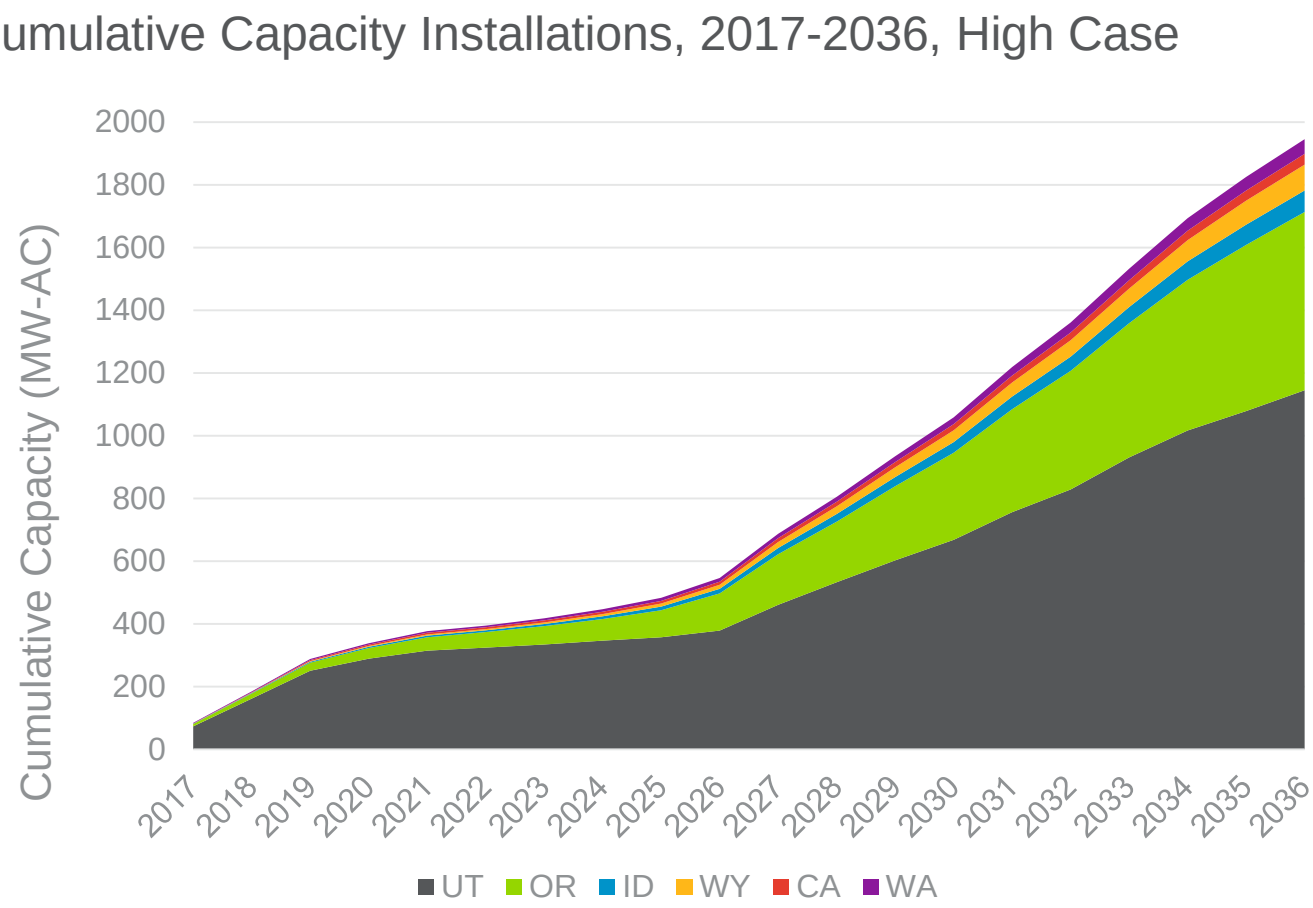
PRIVATE GENERATION – HIGH CASE



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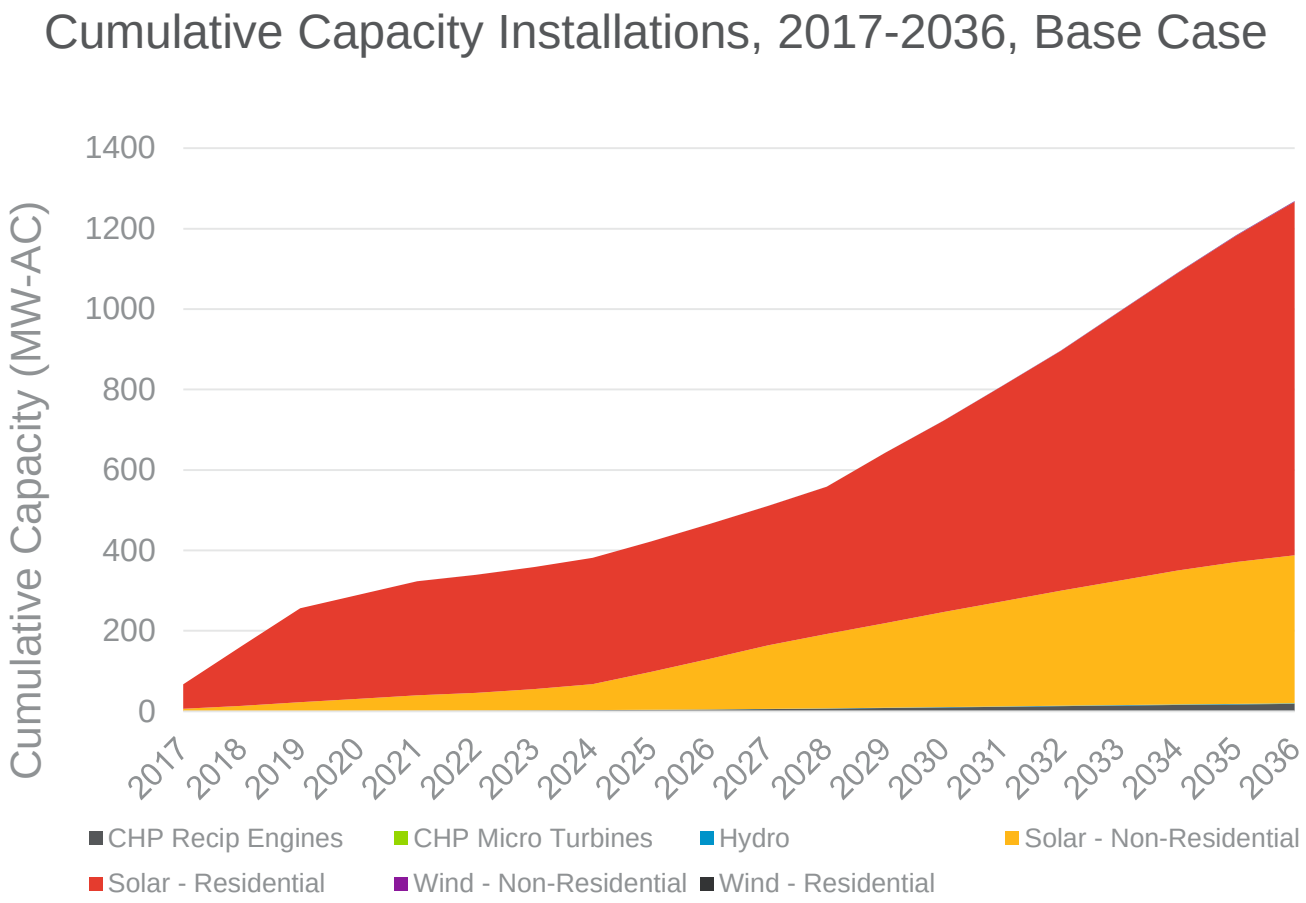
PRIVATE GENERATION – BASE CASE



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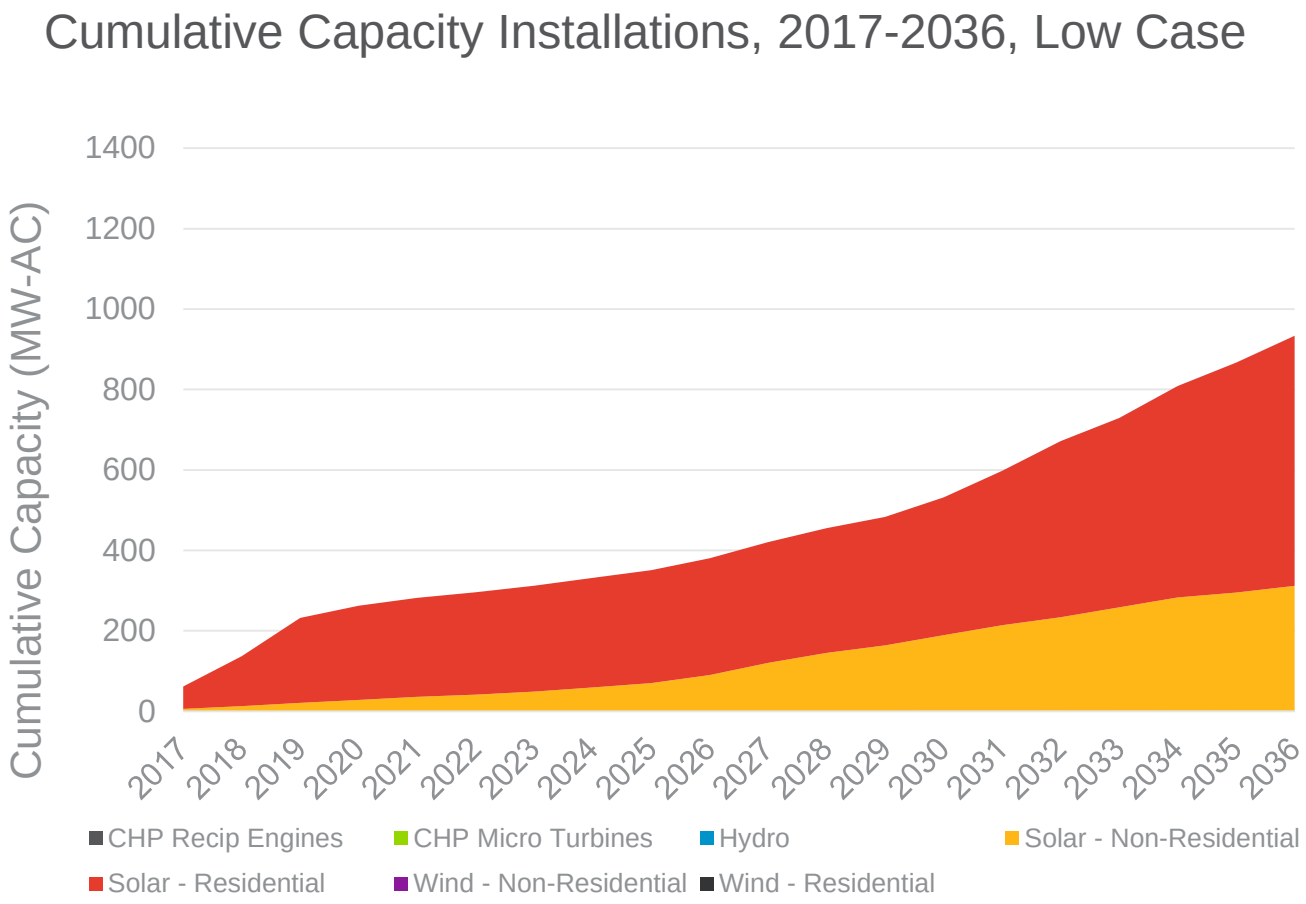
PRIVATE GENERATION – LOW CASE



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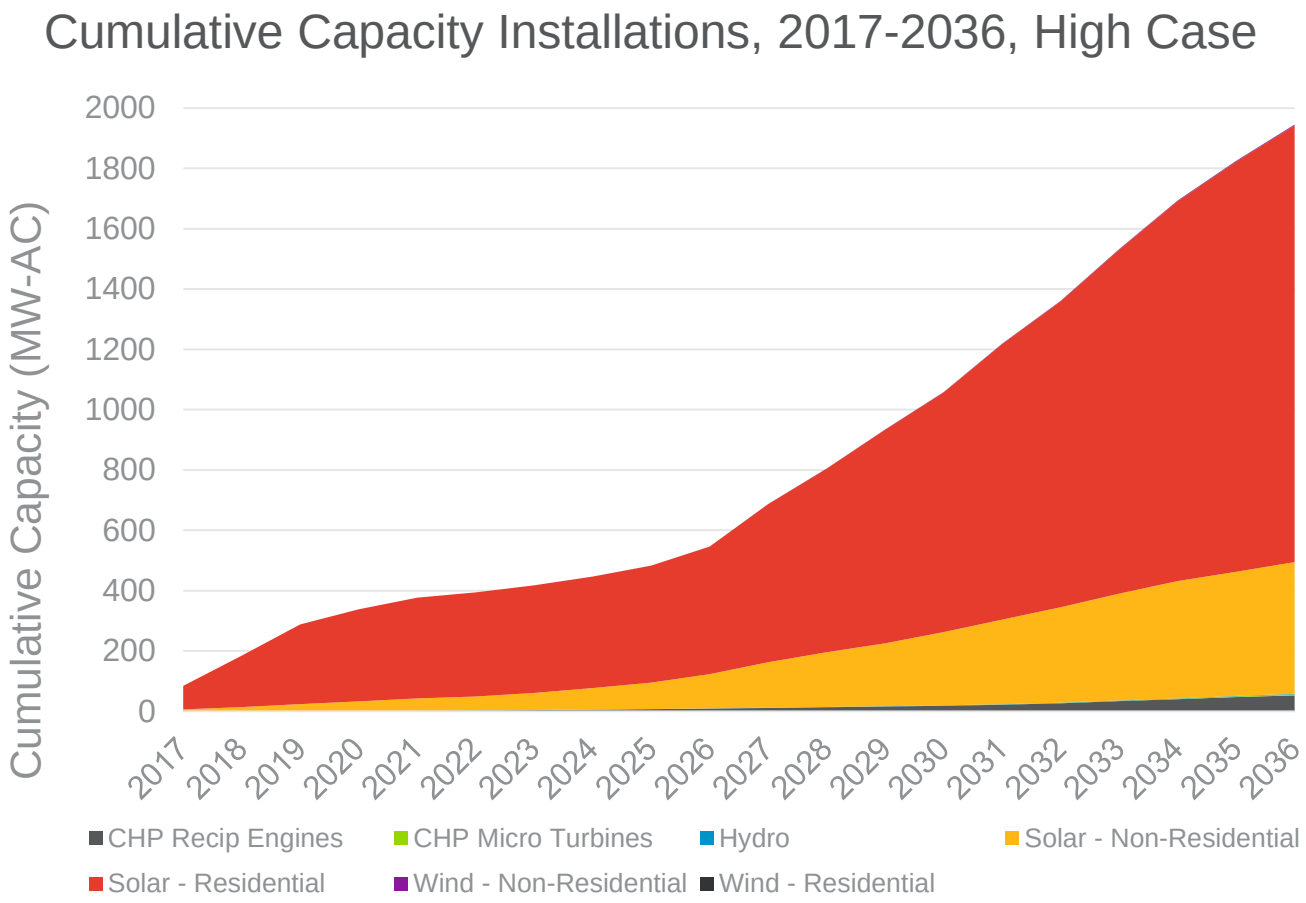
PRIVATE GENERATION – HIGH CASE



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COMPARISON TO 2014 STUDY

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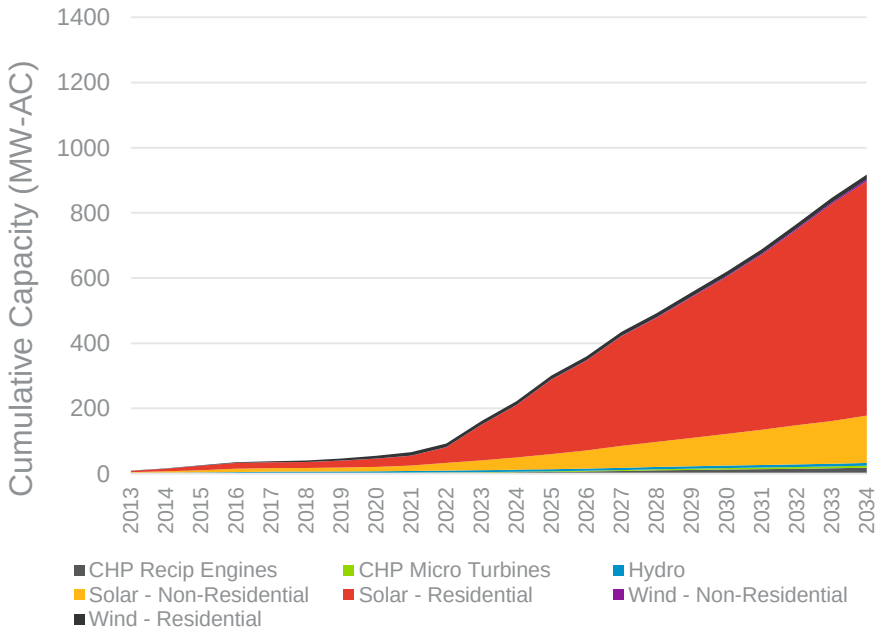
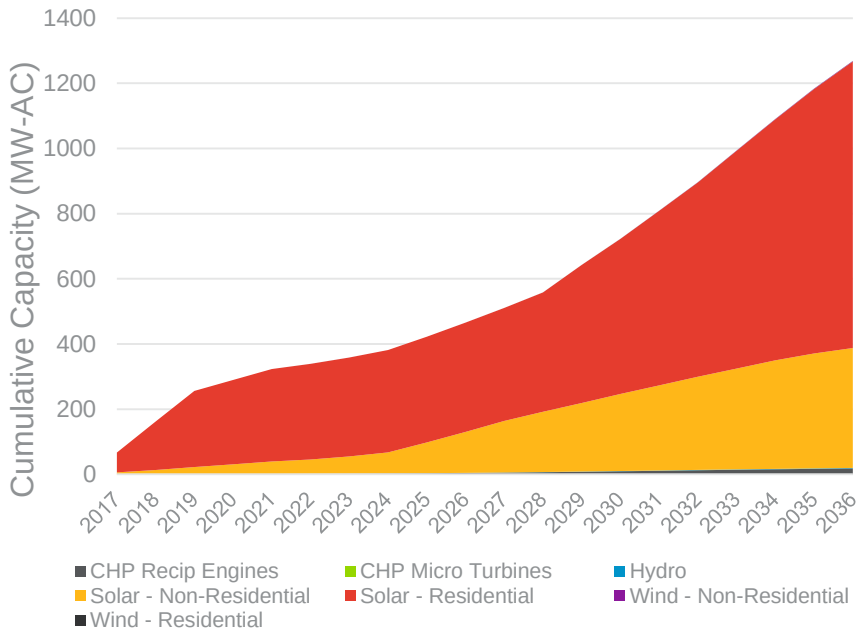
COMPARISON TO 2014 STUDY RESULTS

Since the 2014 study, projected PV capacity is expected to grow at a faster rate. The main reasons for the change in adoption include larger than projected PV system cost declines and the extension of state incentives and the Federal ITC.

Cumulative Market Penetration Results by Technology (MW-AC), 2013 – 2034, Base Case (2014 Study)



Cumulative Market Penetration Results by Technology (MW-AC), 2017 – 2036, Base Case (Current Study)



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APPENDIX

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FEDERAL INCENTIVES

Technology	2016	2017	2018	2019	2020	2021	>2021
Recip. Engines	10%	0%	0%	0%	0%	0%	0%
Micro Turbines	10%	0%	0%	0%	0%	0%	0%
Small Hydro	0%	0%	0%	0%	0%	0%	0%
PV - Com	30%	30%	30%	30%	26%	22%	10%
PV - Res	30%	30%	30%	30%	26%	22%	0%
Wind - Com	30%	0%	0%	0%	0%	0%	0%
Wind - Res	30%	0%	0%	0%	0%	0%	0%

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

STATE INCENTIVES - UT

Technology	2016	2017	2018	2019	2020	2021	>2021
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 ($)*	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Wind – Com (%)	10	10	10	10	10	10	10
Wind – Res ($)*	2,000	2,000	2,000	2,000	2,000	2,000	2,000

Renewable Energy Systems Tax Credit, http://programs.dsireusa.org/system/program/detail/83

***Program Cap:** Residential cap = $2,000; commercial systems <660kW, no limit

** The Utah Renewable Energy Systems Tax Credit is assumed for the purpose of this report to continue at its current incentive level. The timing and value of any possible changes to the state tax credit remain unclear.

STATE INCENTIVES - CA

Technology	2016	2017	2018	2019	2020	2021	>2021
Recip. Engines	0	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0	0
PV - Com	0	0	0	0	0	0	0
PV - Res	0	0	0	0	0	0	0
Wind - Com	0	0	0	0	0	0	0
Wind - Res	0	0	0	0	0	0	0

STATE INCENTIVES - OR

Technology	2016	2017	2018	2019	2020	2021	>2021
Recip. Engines	0	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0	0
PV – Com ($/W)*	0.81	0.78	0.75	0.72	0.69	0.66	0.63
PV – Res ($/W)*& ($/system)**	0.62 (6,000)	0.60 (6,000)	0.57 (6,000)	0.55 (6,000)	0.52 (6,000)	0.50 (6,000)	0.48 (6,000)
Wind – Com ($/kWh)	0	0	0	0	0	0	0
Wind – Res ($/system)**	6,000	6,000	6,000	6,000	6,000	6,000	6,000

* Energy Trust Solar Incentive (capped at $2M/year for residential and $1.6M/year for non-residential)

** Residential Energy Tax Credit - $6,000 over the life of the system, distributed $1,500/yr. in first four years. http://programs.dsireusa.org/system/program/detail/638

*** The Residential Energy Tax Credit (RETC), in its current legislative form, is set to expire at the end of 2017. It is not yet known whether the Oregon Legislature will extend the RETC beyond 2017. Similarly, should the RETC be extended beyond 2017, it is not known if it would have the same value or eligibility criteria. However, for purposes of this analysis, it was assumed that the RETC will be extended beyond 2017 with the same value and eligibility criteria as exists as of the date of this report.

STATE INCENTIVES - WA

Technology	2016	2017	2018	2019	2020	2021	>2021
Recip. Engines	0	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0	0
PV – Com ($/kWh)*	0.15	0.15	0.15	0.15	0.08	0	0
PV – Res ($/kWh)*	0.15	0.15	0.15	0.15	0.08	0	0
Wind – Com ($/kWh)*	0.12	0.12	0.12	0.12	0.06	0	0
Wind – Res ($/kWh)*	0.12	0.12	0.12	0.12	0.06	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

STATE INCENTIVES - WY

Technology	2016	2017	2018	2019	2020	2021	>2021
Recip. Engines	0	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0	0
PV - Com	0	0	0	0	0	0	0
PV - Res	0	0	0	0	0	0	0
Wind - Com	0	0	0	0	0	0	0
Wind - Res	0	0	0	0	0	0	0

STATE INCENTIVES - ID

Technology	2016	2017	2018	2019	2020	2021	>2021
Recip. Engines	0	0	0	0	0	0	0
Micro Turbines	0	0	0	0	0	0	0
Small Hydro	0	0	0	0	0	0	0
PV - Com	0	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	40,20,20,20
Wind – Com	0	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	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.

