Scenarios 1B and 2C Key Findings

Scenario 1B – Current Policy

- Least Cost vs. Least Risk
  - Least cost strategy already has low risk, additional risk reduction comes at a high cost relative to the reduction in risk
  - Least cost range is from around $50 billion to $177 billion with a mean at $79.6 billion
  - Least risk range is from around $60 billion to $171 billion with a mean at $83 billion

Scenario 1B – Current Policy

- Adequacy and RPS drives builds
  - The planning period starts not meeting adequacy standards in many of the futures
    - DR is optioned because it has a shorter lead time than generation options, small incremental resource size and low cost
  - Economic builds are few and far between
    - Economic builds occur in less than 1% of futures in the least cost resource strategy
  - Thermal build options selected for adequacy seem related to retirements of Boardman and Centralia
    - Gas peaking options in 2021 lead to a build mid 2022 and combined cycle options in 2023 lead to a build in 2025
  - REC banking delays the need for constructing renewables until well past the action plan period

Scenario 2C – Carbon Risk

- Least Cost vs. Least Risk
  - Similar to 1B, reduction in risk comes at a relatively high cost
  - Least cost range is from $57 billion to $257 billion with a mean at $104.7 billion
  - Least risk range is from $59 billion to $249 billion with a mean at $106.1 billion

Note that comparison of the "net system cost" and "system risk" for Scenarios 1B and 2C must recognize that "carbon costs" are included in 2C and not in 1B

Scenario 2C – Carbon Risk

- In the least cost strategy the thermal options selected are all combined cycle gas plants, no gas peaking plant is selected
- DR still plays a major role in the resource strategy
- Conservation by the end of the study supplies around 80% of the capacity added to the system

Comparing 1B and 2C

- Conservation
  - Action plan period has 50 to 70 aMW more conservation purchased in 2C when comparing least cost strategies
  - Over the 20-year study, 2C has around 500 aMW more conservation when comparing least cost strategies
- DR looks substantively similar in both scenarios

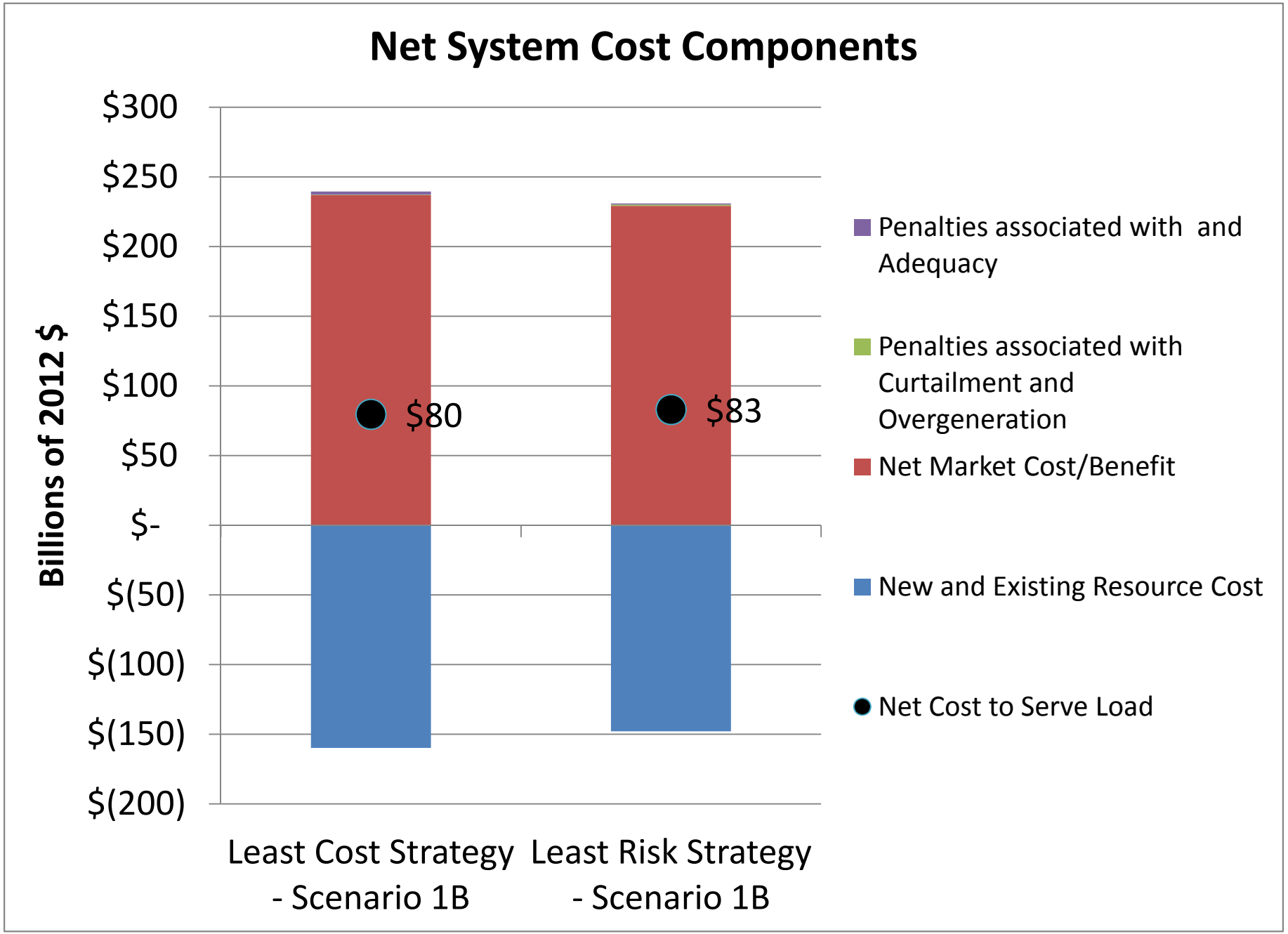
Comparing 1B and 2C

- Thermal Options
  - In the Carbon Risk scenario more efficient combined cycle combustion turbines are selected rather than peaking units
  - In the Carbon Risk scenario Economic builds increase significantly which is likely based on market price impacts of CO2 tax
- Existing Dispatch
  - Existing units with associated carbon emissions have a much lower dispatch over the planning period

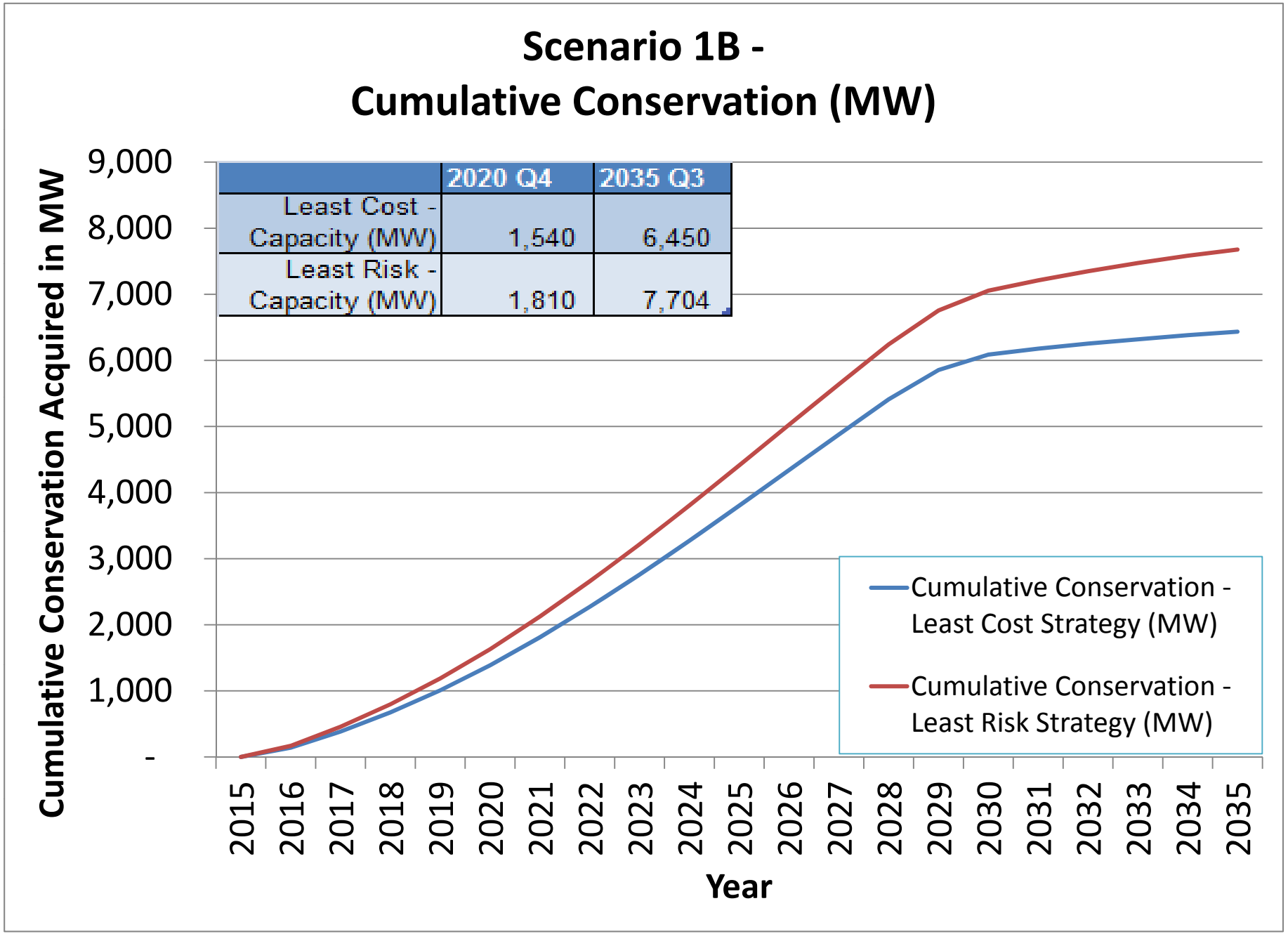
Comparing 1B and 2C

- Carbon emissions are significantly reduced
  - Total aggregated study emissions are around 65% of the emissions in 1B
  - On average 80% of the $25 billion difference in net system cost between 1B and 2C is due to the assumed cost of carbon
    - This assumes that exports are treated as an increase to regional revenues that offset carbon cost expenses


Least Cost Strategy vs Least Risk Strategy
Probability
Net System Cost - ($2012 billions)
28
35
41
48
55
62
69
76
82
89
96
103
110
117
123
130
137
144
151
157
164
171
178
185
192
Least Cost Strategy - Scenario 1B
Least Risk Strategy - Scenario 1B
Mean
System Risk
Mean
System Risk

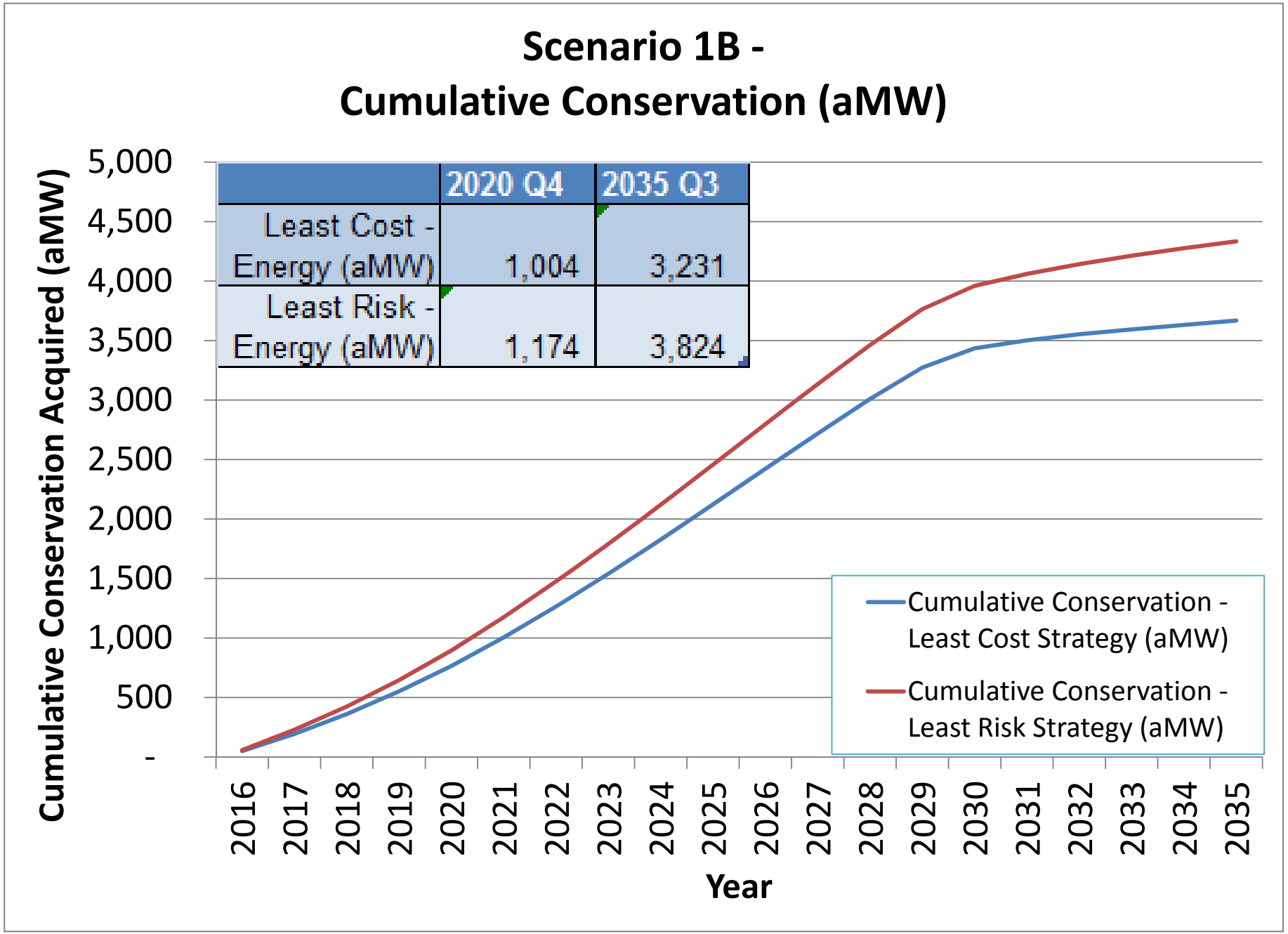

Net System Cost Components
Billions of 2012 $
$300
$250
$200
$150
$100
$50
$-
$(50)
$(100)
$(150)
$(200)
$80
$83
Least Cost Strategy - Scenario 1B
Least Risk Strategy - Scenario 1B
Penalties associated with and Adequacy
Penalties associated with Curtailment and Overgeneration
Net Market Cost/Benefit
New and Existing Resource Cost
Net Cost to Serve Load

Scenario 1B - Cumulative Conservation (MW)

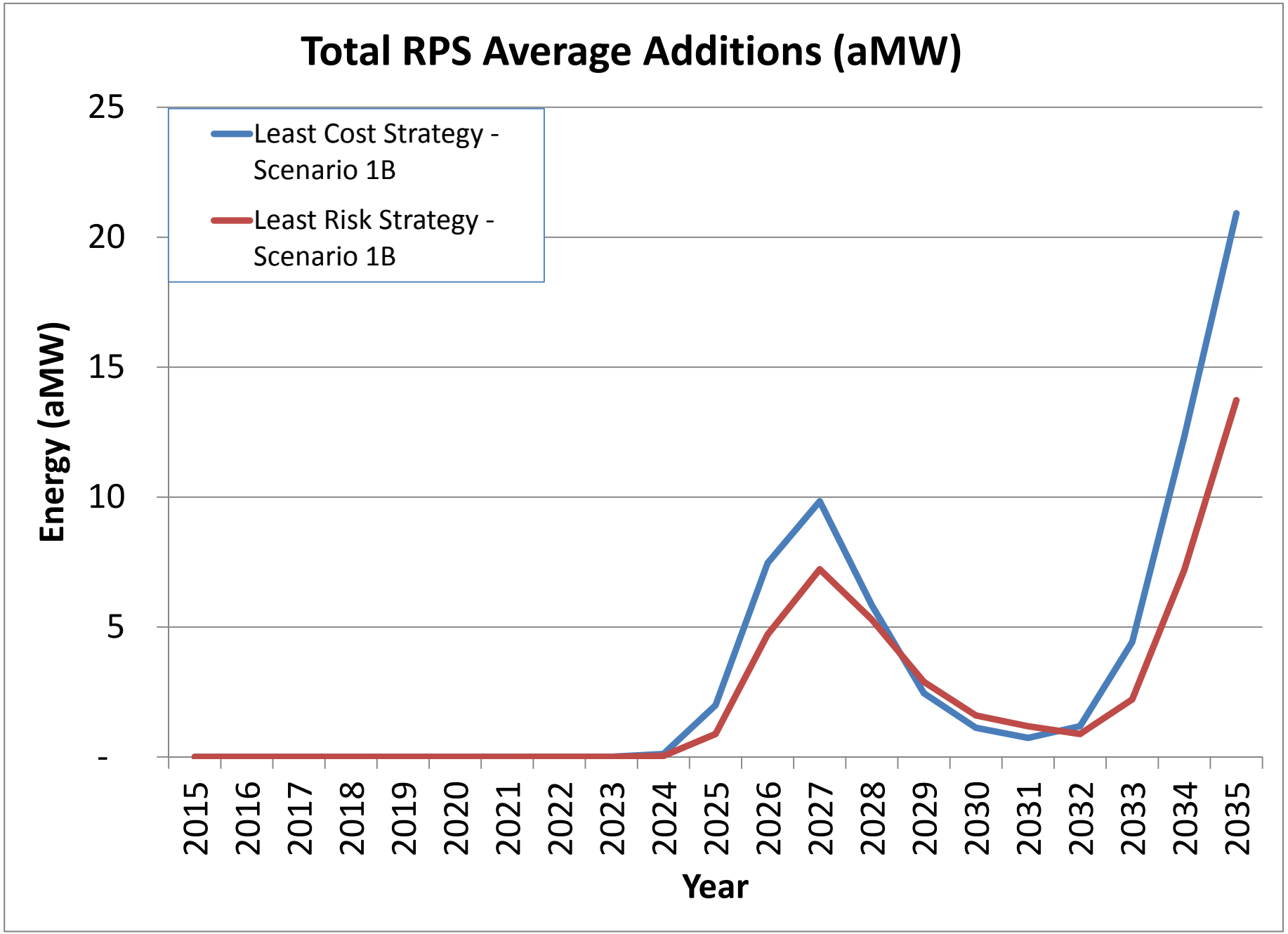


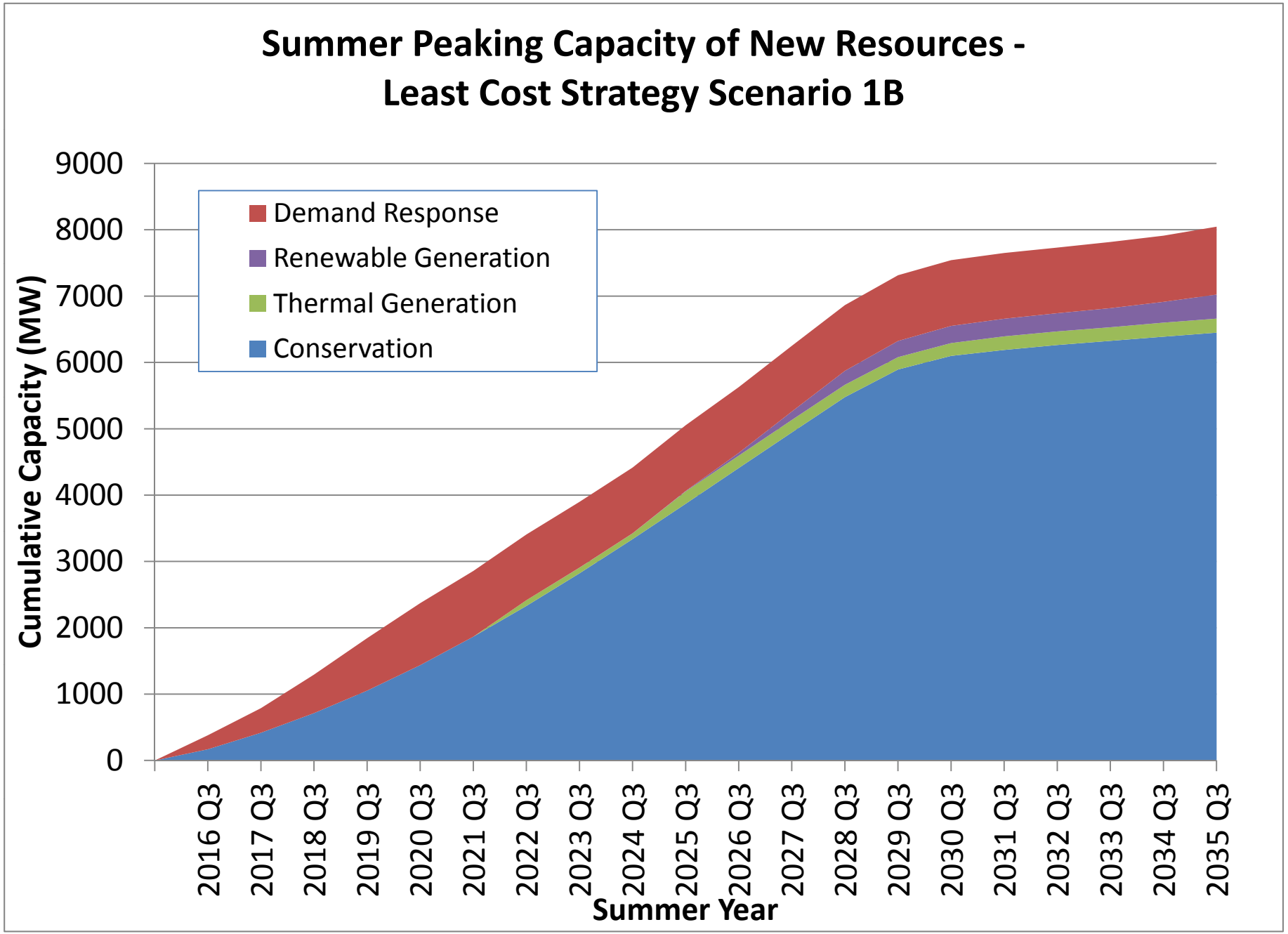
	2020 Q4	2035 Q3
Least Cost - Capacity (MW)	1,540	6,450
Least Risk - Capacity (MW)	1,810	7,704

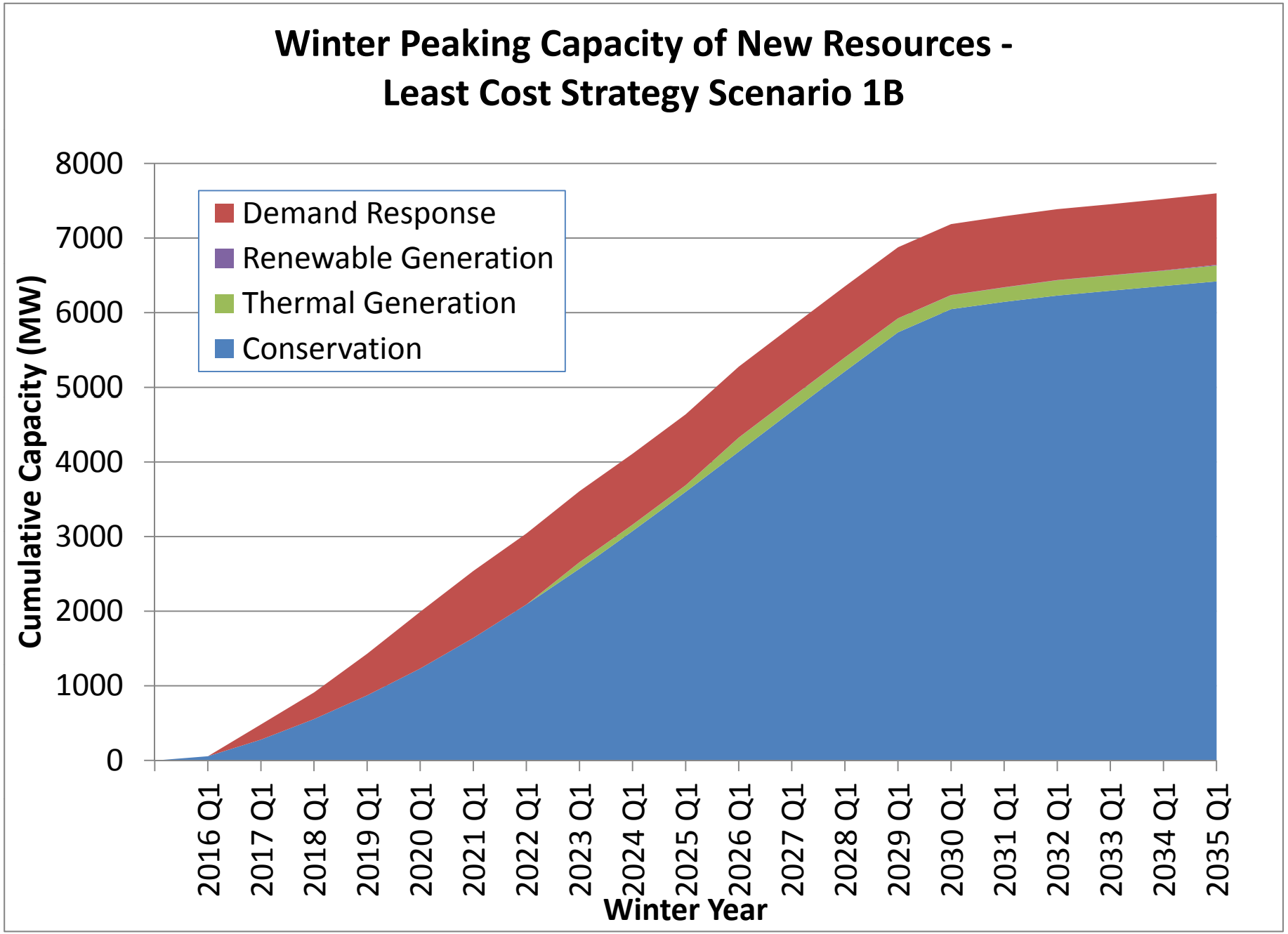
Scenario 1B - Cumulative Conservation (aMW)

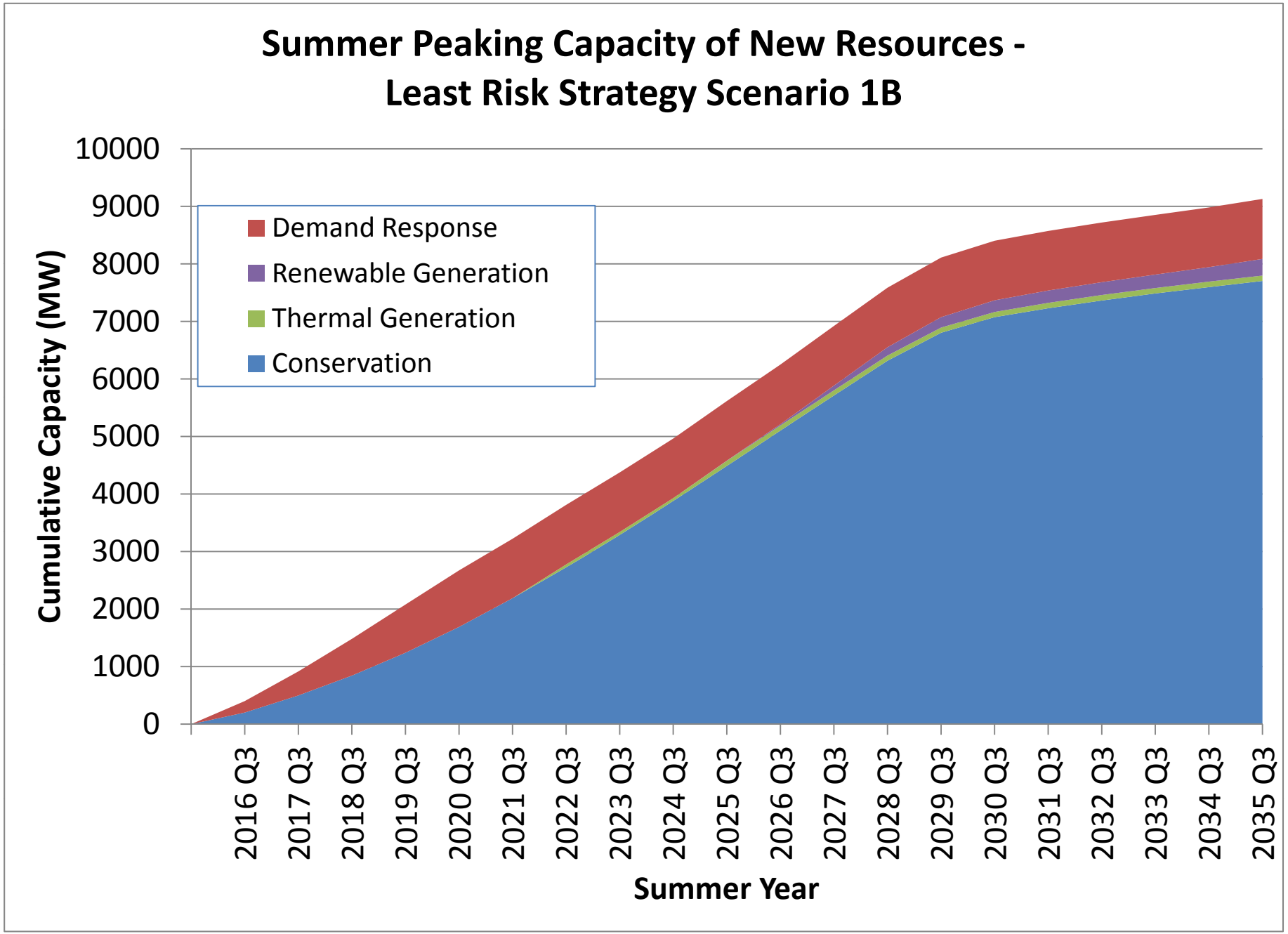


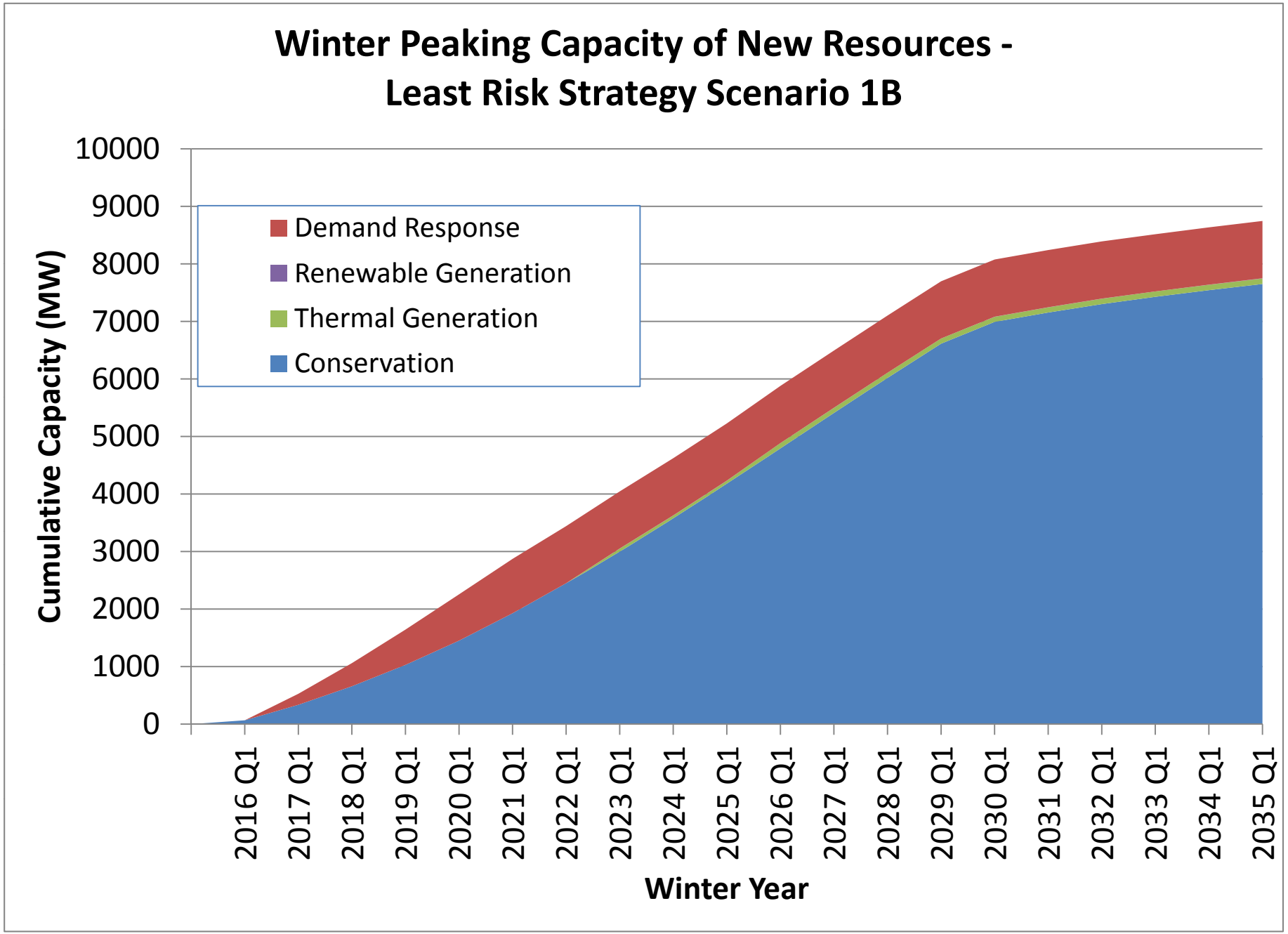
	2020 Q4	2035 Q3
Least Cost - Energy (aMW)	1,004	3,231
Least Risk - Energy (aMW)	1,174	3,824

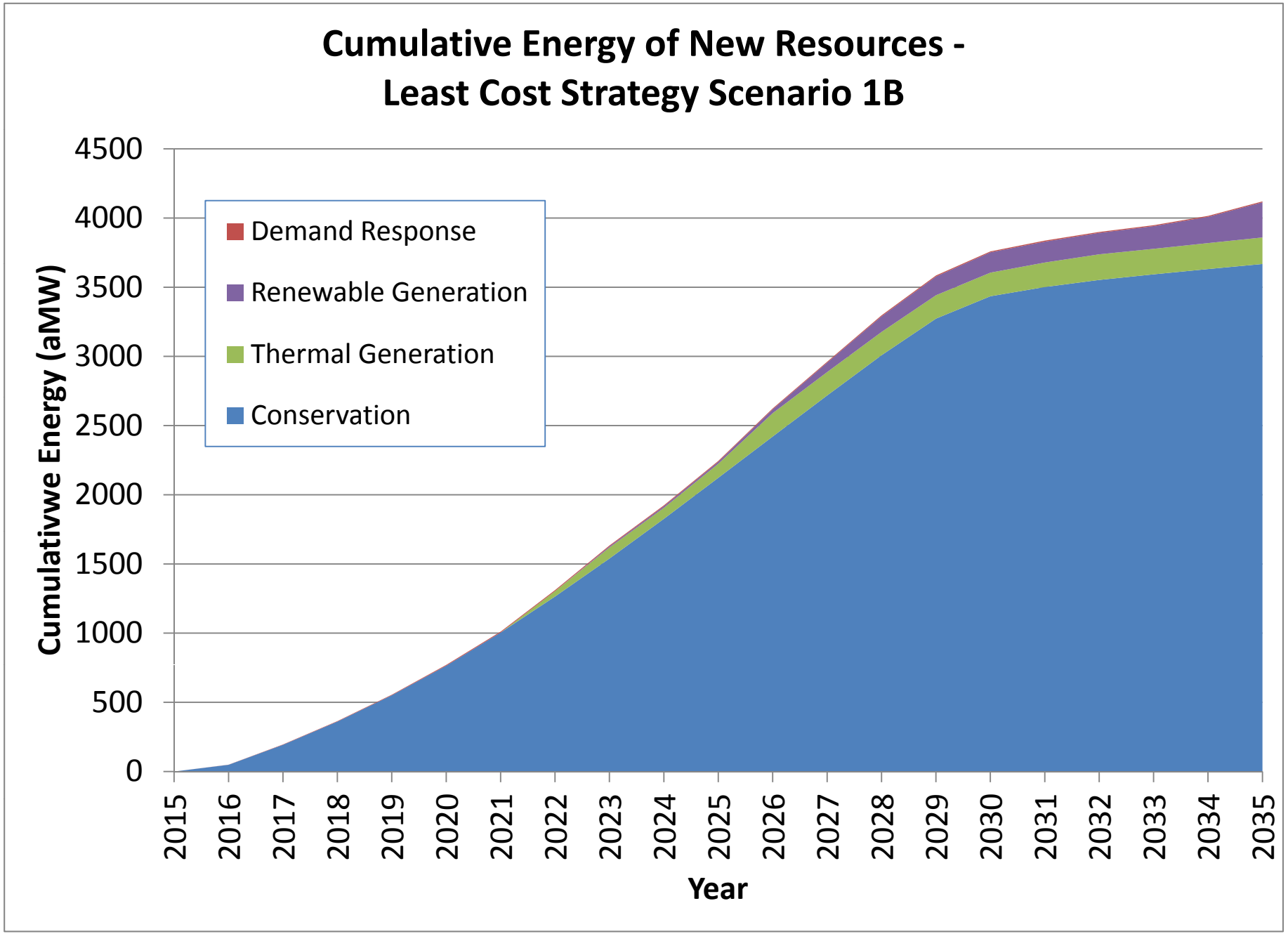

Total RPS Average Additions (aMW)
Least Cost Strategy - Scenario 1B
Least Risk Strategy - Scenario 1B
Energy (aMW)
25
20
15
10
5
-
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
Year

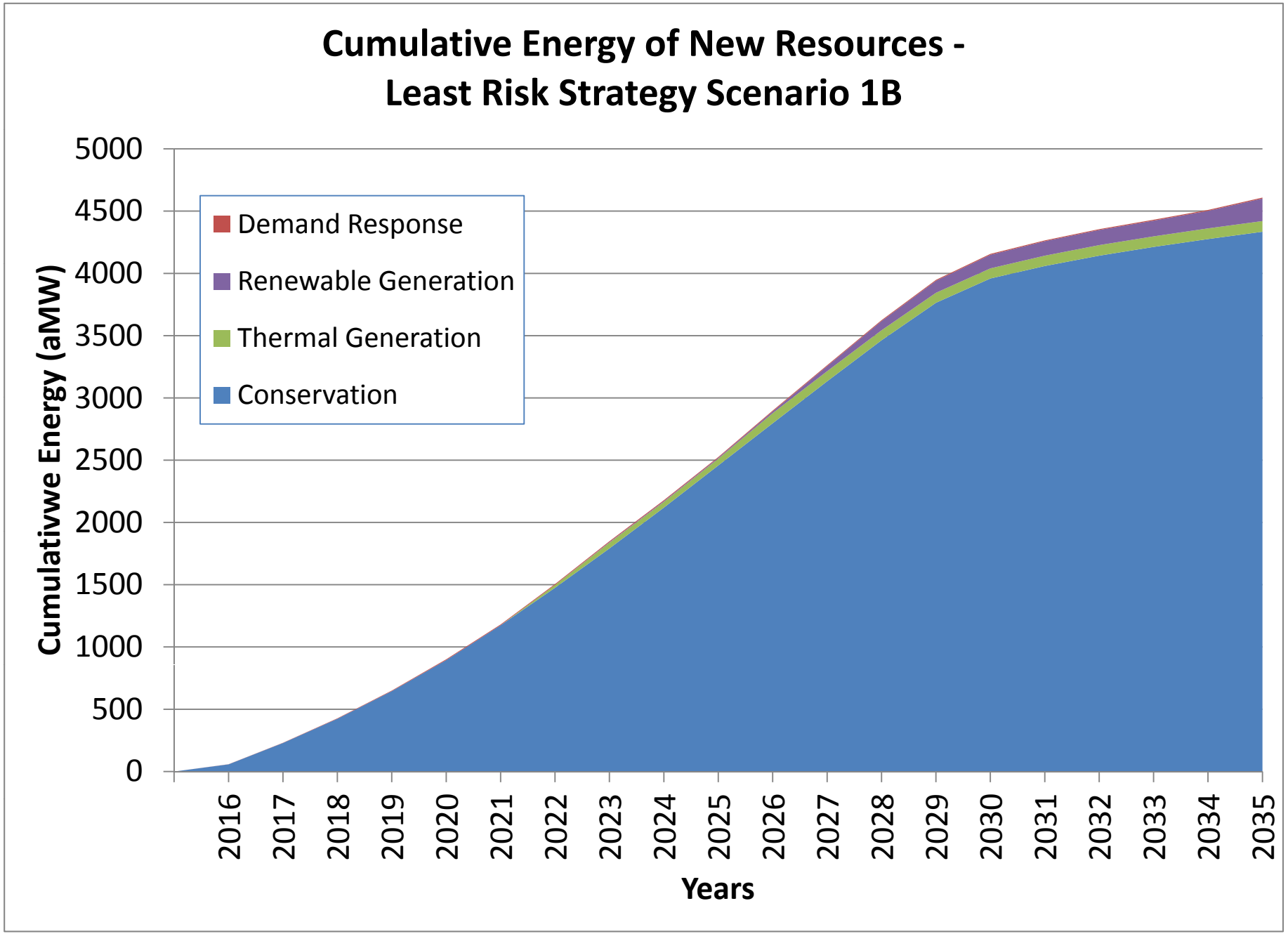

Summer Peaking Capacity of New Resources -
Least Cost Strategy Scenario 1B
Cumulative Capacity (MW)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016 Q3
2017 Q3
2018 Q3
2019 Q3
2020 Q3
2021 Q3
2022 Q3
2023 Q3
2024 Q3
2025 Q3
2026 Q3
2027 Q3
2028 Q3
2029 Q3
2030 Q3
2031 Q3
2032 Q3
2033 Q3
2034 Q3
2035 Q3
Summer Year

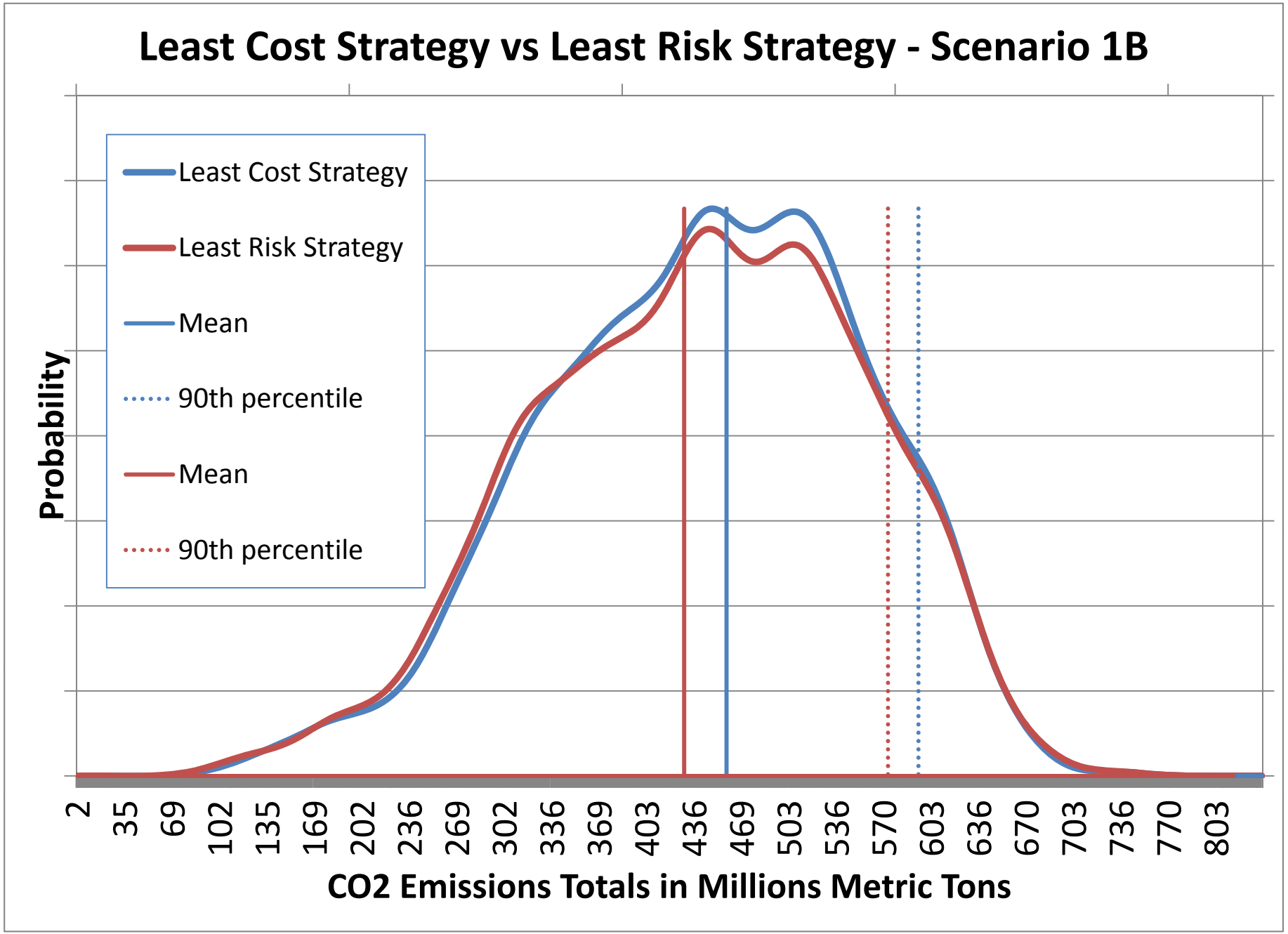

Winter Peaking Capacity of New Resources -
Least Cost Strategy Scenario 1B
Cumulative Capacity (MW)
8000
7000
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016 Q1
2017 Q1
2018 Q1
2019 Q1
2020 Q1
2021 Q1
2022 Q1
2023 Q1
2024 Q1
2025 Q1
2026 Q1
2027 Q1
2028 Q1
2029 Q1
2030 Q1
2031 Q1
2032 Q1
2033 Q1
2034 Q1
2035 Q1
Winter Year

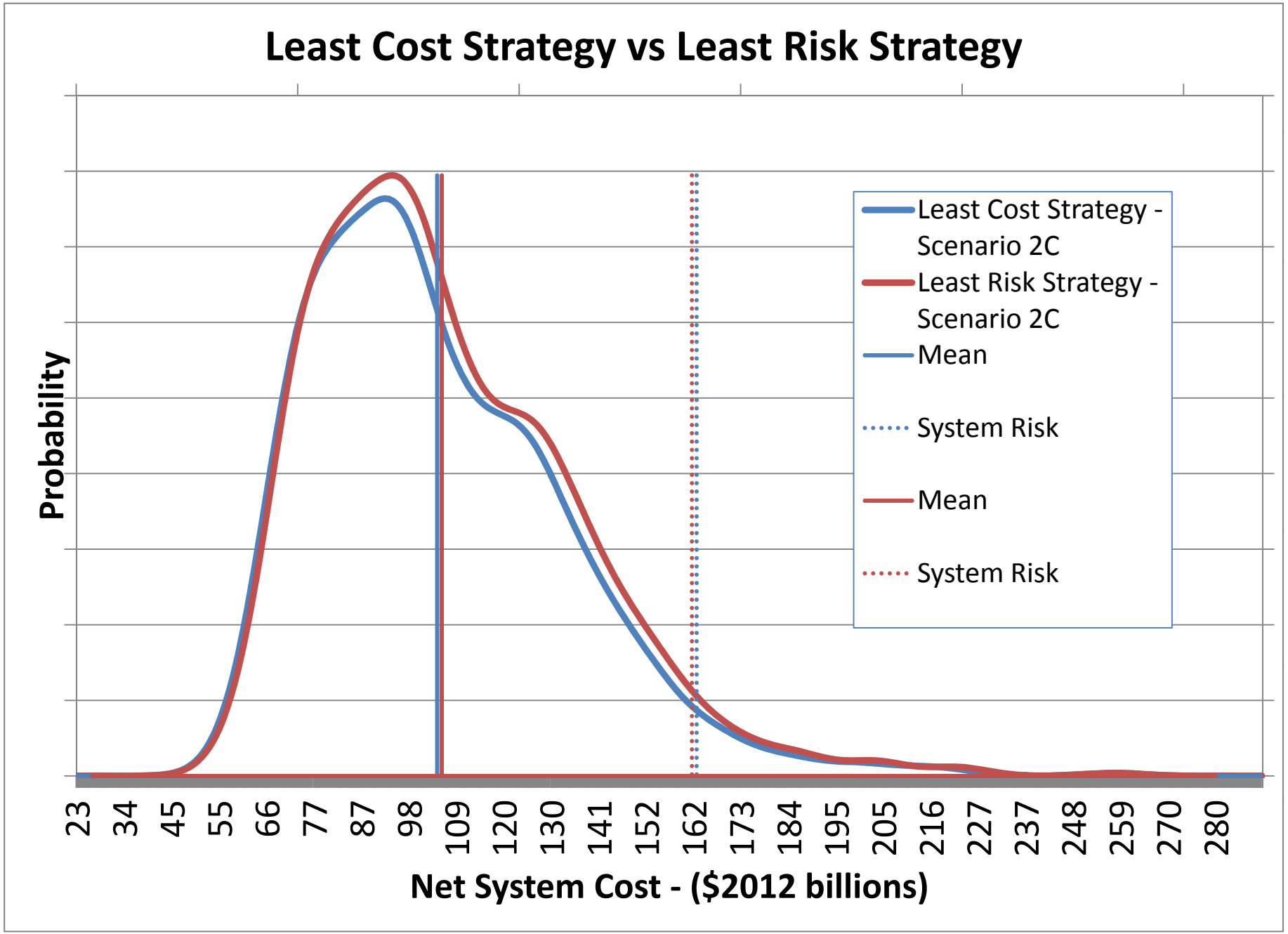

Summer Peaking Capacity of New Resources -
Least Risk Strategy Scenario 1B
Cumulative Capacity (MW)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016 Q3
2017 Q3
2018 Q3
2019 Q3
2020 Q3
2021 Q3
2022 Q3
2023 Q3
2024 Q3
2025 Q3
2026 Q3
2027 Q3
2028 Q3
2029 Q3
2030 Q3
2031 Q3
2032 Q3
2033 Q3
2034 Q3
2035 Q3
Summer Year

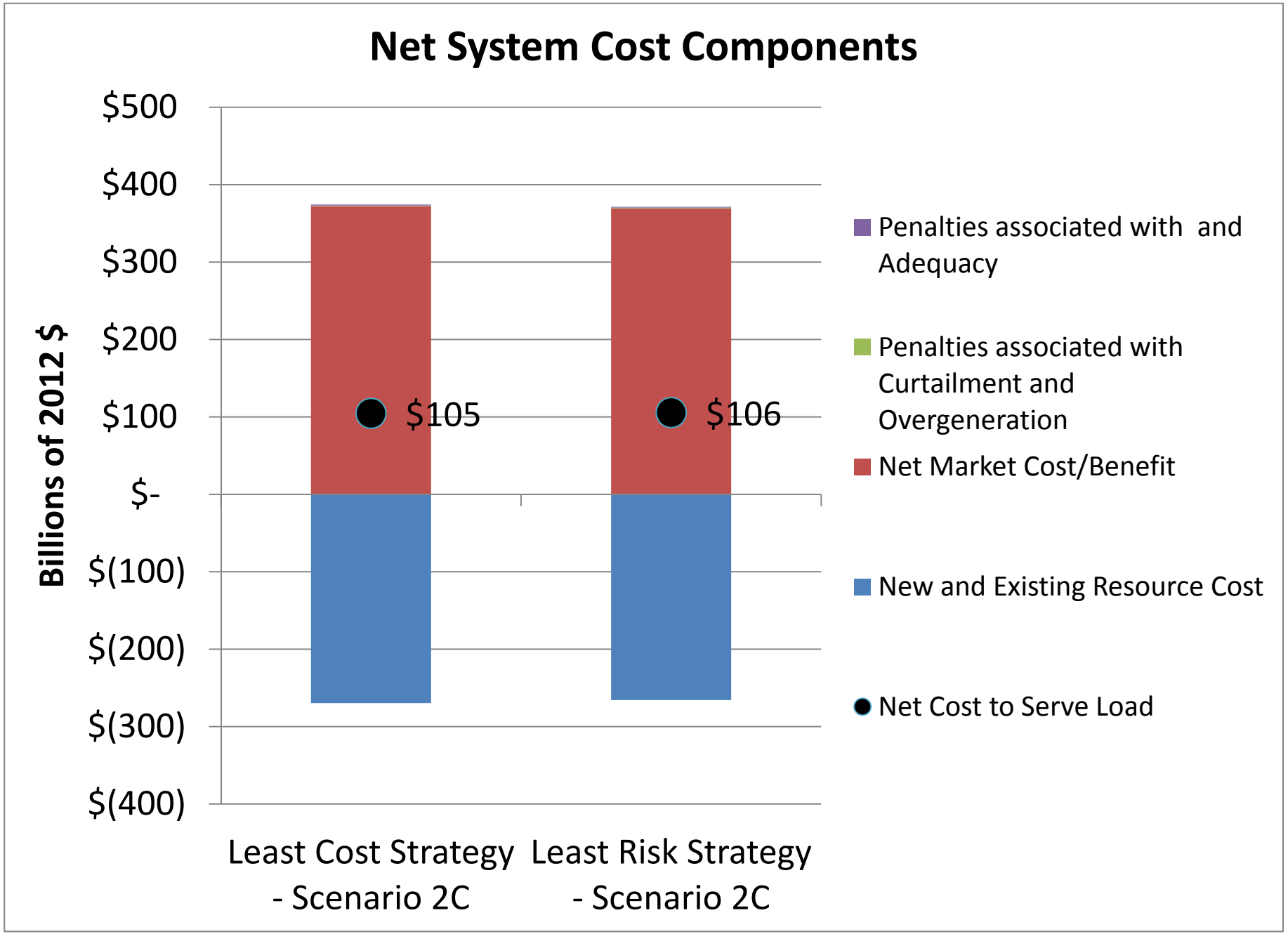

Winter Peaking Capacity of New Resources -
Least Risk Strategy Scenario 1B
Cumulative Capacity (MW)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016 Q1
2017 Q1
2018 Q1
2019 Q1
2020 Q1
2021 Q1
2022 Q1
2023 Q1
2024 Q1
2025 Q1
2026 Q1
2027 Q1
2028 Q1
2029 Q1
2030 Q1
2031 Q1
2032 Q1
2033 Q1
2034 Q1
2035 Q1
Winter Year


Cumulative Energy of New Resources -
Least Cost Strategy Scenario 1B
Cumulativwe Energy (aMW)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
Year

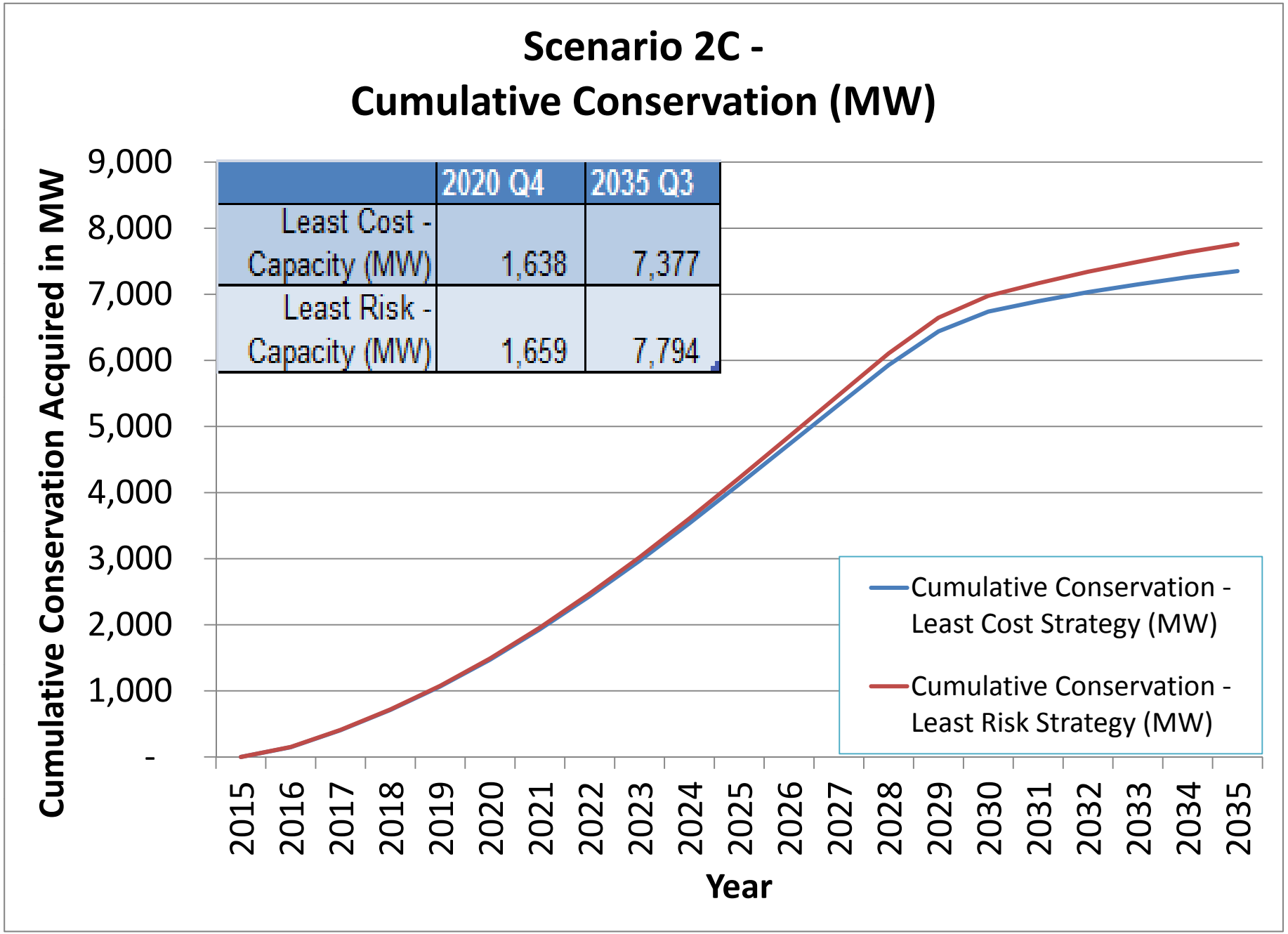

Cumulative Energy of New Resources -
Least Risk Strategy Scenario 1B
Cumulativwe Energy (aMW)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
Years


Least Cost Strategy vs Least Risk Strategy - Scenario 1B
Least Cost Strategy
Least Risk Strategy
Mean
90th percentile
Mean
90th percentile
Probability
2
35
69
102
135
169
202
236
269
302
336
369
403
436
469
503
536
570
603
636
670
703
736
770
803
CO2 Emissions Totals in Millions Metric Tons


Least Cost Strategy vs Least Risk Strategy
Probability
Least Cost Strategy - Scenario 2C
Least Risk Strategy - Scenario 2C
Mean
System Risk
Mean
System Risk
23
34
45
55
66
77
87
98
109
120
130
141
152
162
173
184
195
205
216
227
237
248
259
270
280
Net System Cost - ($2012 billions)

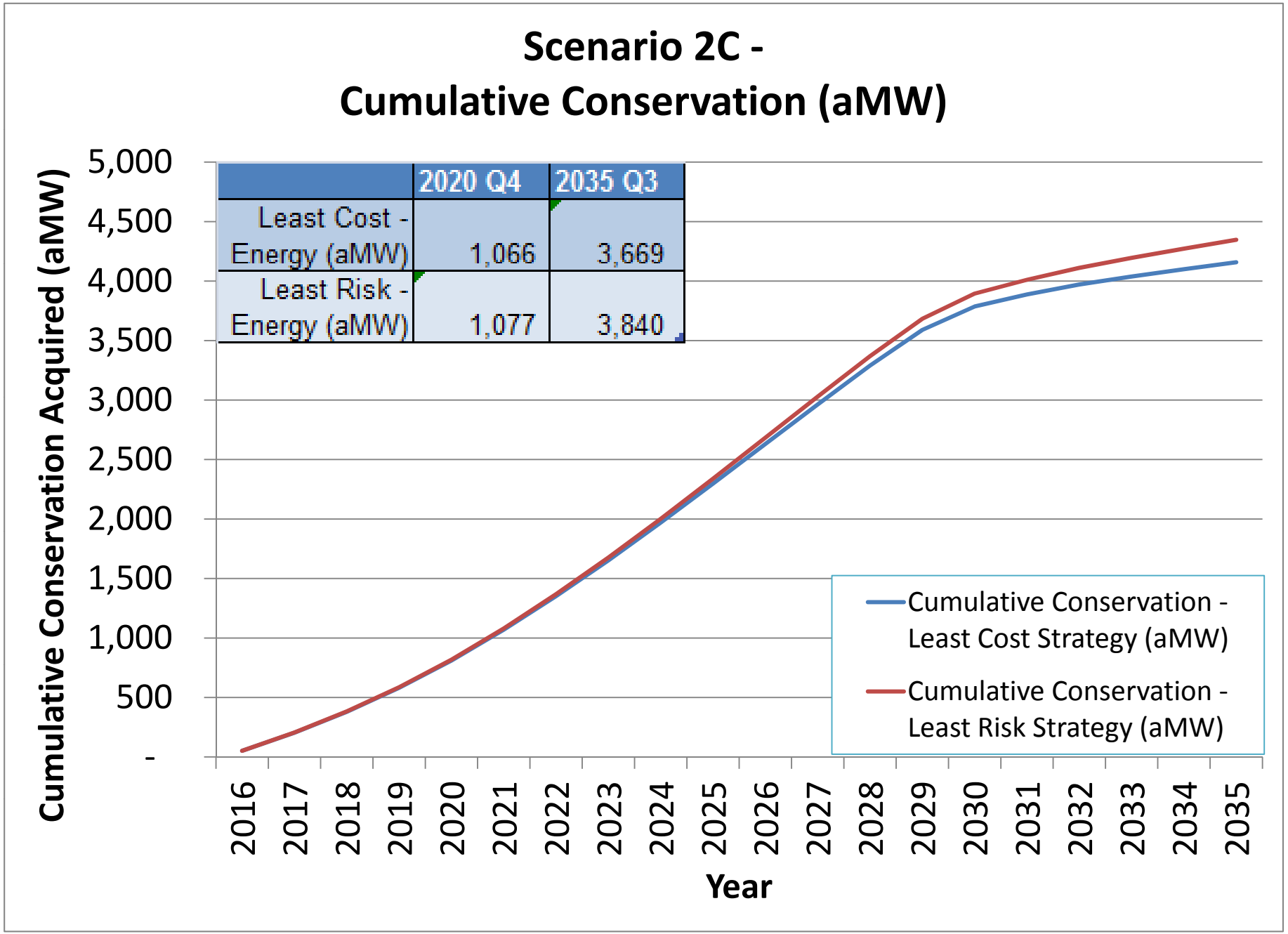

Net System Cost Components
Billions of 2012 $
$500
$400
$300
$200
$100
$-
$(100)
$(200)
$(300)
$(400)
$105
$106
Least Cost Strategy - Scenario 2C
Least Risk Strategy - Scenario 2C
Penalties associated with and Adequacy
Penalties associated with Curtailment and Overgeneration
Net Market Cost/Benefit
New and Existing Resource Cost
Net Cost to Serve Load

Scenario 2C - Cumulative Conservation (MW)

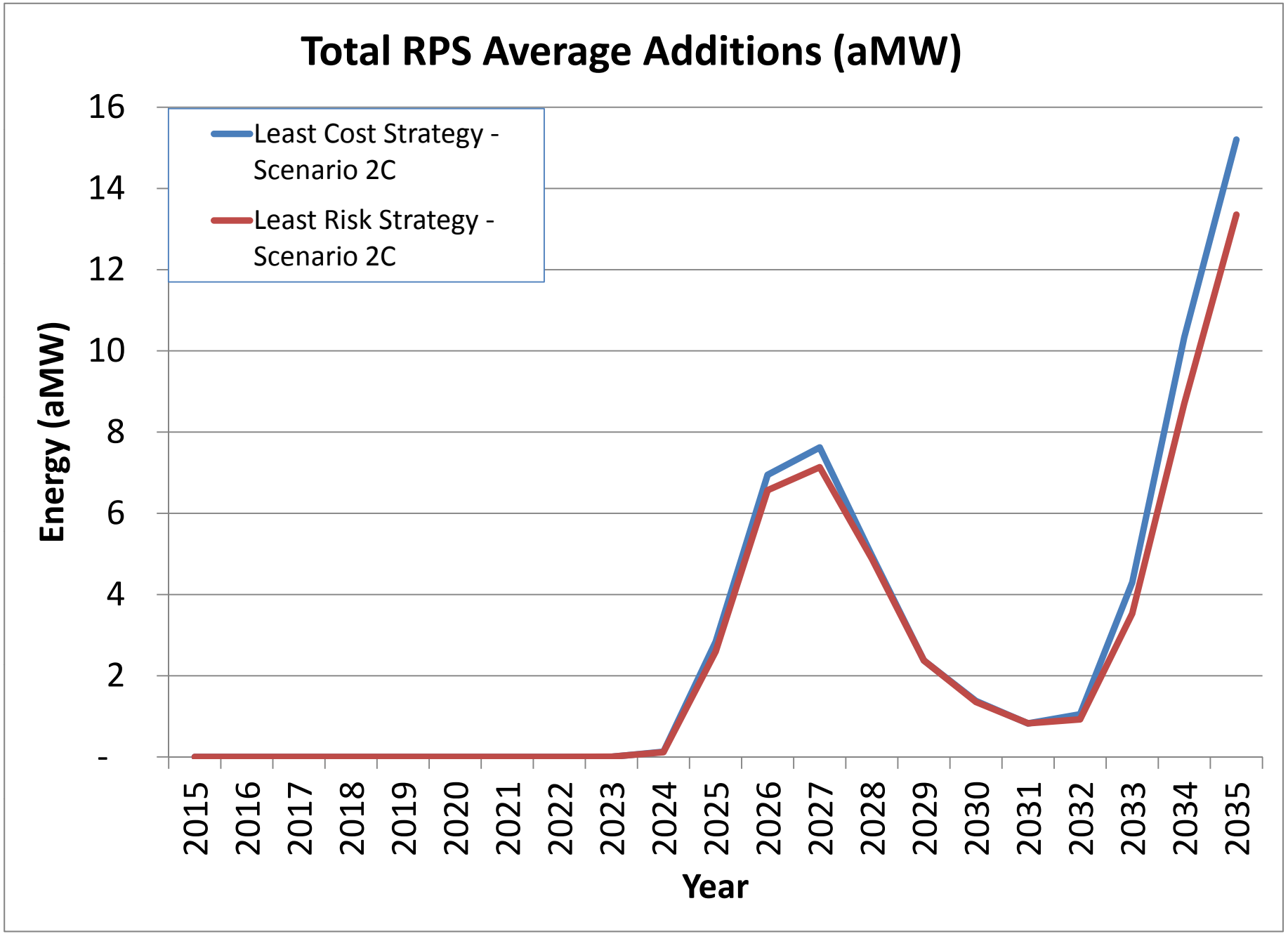


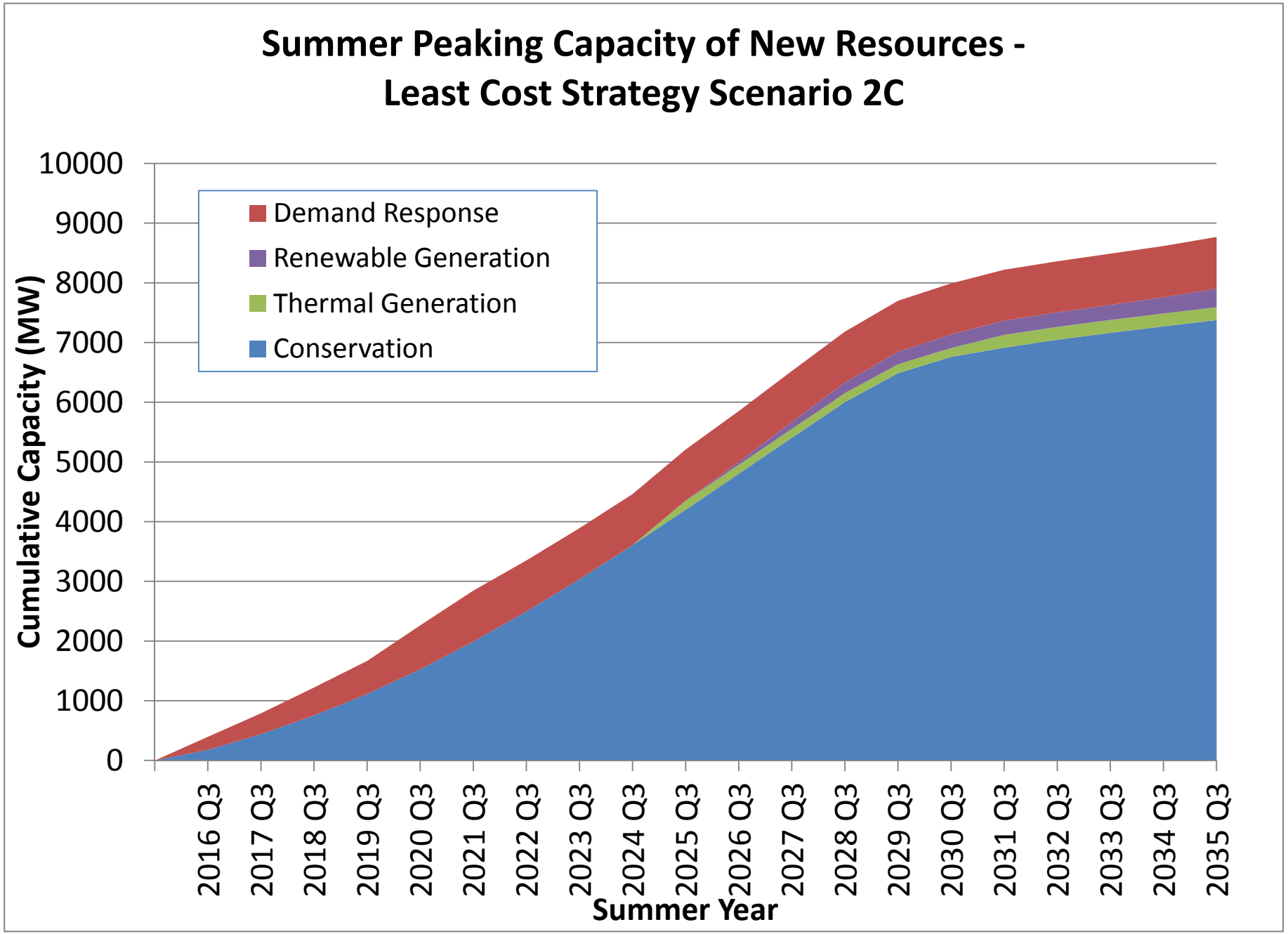
	2020 Q4	2035 Q3
Least Cost - Capacity (MW)	1,638	7,377
Least Risk - Capacity (MW)	1,659	7,794

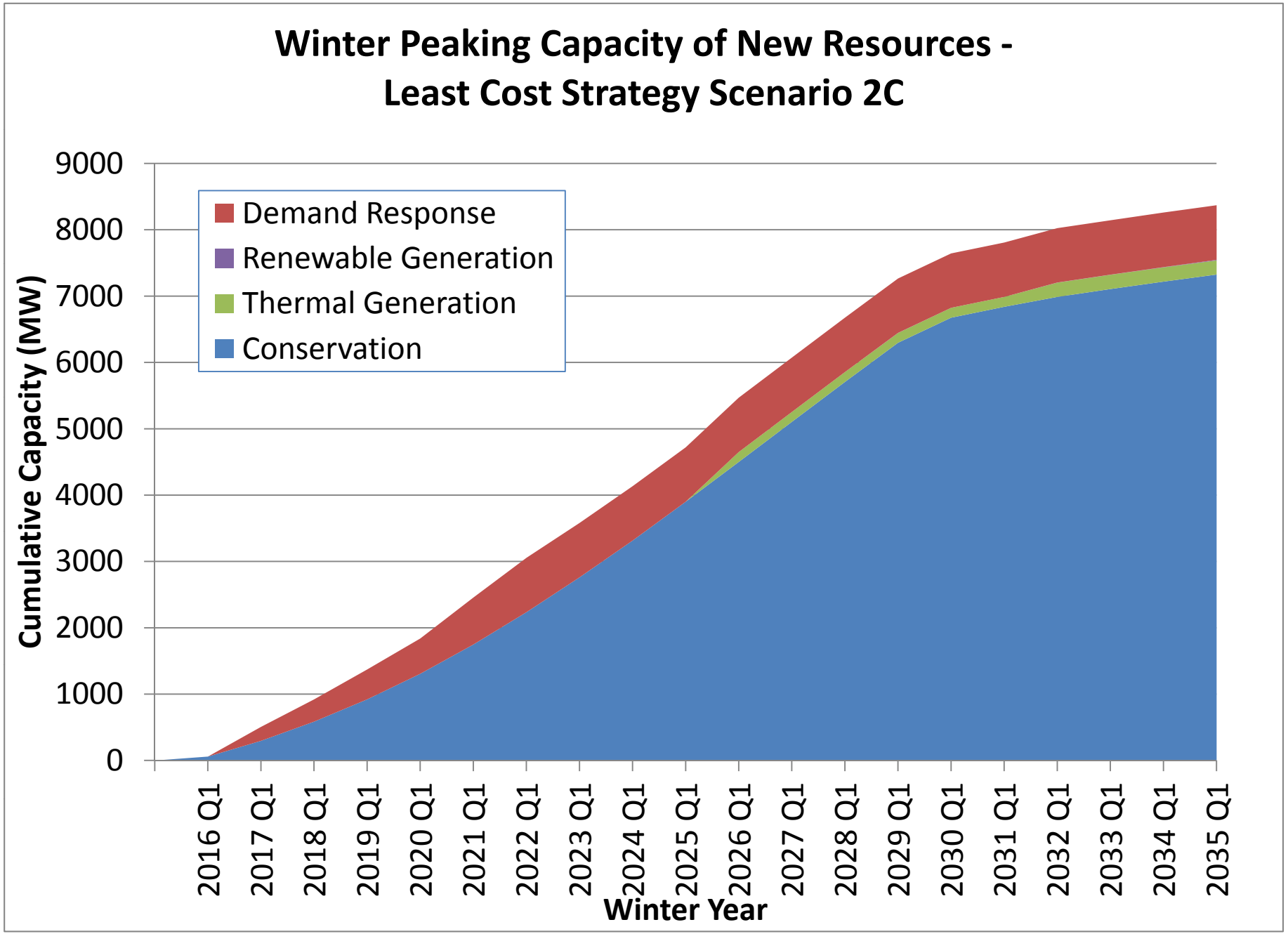
Scenario 2C - Cumulative Conservation (aMW)

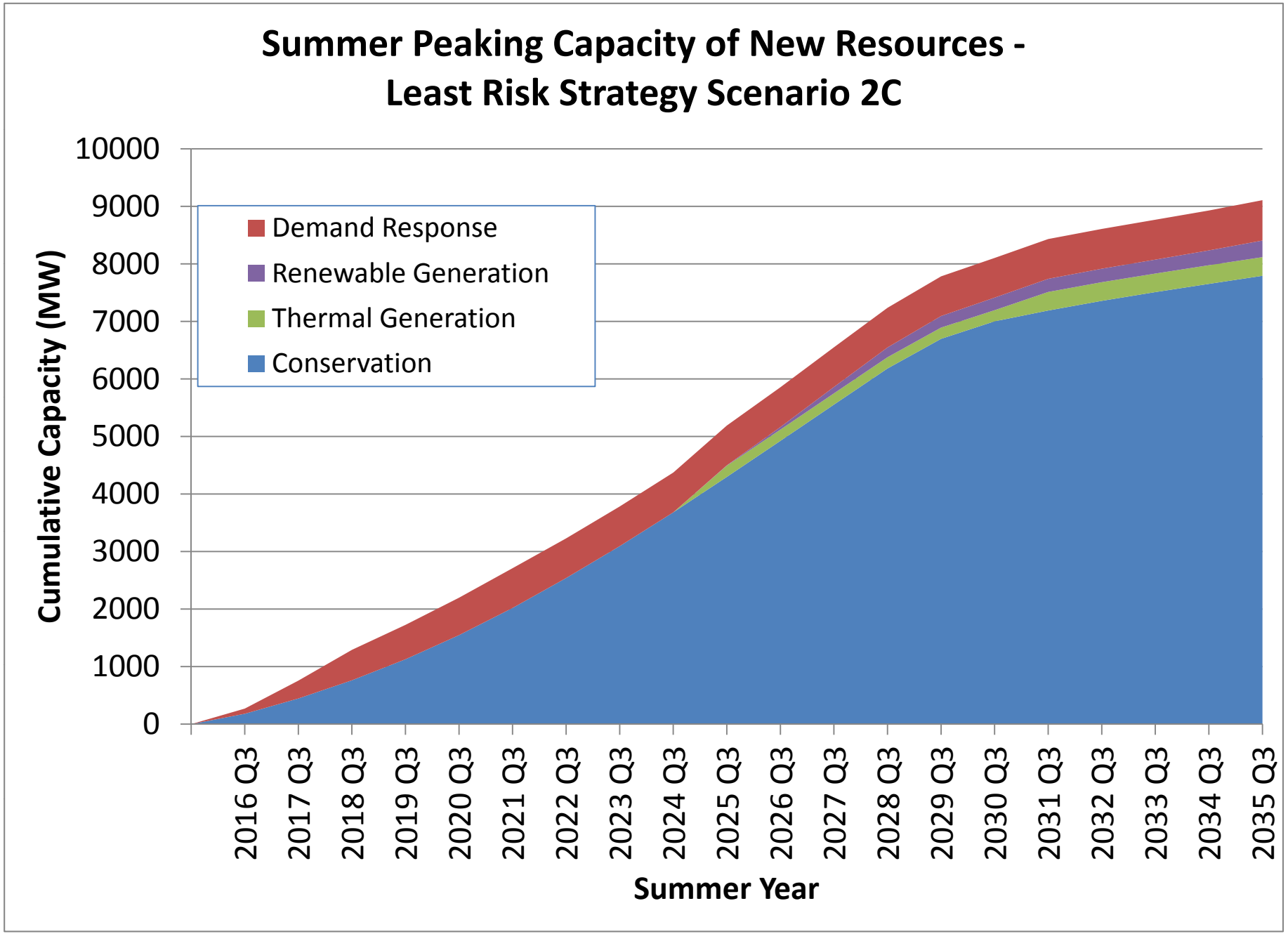


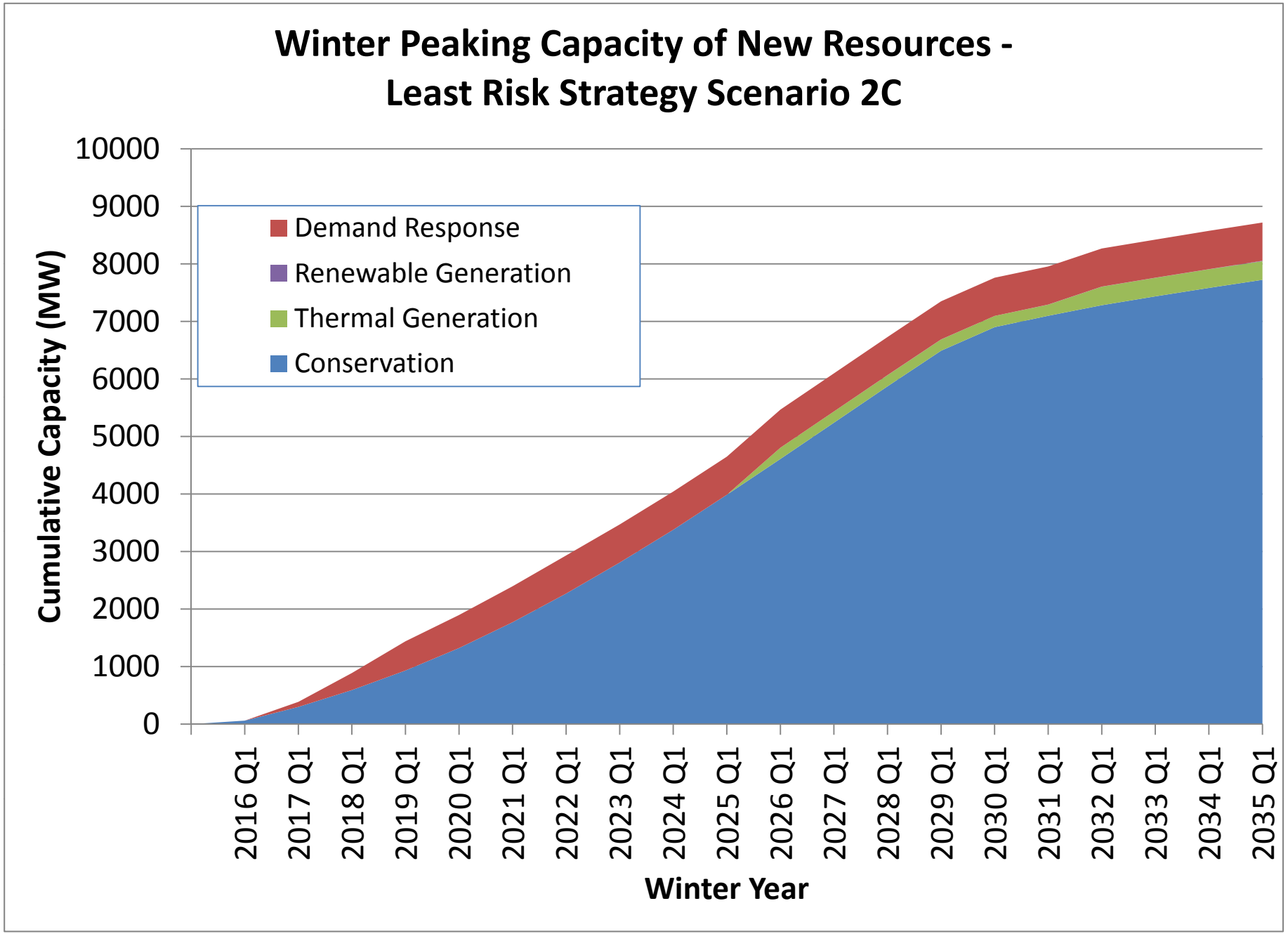
	2020 Q4	2035 Q3
Least Cost - Energy (aMW)	1,066	3,669
Least Risk - Energy (aMW)	1,077	3,840

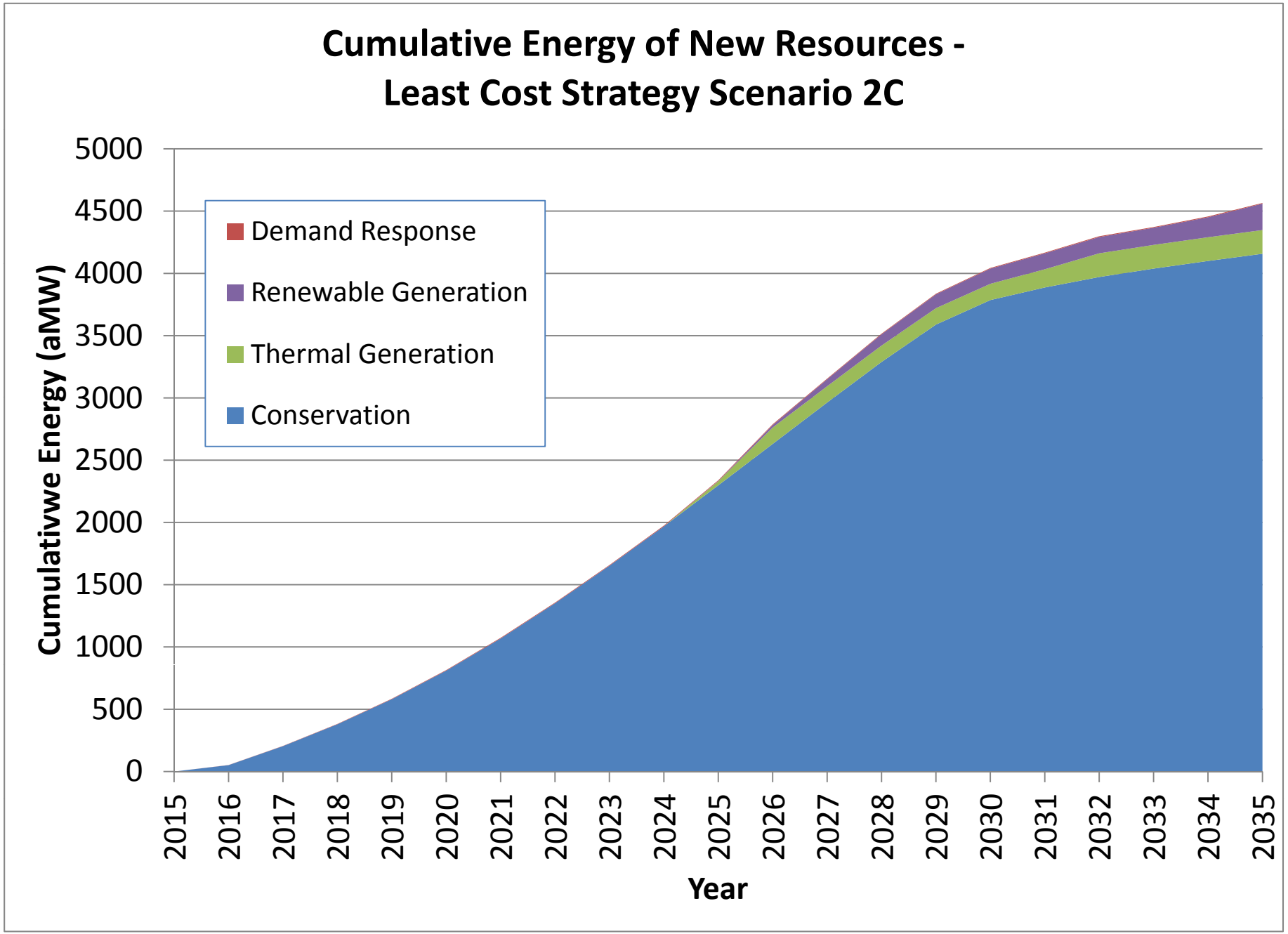

Total RPS Average Additions (aMW)
Least Cost Strategy - Scenario 2C
Least Risk Strategy - Scenario 2C
Energy (aMW)
16
14
12
10
8
6
4
2
-
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
Year

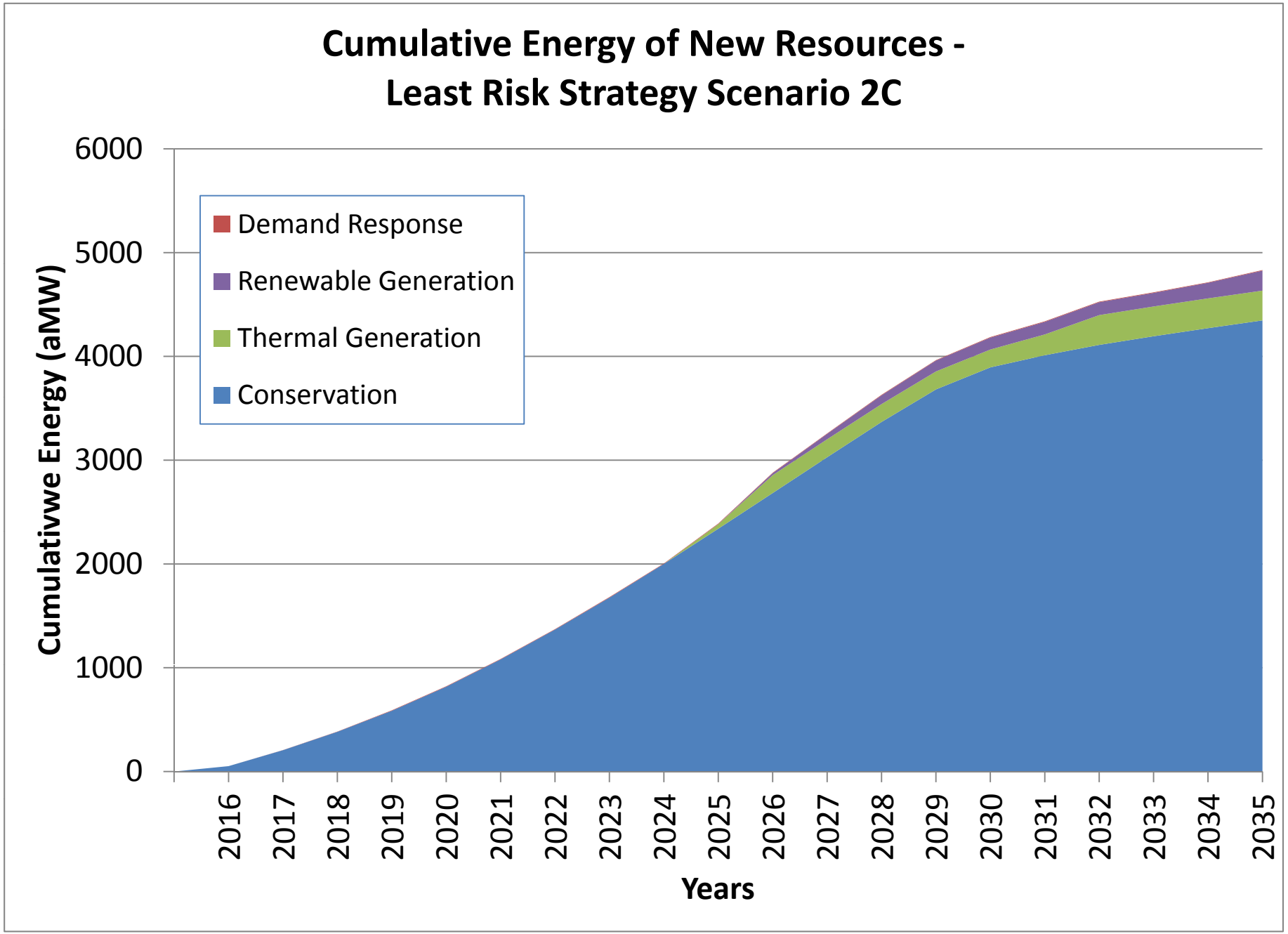

Summer Peaking Capacity of New Resources -
Least Cost Strategy Scenario 2C
Cumulative Capacity (MW)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016 Q3
2017 Q3
2018 Q3
2019 Q3
2020 Q3
2021 Q3
2022 Q3
2023 Q3
2024 Q3
2025 Q3
2026 Q3
2027 Q3
2028 Q3
2029 Q3
2030 Q3
2031 Q3
2032 Q3
2033 Q3
2034 Q3
2035 Q3
Summer Year

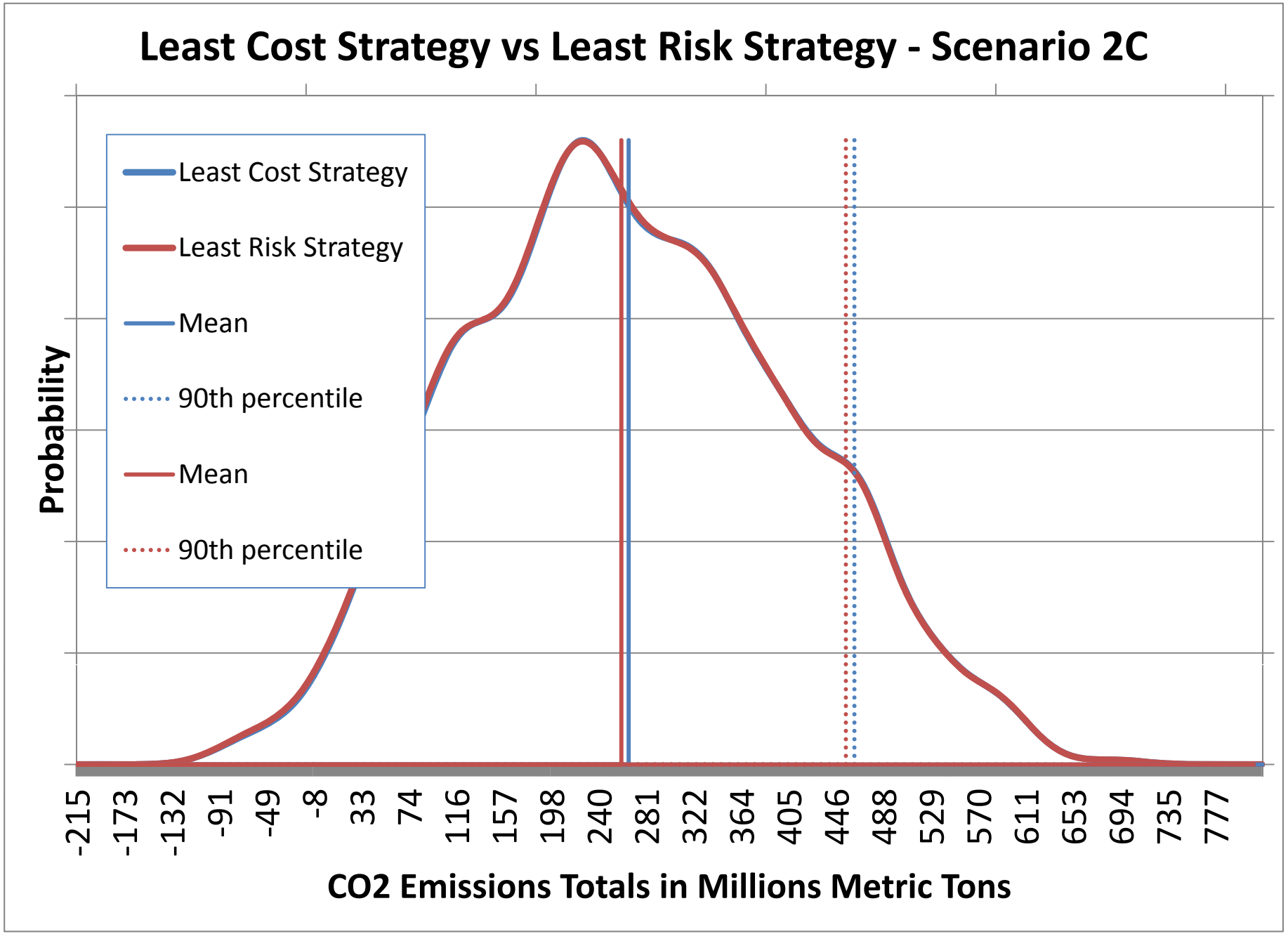

Winter Peaking Capacity of New Resources -
Least Cost Strategy Scenario 2C
Cumulative Capacity (MW)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016 Q1
2017 Q1
2018 Q1
2019 Q1
2020 Q1
2021 Q1
2022 Q1
2023 Q1
2024 Q1
2025 Q1
2026 Q1
2027 Q1
2028 Q1
2029 Q1
2030 Q1
2031 Q1
2032 Q1
2033 Q1
2034 Q1
2035 Q1
Winter Year


Summer Peaking Capacity of New Resources -
Least Risk Strategy Scenario 2C
Cumulative Capacity (MW)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016 Q3
2017 Q3
2018 Q3
2019 Q3
2020 Q3
2021 Q3
2022 Q3
2023 Q3
2024 Q3
2025 Q3
2026 Q3
2027 Q3
2028 Q3
2029 Q3
2030 Q3
2031 Q3
2032 Q3
2033 Q3
2034 Q3
2035 Q3
Summer Year


Winter Peaking Capacity of New Resources -
Least Risk Strategy Scenario 2C
Cumulative Capacity (MW)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016 Q1
2017 Q1
2018 Q1
2019 Q1
2020 Q1
2021 Q1
2022 Q1
2023 Q1
2024 Q1
2025 Q1
2026 Q1
2027 Q1
2028 Q1
2029 Q1
2030 Q1
2031 Q1
2032 Q1
2033 Q1
2034 Q1
2035 Q1
Winter Year


Cumulative Energy of New Resources -
Least Cost Strategy Scenario 2C
Cumulativwe Energy (aMW)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
Year


Cumulative Energy of New Resources -
Least Risk Strategy Scenario 2C
Cumulativwe Energy (aMW)
6000
5000
4000
3000
2000
1000
0
Demand Response
Renewable Generation
Thermal Generation
Conservation
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
Years


Least Cost Strategy vs Least Risk Strategy - Scenario 2C
Least Cost Strategy
Least Risk Strategy
Mean
90th percentile
Mean
90th percentile
Probability
-215
-173
-132
-91
-49
-8
33
74
116
157
198
240
281
322
364
405
446
488
529
570
611
653
694
735
777
CO2 Emissions Totals in Millions Metric Tons