Laboratory Testing Results

Impacts of Air Flow and Charge on Heat Pump Performance

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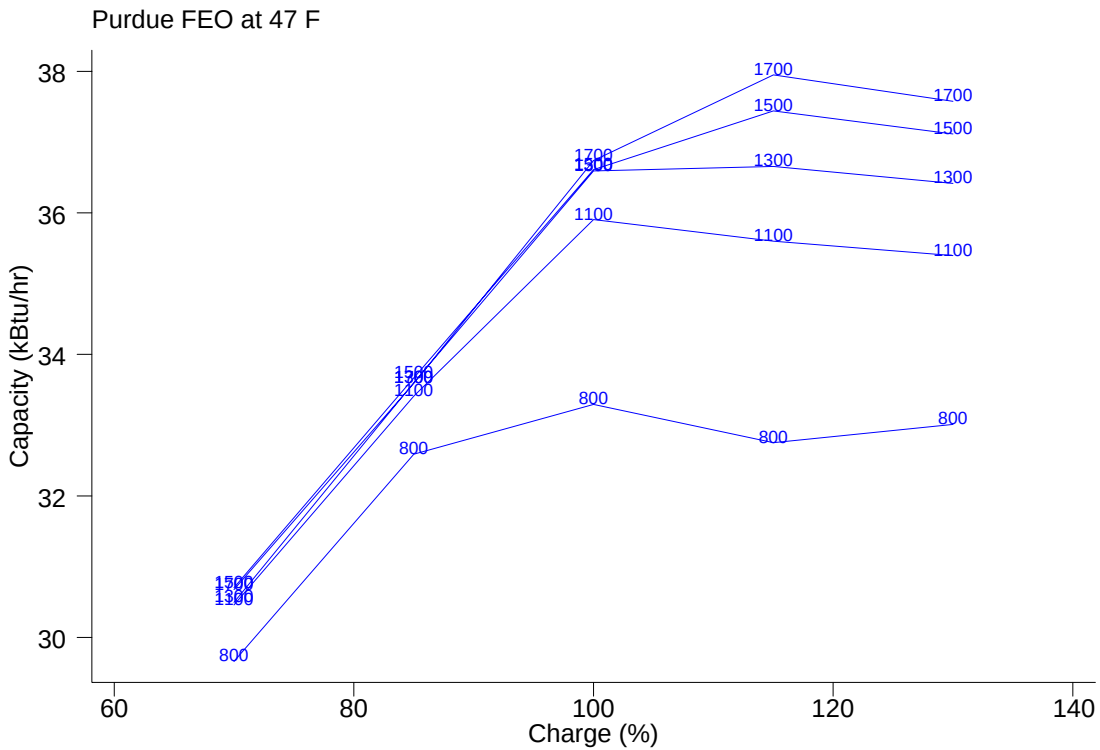
Testing Goals

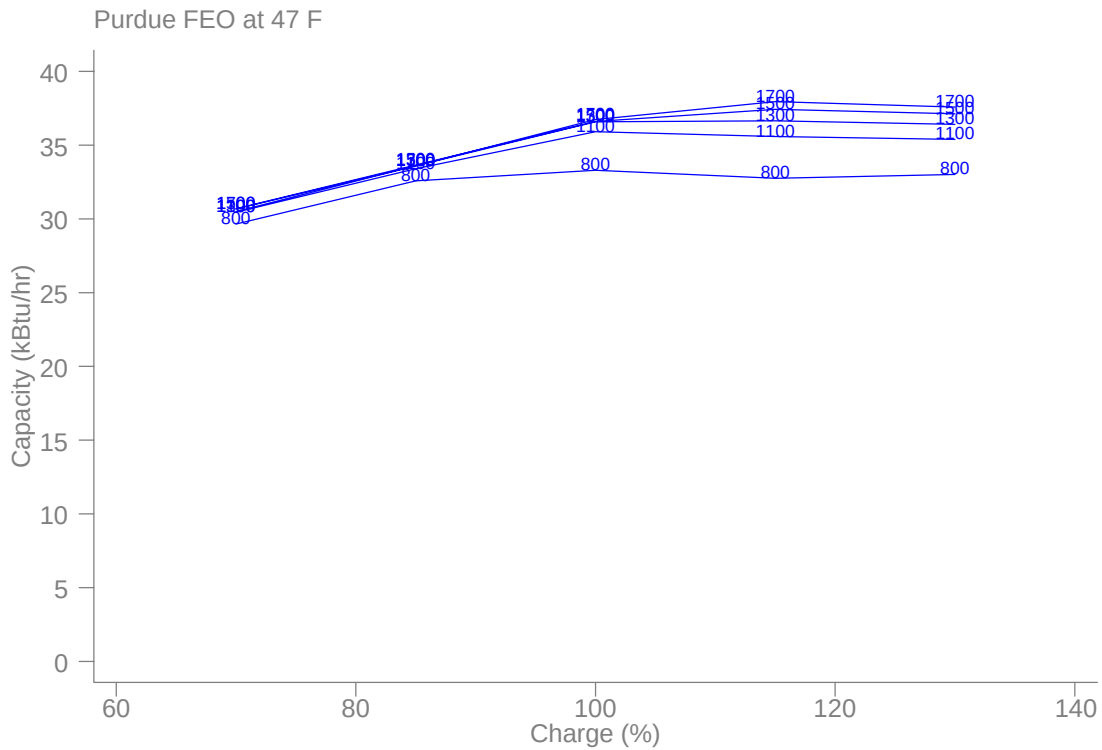
- Determine the effects of Charge and Air Flow variations on Heat Pump performance in heating.
- Assess the Impact of TXV versa Fixed Metering as a result of variation in Charge and Air Flow.
- Provide measures of Cycling degradation (C_d) on typical Heat Pump over the range of testing.
- Provide measure of Defrost degradation factor over range of testing.

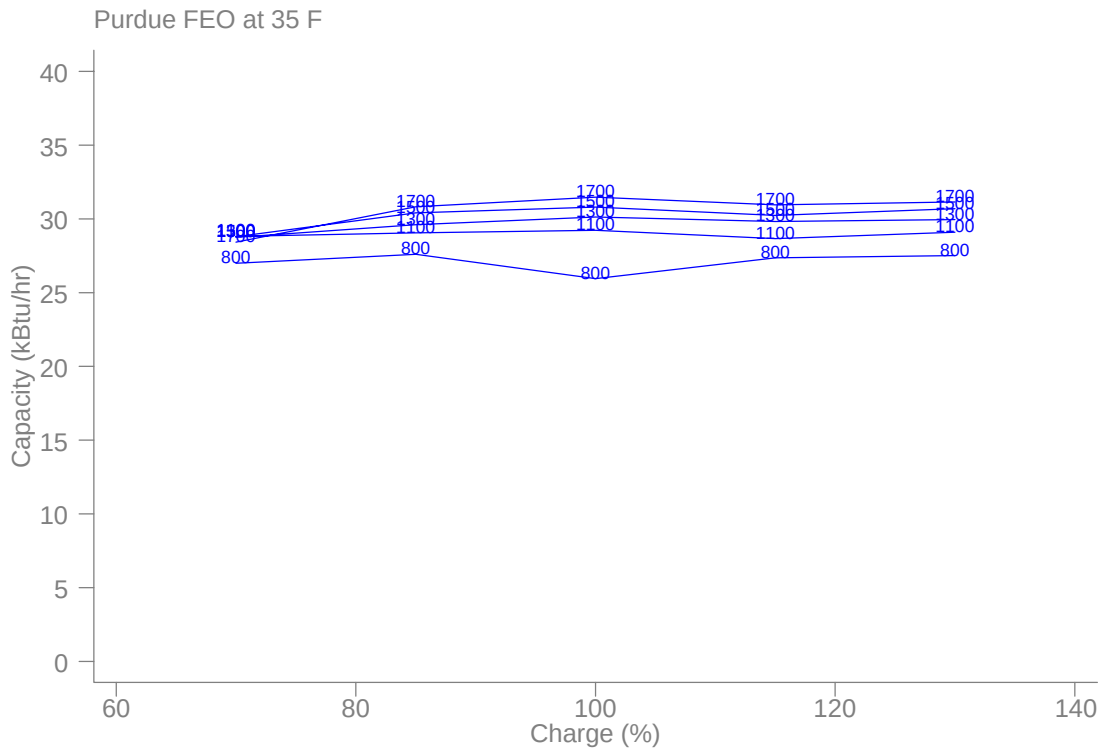
Review of Testing Results

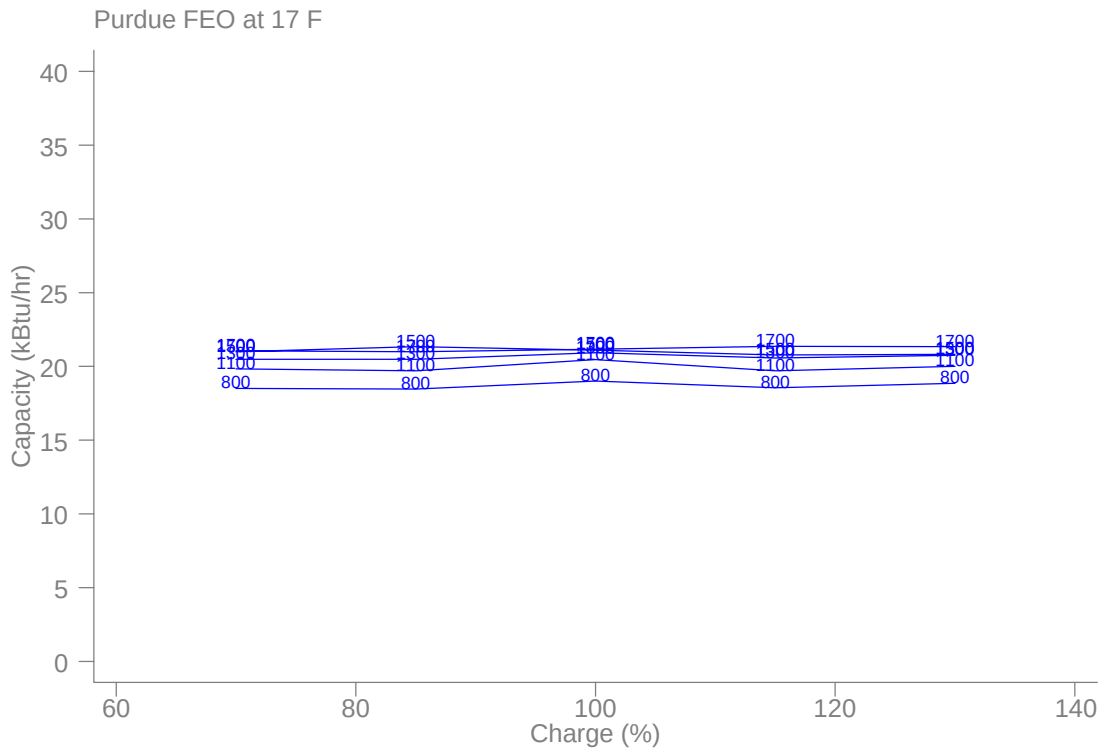
- Difficulties of measurement resulted in corrections over previously presented data
- Some measurement error on the results, perhaps 1-3% depending on flow conditions.
- Much more problematic at low flows

Capacity Impacts: Fixed Metering

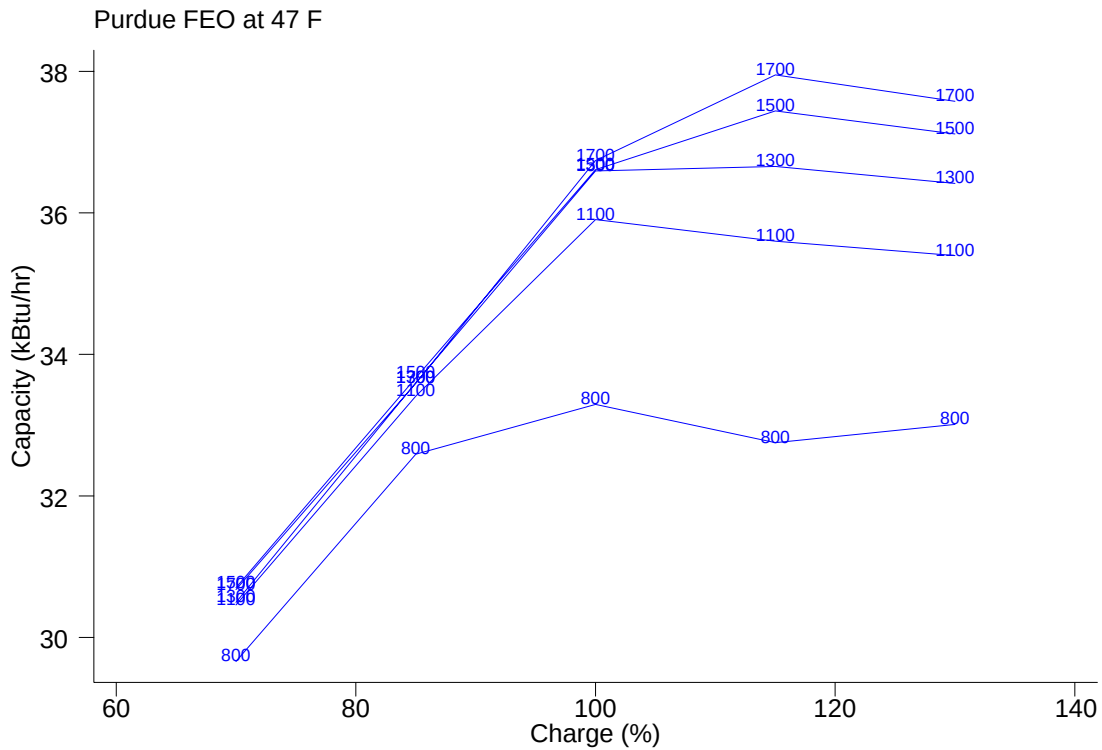


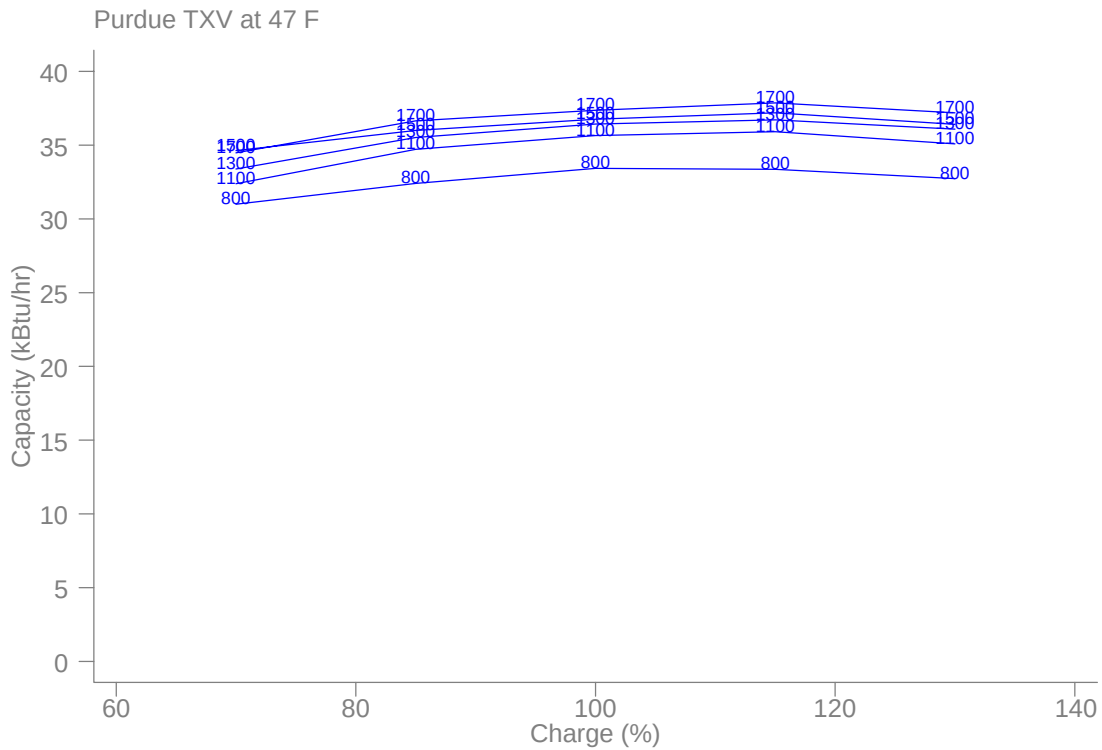

Purdue FEO at 47 F
Capacity (kBtu/hr)
Charge (%)
0
5
10
15
20
25
30
35
40
60
80
100
120
140
1700
1500
1300
1100
800

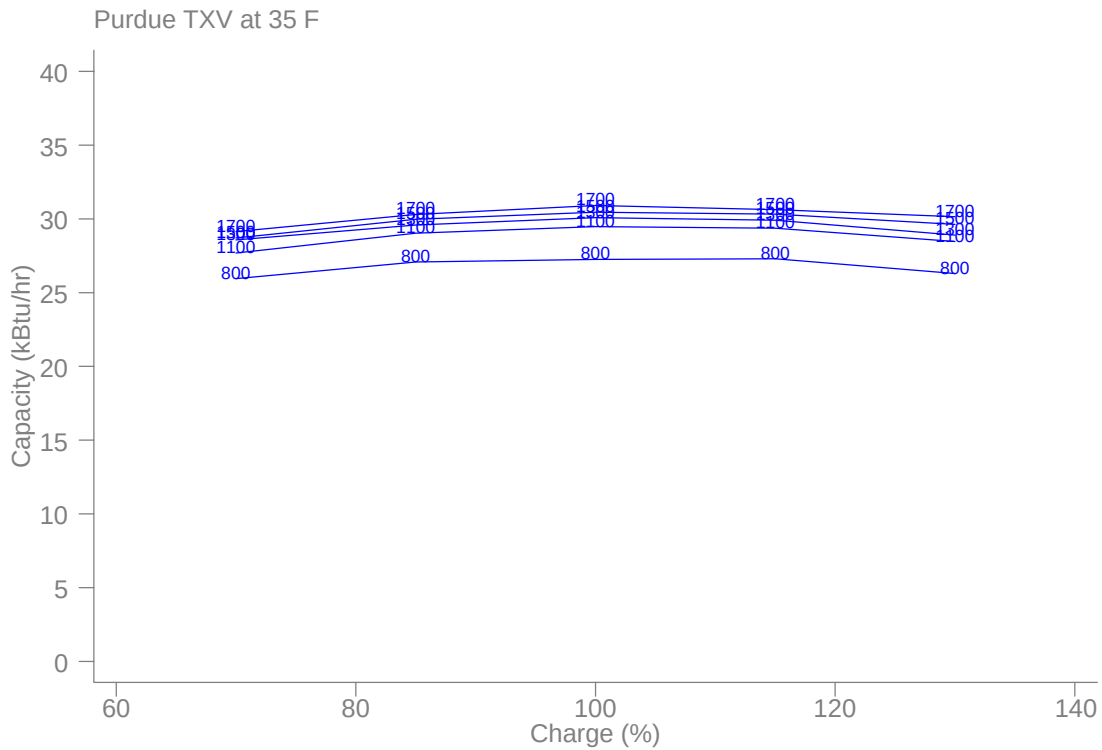

Purdue FEO at 35 F
Capacity (kBtu/hr)
Charge (%)
0
5
10
15
20
25
30
35
40
60
80
100
120
140
1700
1500
1300
1100
800

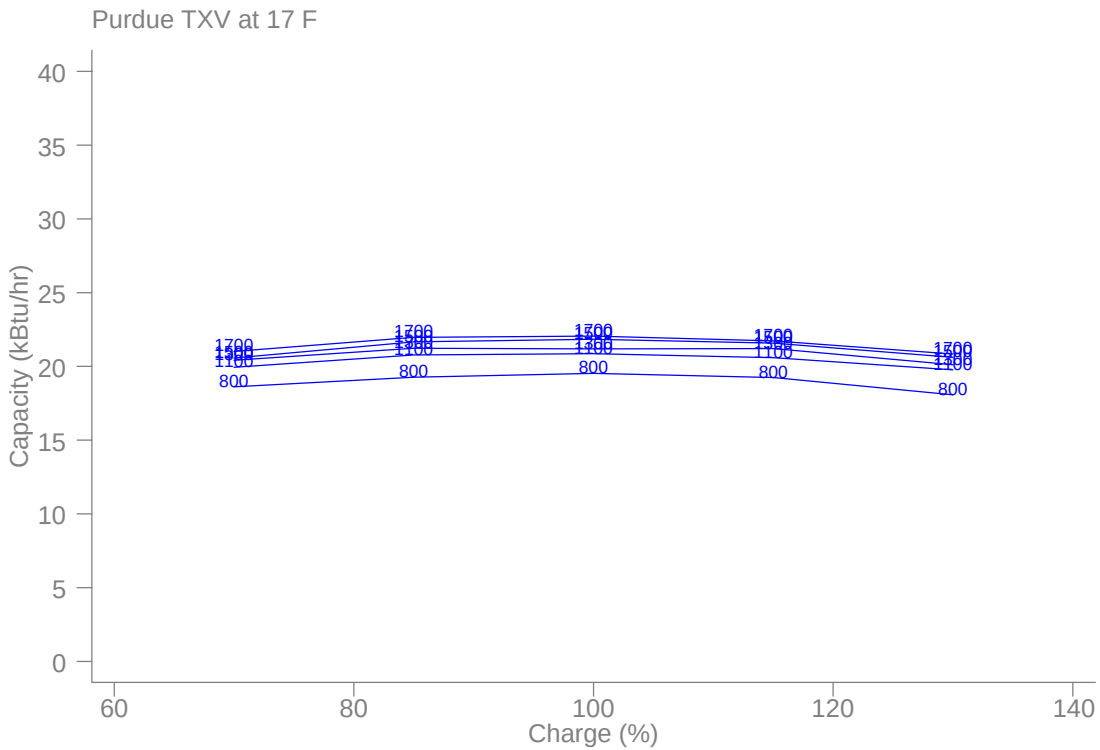

Purdue FEO at 17 F
Capacity (kBtu/hr)
Charge (%)
0
5
10
15
20
25
30
35
40
60
80
100
120
140
1700
1500
1300
1100
800

Capacity Impacts: TXV

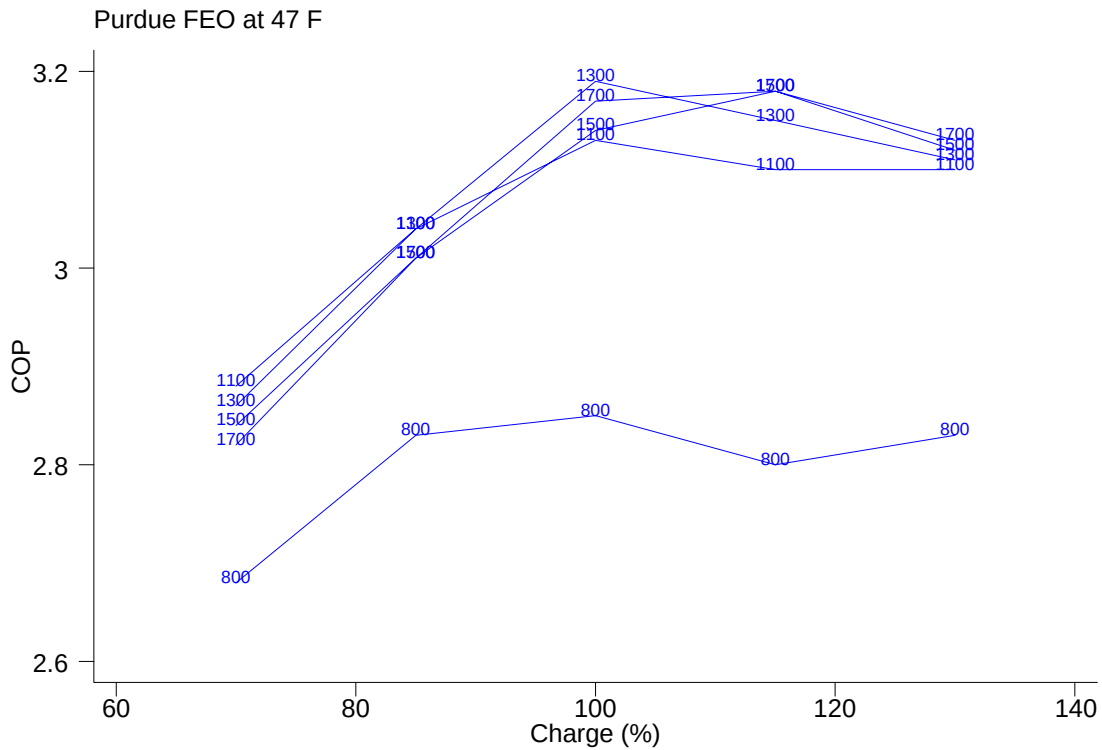


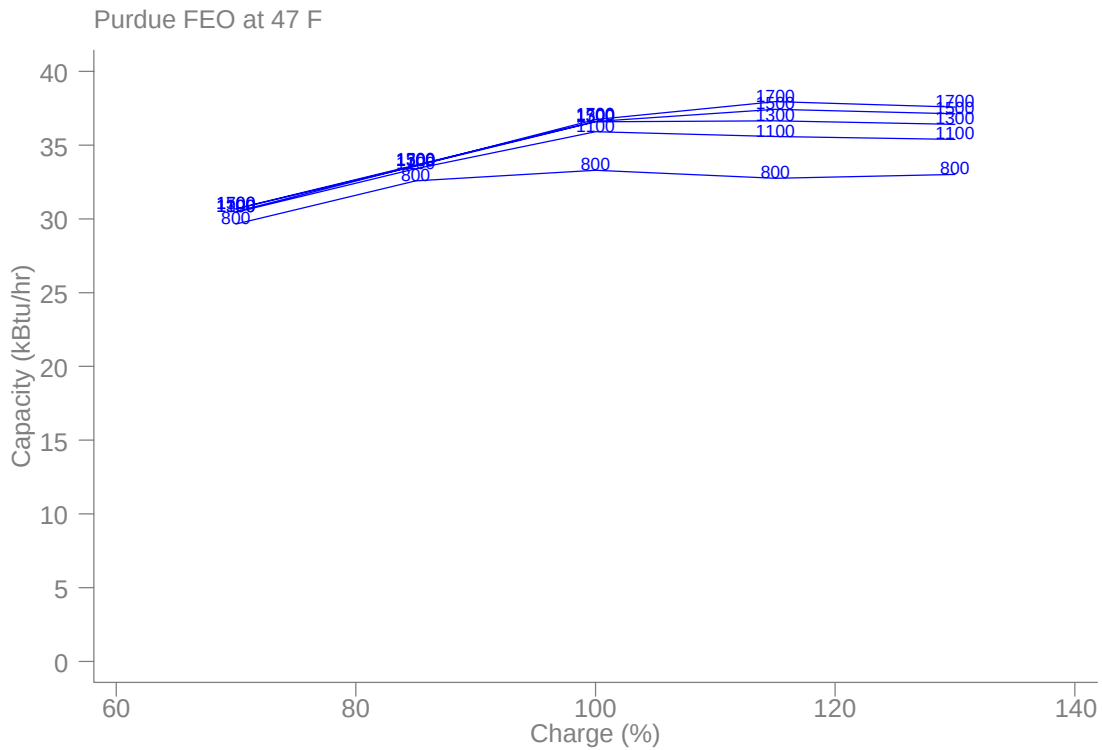

Purdue TXV at 47 F
Capacity (kBtu/hr)
Charge (%)
0
5
10
15
20
25
30
35
40
60
80
100
120
140
1700
1500
1300
1100
800

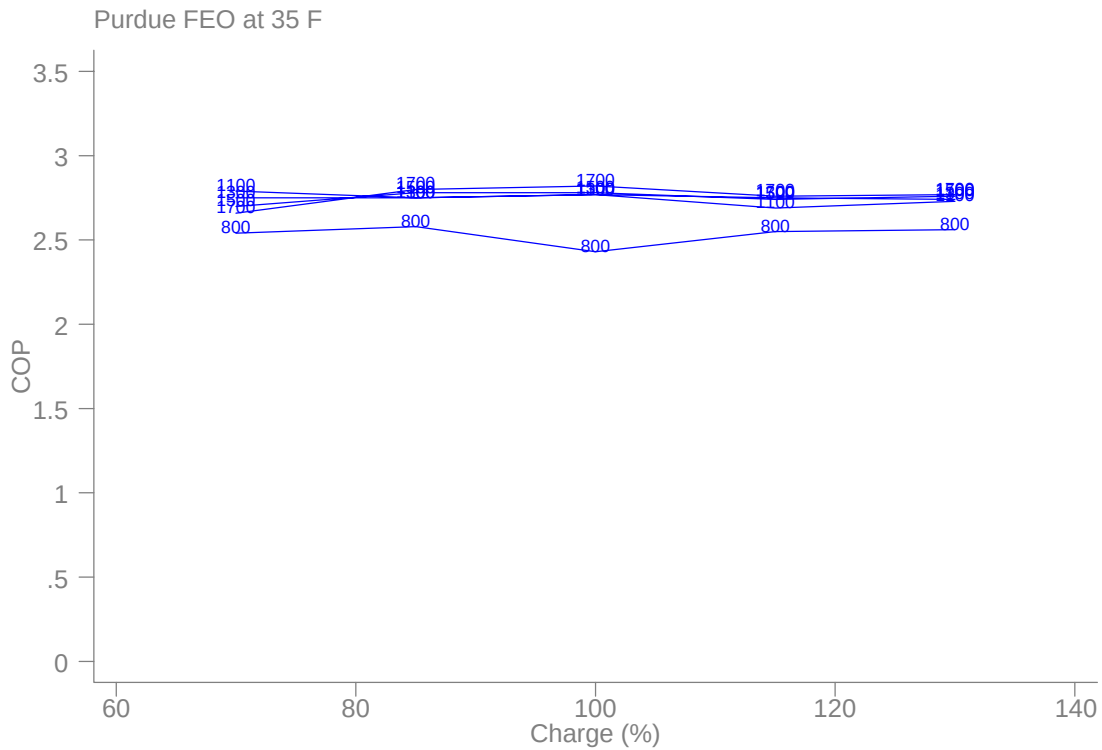

Purdue TXV at 35 F
Capacity (kBtu/hr)
Charge (%)
0
5
10
15
20
25
30
35
40
60
80
100
120
140
1700
1500
1400
1300
1200
1100
800

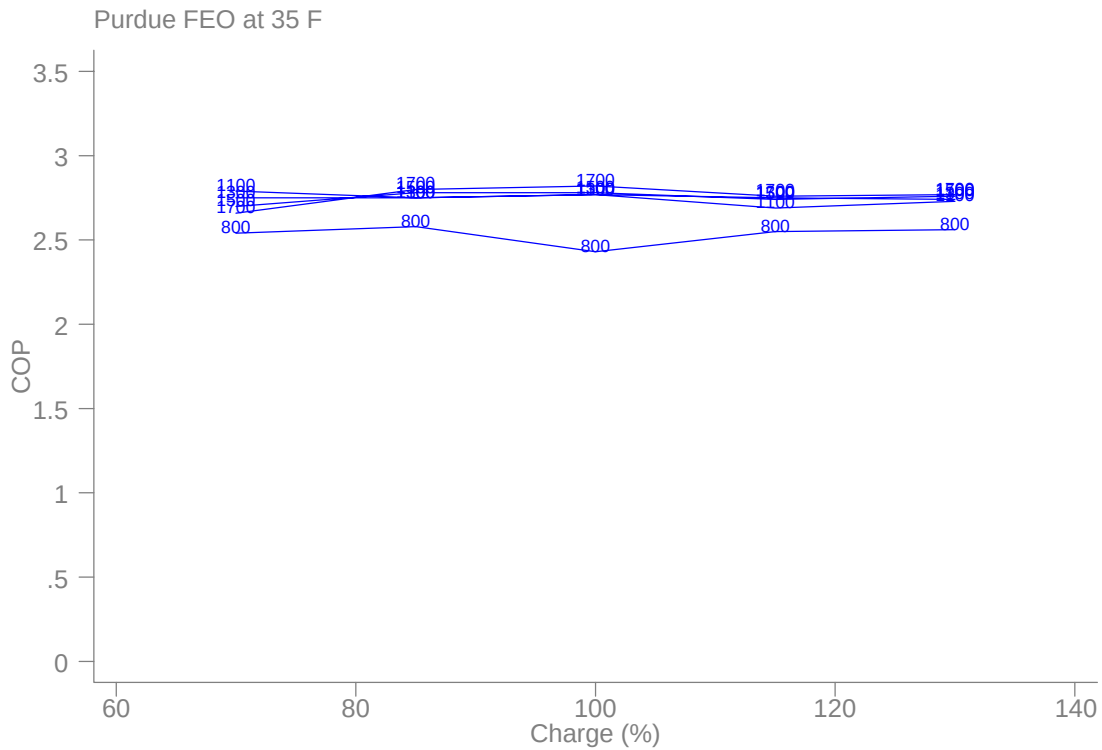

Purdue TXV at 17 F
Capacity (kBtu/hr)
Charge (%)
0
5
10
15
20
25
30
35
40
60
80
100
120
140
1700
1600
1500
1400
1300
1200
1100
800

COP Impacts: Fixed Metering

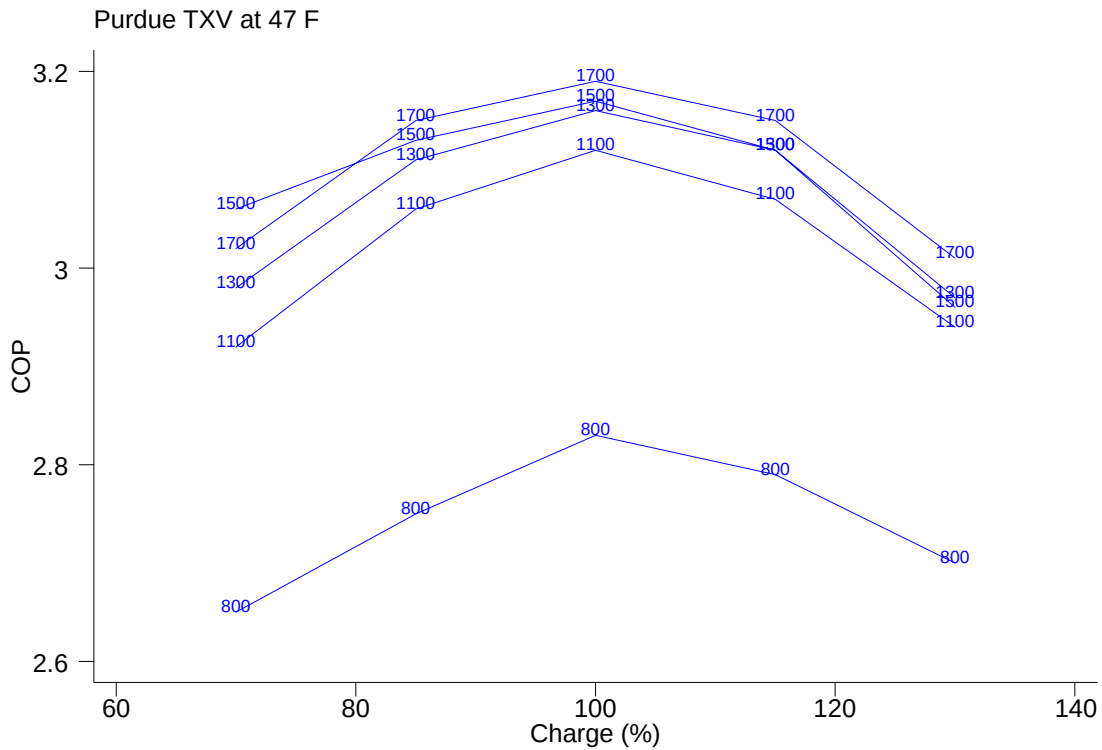


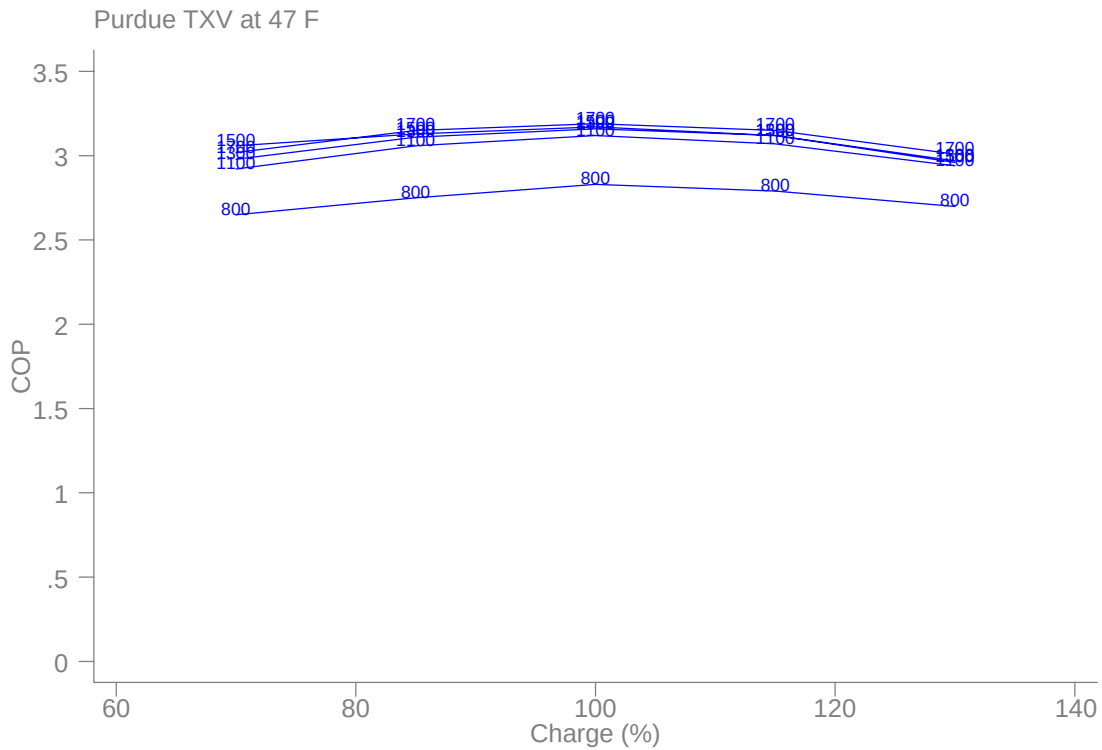

Purdue FEO at 47 F
Capacity (kBtu/hr)
Charge (%)
0
5
10
15
20
25
30
35
40
60
80
100
120
140
1700
1500
1300
1100
800

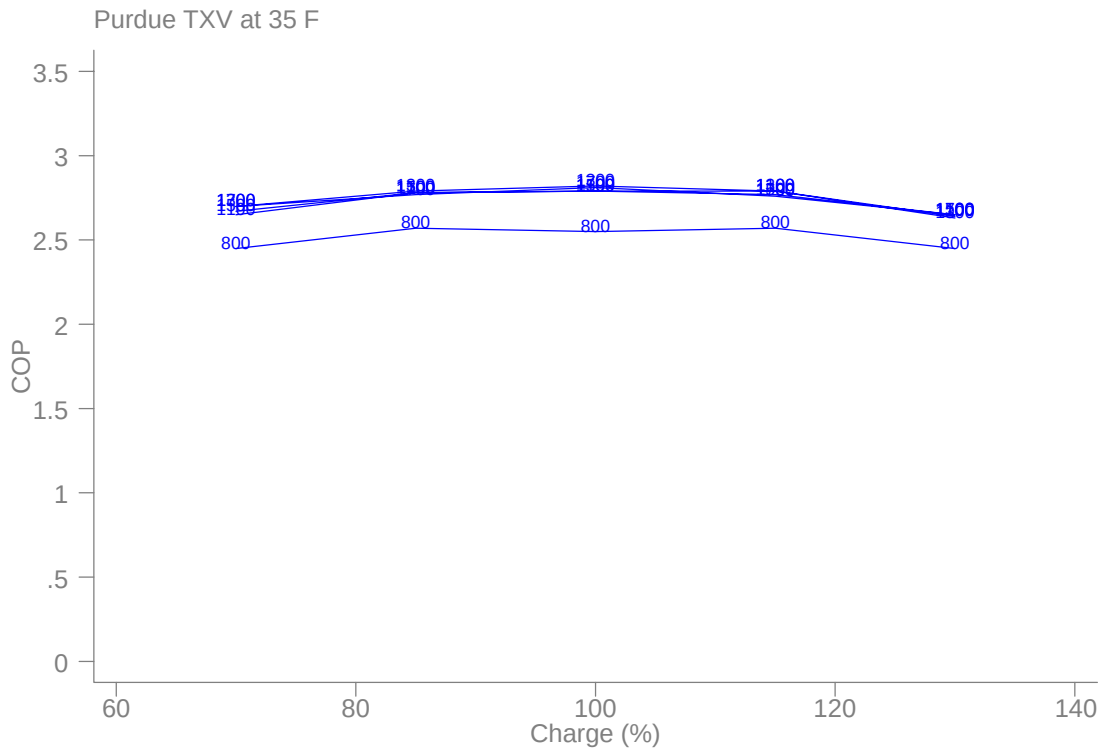

Purdue FEO at 35 F
COP
3.5
3
2.5
2
1.5
1
.5
0
60
80
100
120
140
Charge (%)
800
800
800
800
800

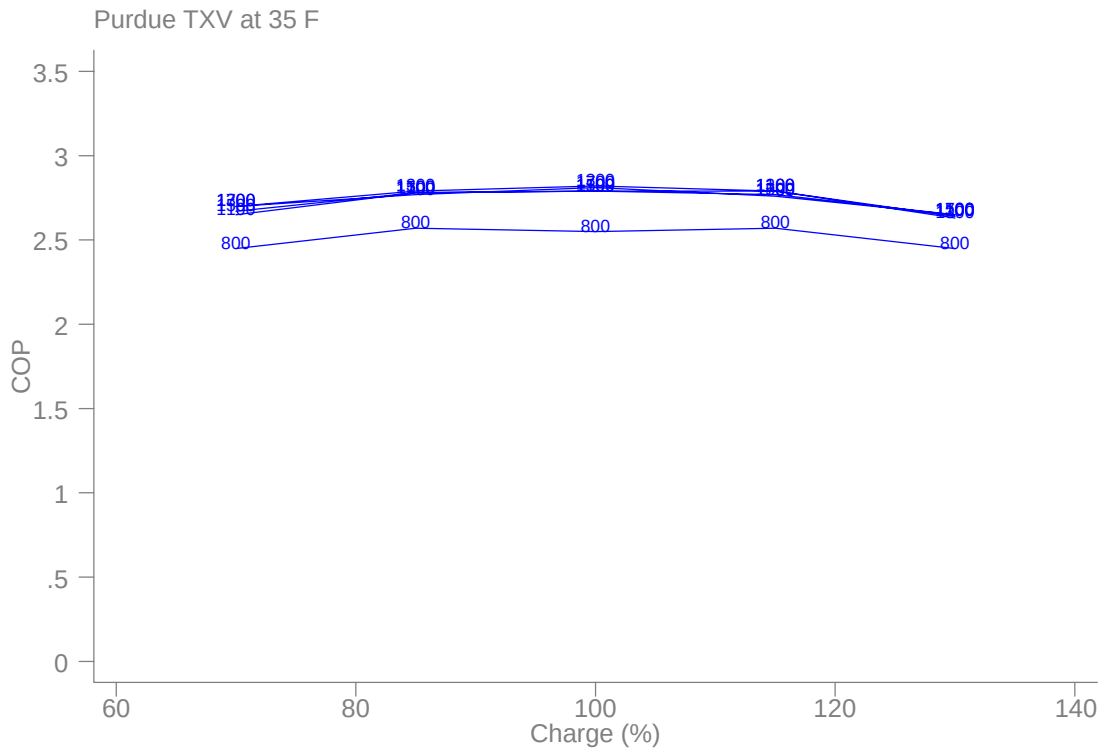

Purdue FEO at 35 F
COP
3.5
3
2.5
2
1.5
1
.5
0
60
80
100
120
140
Charge (%)
800
800
800
800
800

COP Impacts: TXV

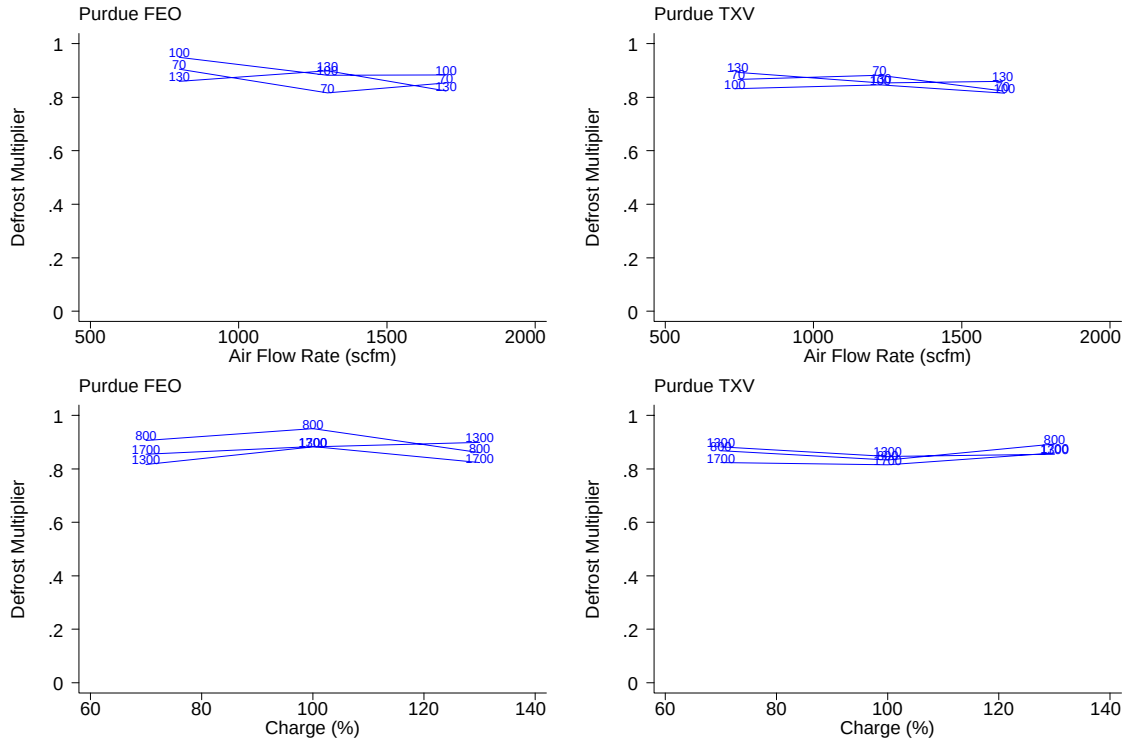



Purdue TXV at 47 F
COP
Charge (%)
3.5
3
2.5
2
1.5
1
.5
0
60
80
100
120
140
800
800
800
800
800

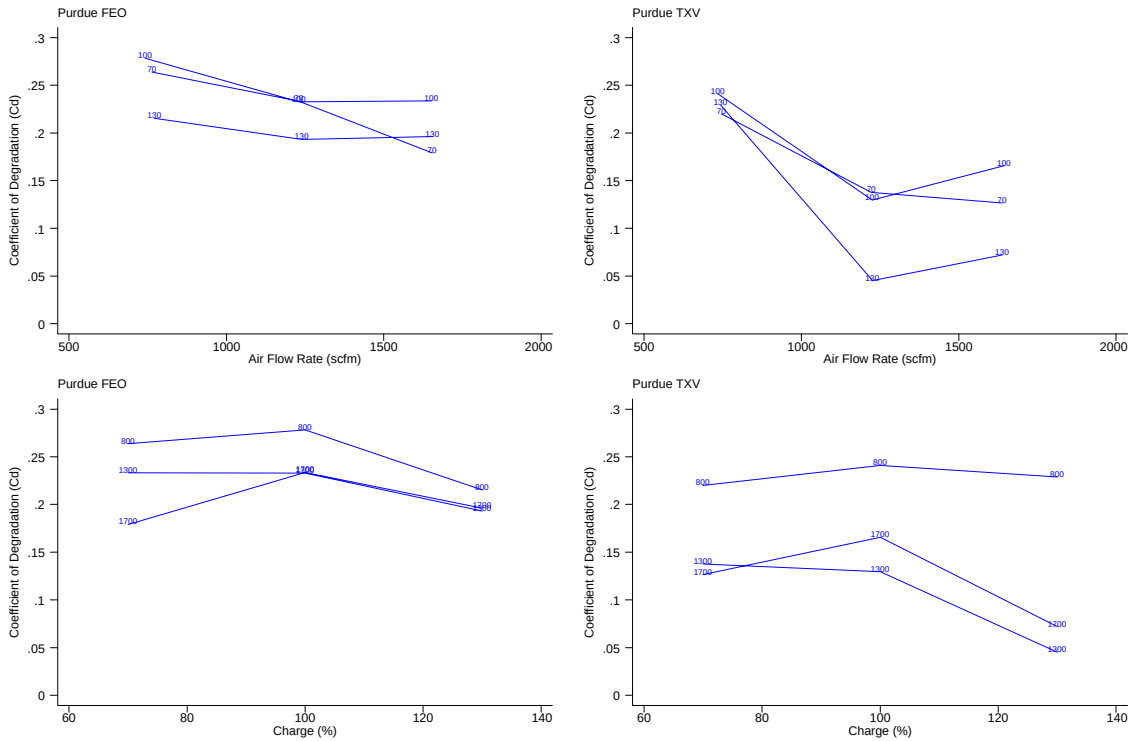

Purdue TXV at 35 F
COP
3.5
3
2.5
2
1.5
1
.5
0
60
80
100
120
140
Charge (%)
800
800
800
800
800


Purdue TXV at 35 F
COP
3.5
3
2.5
2
1.5
1
.5
0
60
80
100
120
140
Charge (%)
800
800
800
800
800

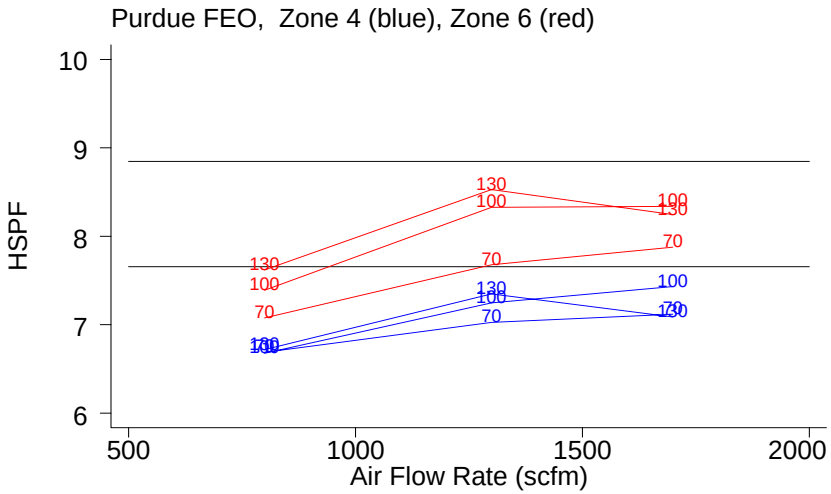
Defrost Penalties, 35°F

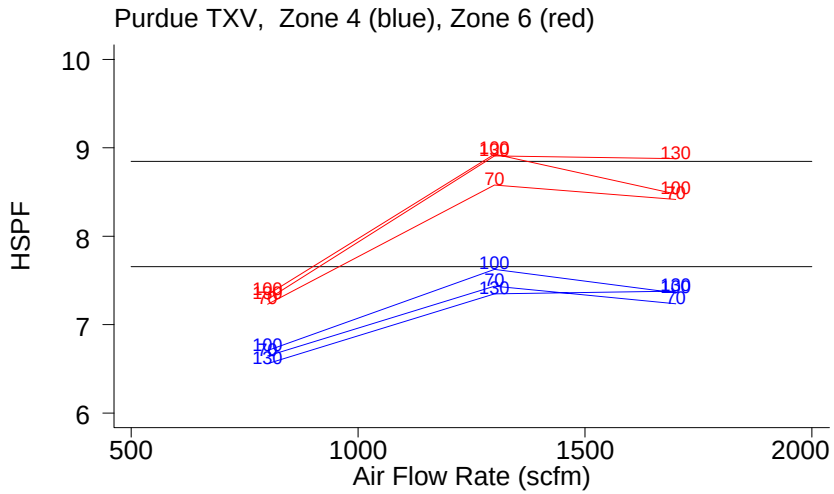


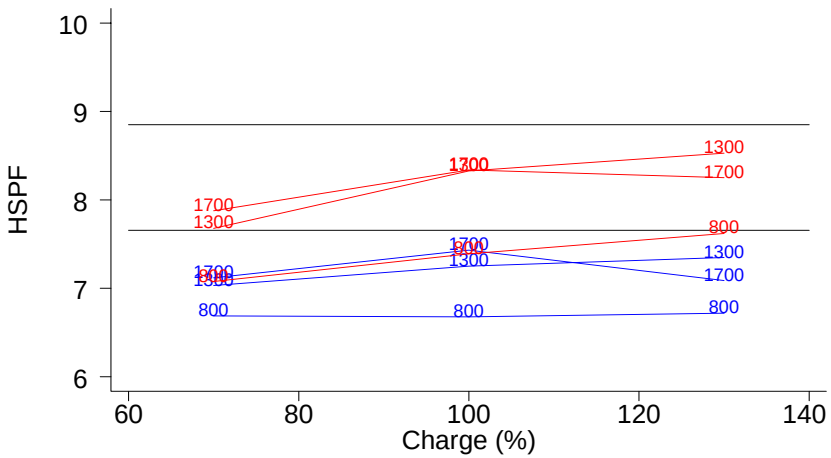
C_d

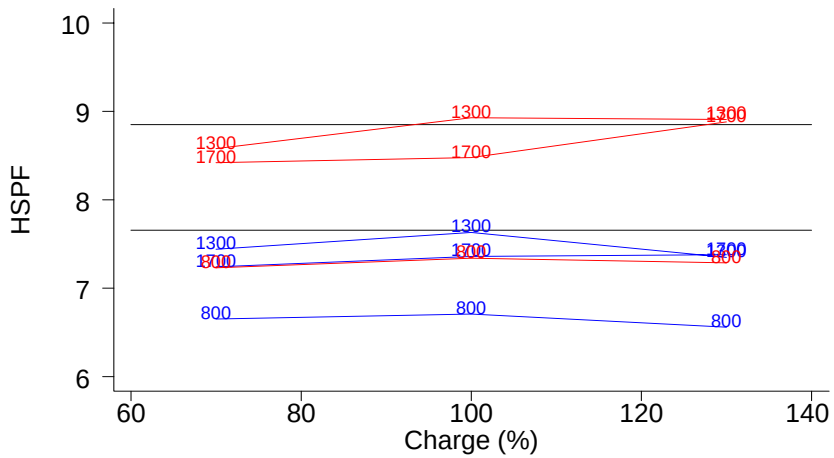

Purdue FEO
Purdue TXV
Purdue FEO
Purdue TXV
Coefficient of Degradation (Cd)
Air Flow Rate (scfm)
Charge (%)
0
.05
.1
.15
.2
.25
.3
500
1000
1500
2000
60
80
100
120
140
100
70
130
20
800
1300
1700

HSPF: All Metering

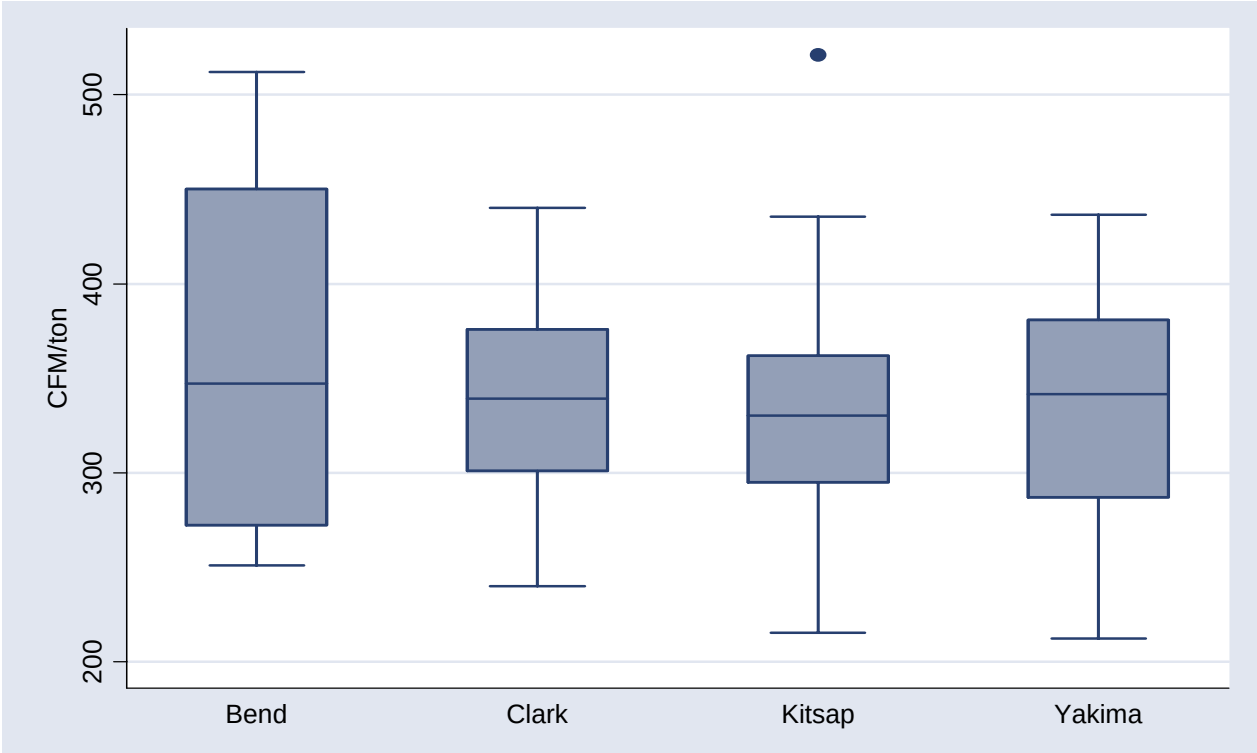








Field Observed Air Handler Flow



Results

- Impacts of refrigerant charge minimal except at very reduced levels (70% of spec)
- Impacts of air flow also limited to cases with very low air handler flow.
- Low air flow is endemic to current installation practice
- TXV improves overall performance but has minimal impacts on the effects of low charge and low air flow
- C_d higher than modeling assumptions for fixed orifice, lower than assumption for TXV
- Defrost degradation factors largely stable at values near the modeled and manufacturer's assumptions.