# HAYSTACK AT SCALE IN A MUNICIPAL ENVIRONMENT

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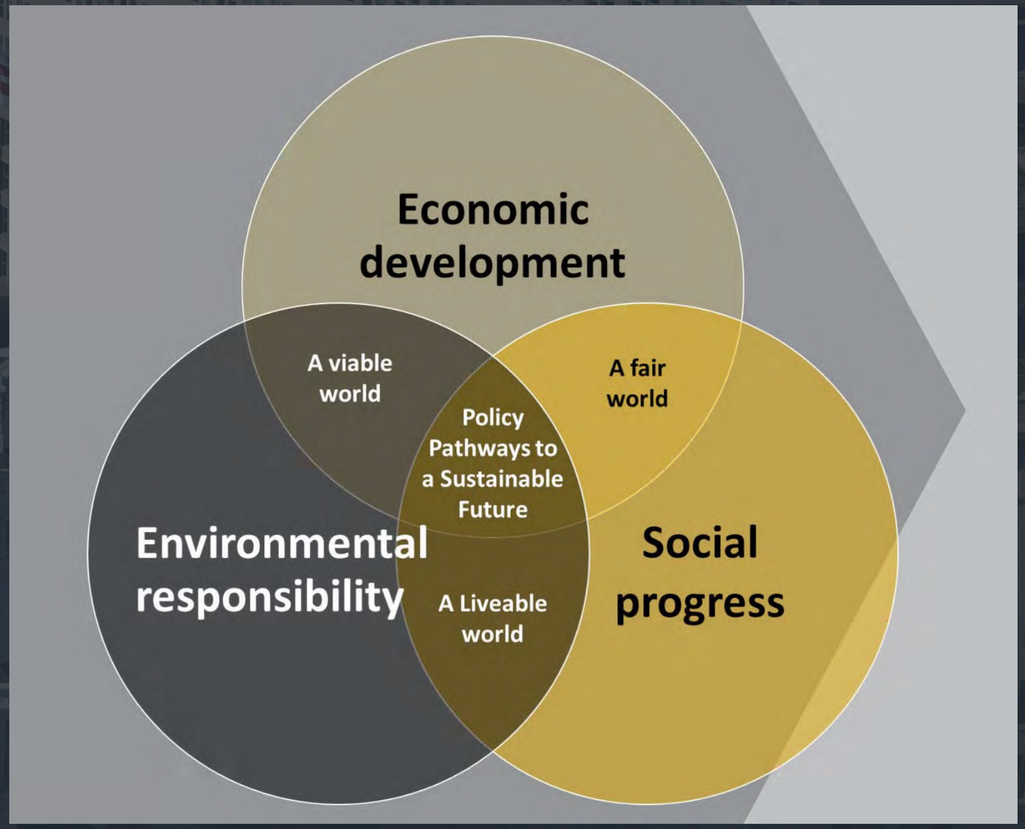
Managing Partner

New City Energy

NEW CITY ENERGY

# OBJECTIVES & VALUES:

INCLUSIVE ECONOMIC DEVELOPMENT
STEWARDSHIP OF RESOURCES
HEALTH & WELLNESS
WORKFORCE DEVELOPMENT
LIFELONG LEARNING
TRANSPARENCY IN GOVERNANCE
ECOLOGICAL VITALITY




(IMAGE CREDIT: GEORGIA TECH)

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# 10YR VISION: RENEWABLES & RETROFITS GENERATING $100B IN ANNUALLY RECURRING SAVINGS (~1000 X CURRENT SCALE)

## DATA IS LIKE SUNSHINE FOR GROWING ASSET PERFORMANCE

# PRESENTATION OVERVIEW:

1) ARGUMENT
2) OVERVIEW OF CUSTOMER #1
3) IMPLEMENTATION DETAILS
4) LESSONS LEARNED
5) TAKE AWAYS

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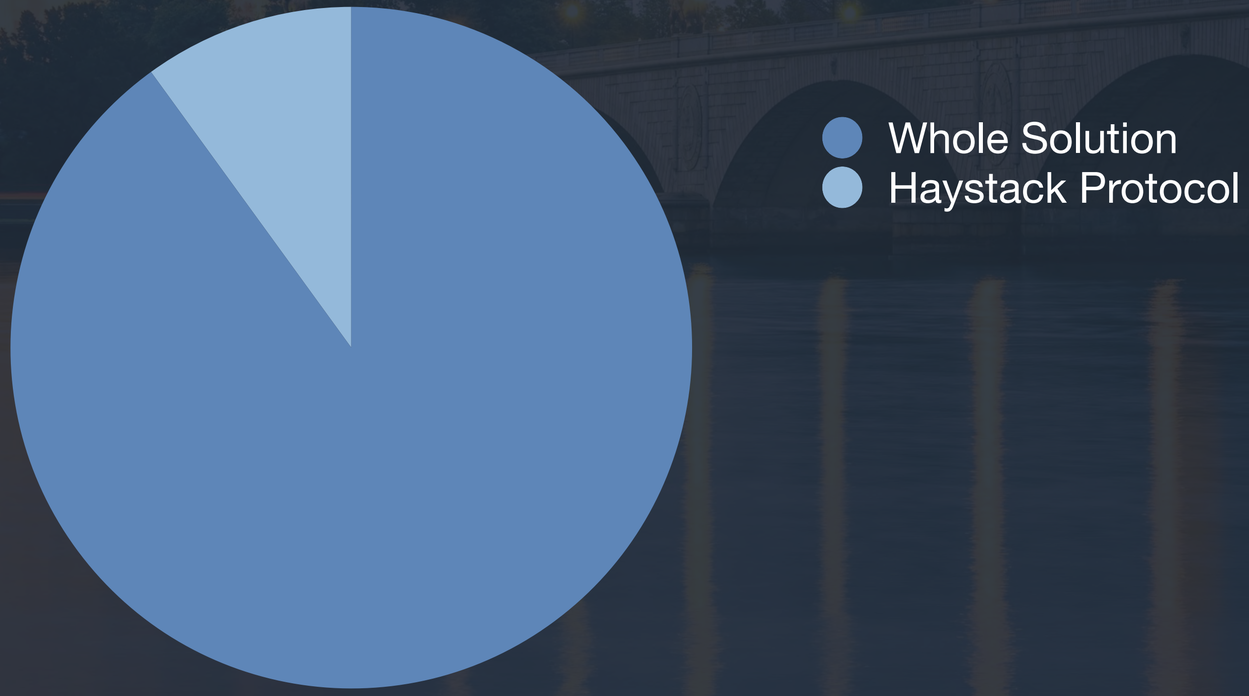
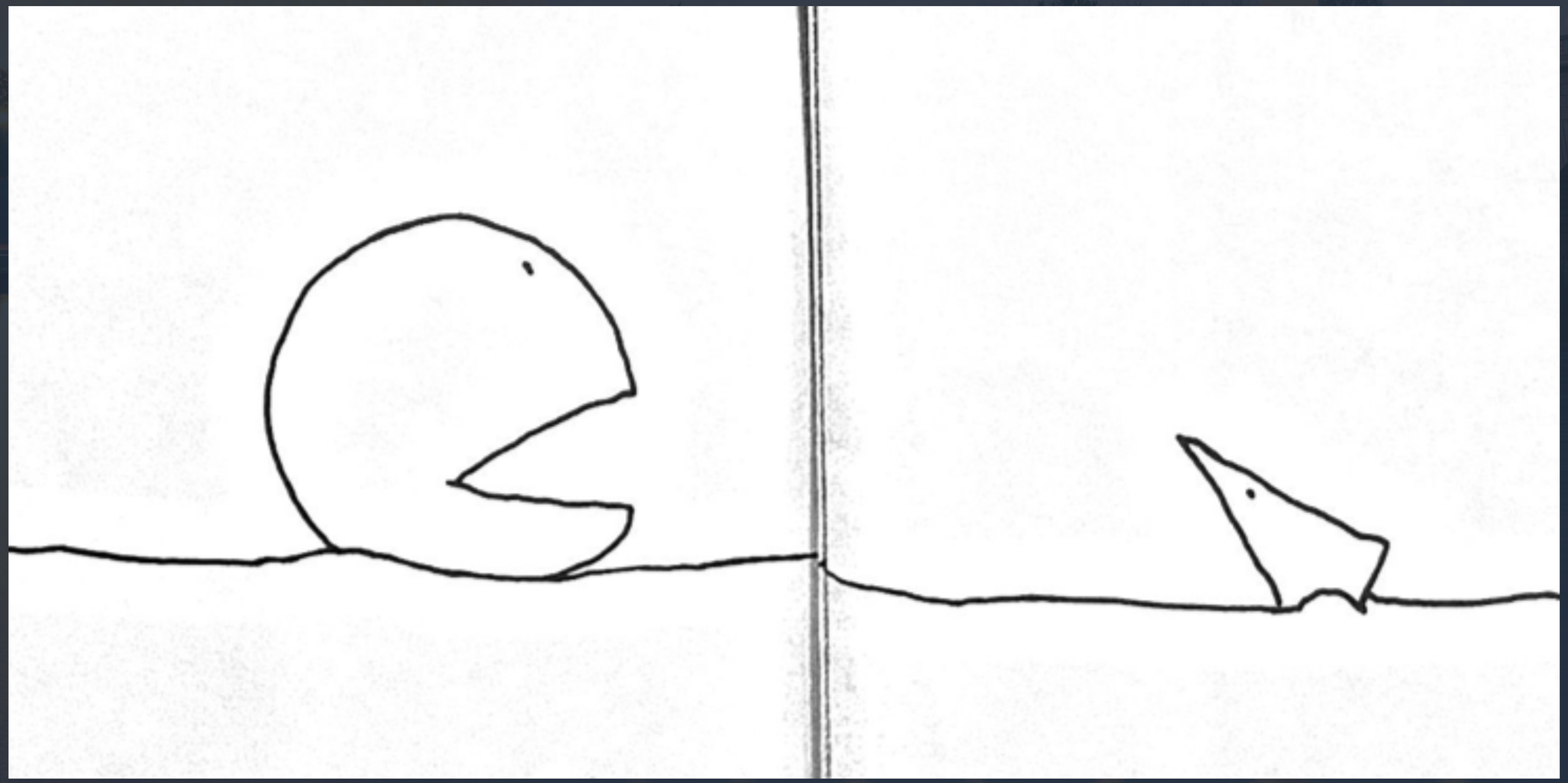
# HAYSTACK PROTOCOL AS PART OF "THE WHOLE SOLUTION" – EVERYTHING NEEDED TO CREATE SUSTAINABILITY & OPTIMAL ASSET VALUE



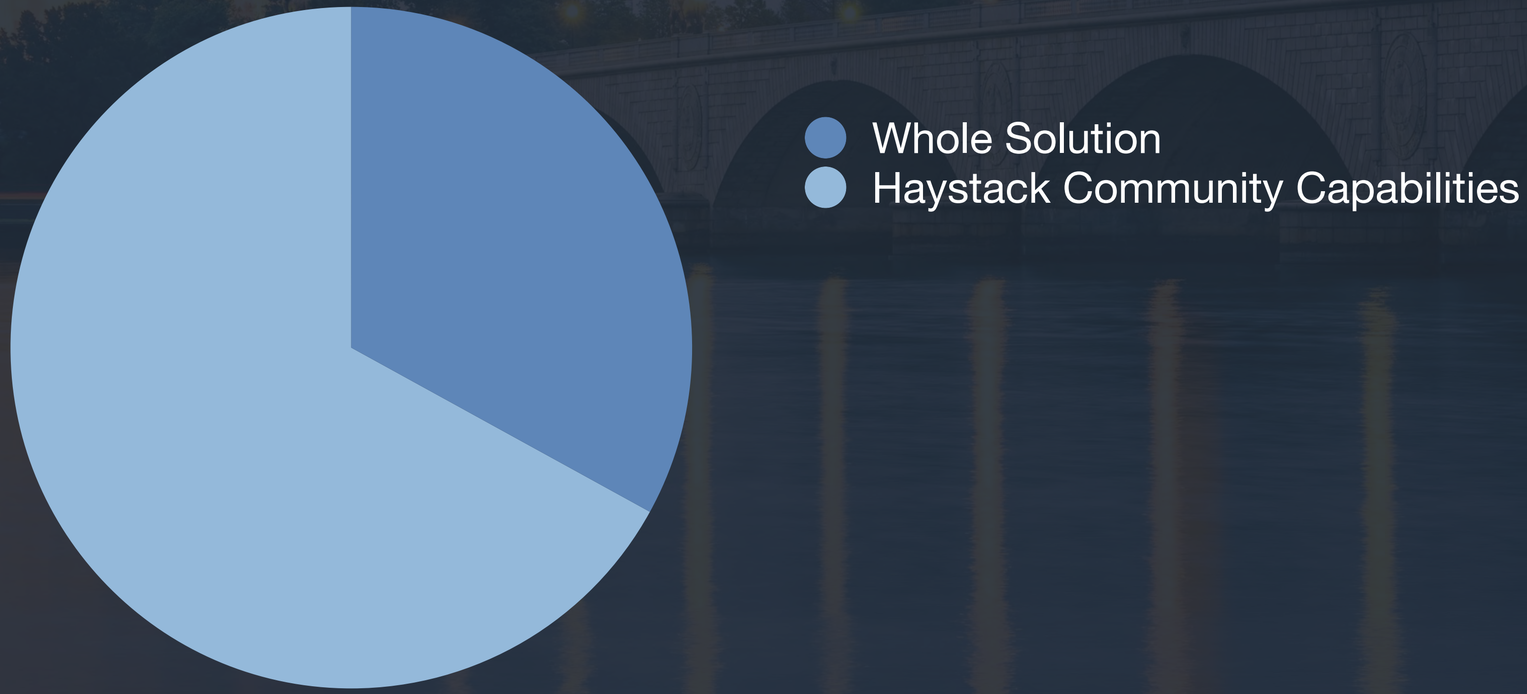
# HAYSTACK PROTOCOL AS PART OF
# "THE WHOLE SOLUTION" – EVERYTHING NEEDED TO CREATE SUSTAINABILITY & OPTIMAL ASSET VALUE



(IMAGE CREDIT: SHEL SILVERSTEIN)

# HAYSTACK COMMUNITY CAPABILITIES

## "THE WHOLE SOLUTION" – EVERYTHING NEEDED TO CREATE SUSTAINABILITY & OPTIMAL ASSET VALUE



# "THE WHOLE SOLUTION" – EVERYTHING NEEDED TO CREATE SUSTAINABILITY & OPTIMAL ASSET VALUE

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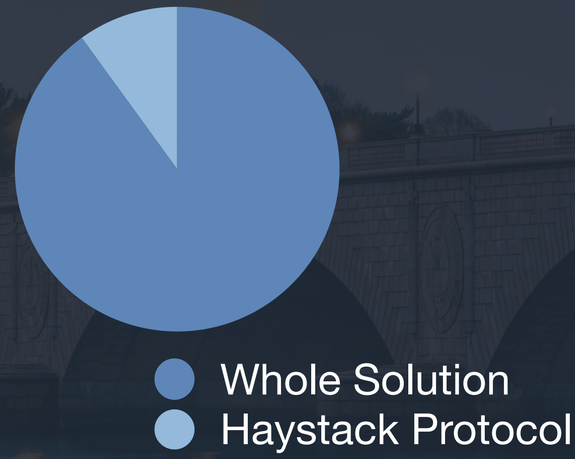
ALSO REQUIRES:
SUSTAINABILITY COMMITMENT
INTEGRATED ENERGY MANAGEMENT
COMPLEX PROGRAM DEVELOPMENT
—>ADDITIONAL STANDARDS
—>BROADER COMMUNITY

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# "THE WHOLE SOLUTION" – REFRAMED:

# THE MINIMUM NECESSARY SOLUTION SET TO CREATE SUSTAINABILITY & OPTIMAL ASSET VALUE

# THE MINIMUM NECESSARY SOLUTION SET TO CREATE SUSTAINABILITY & OPTIMAL ASSET VALUE

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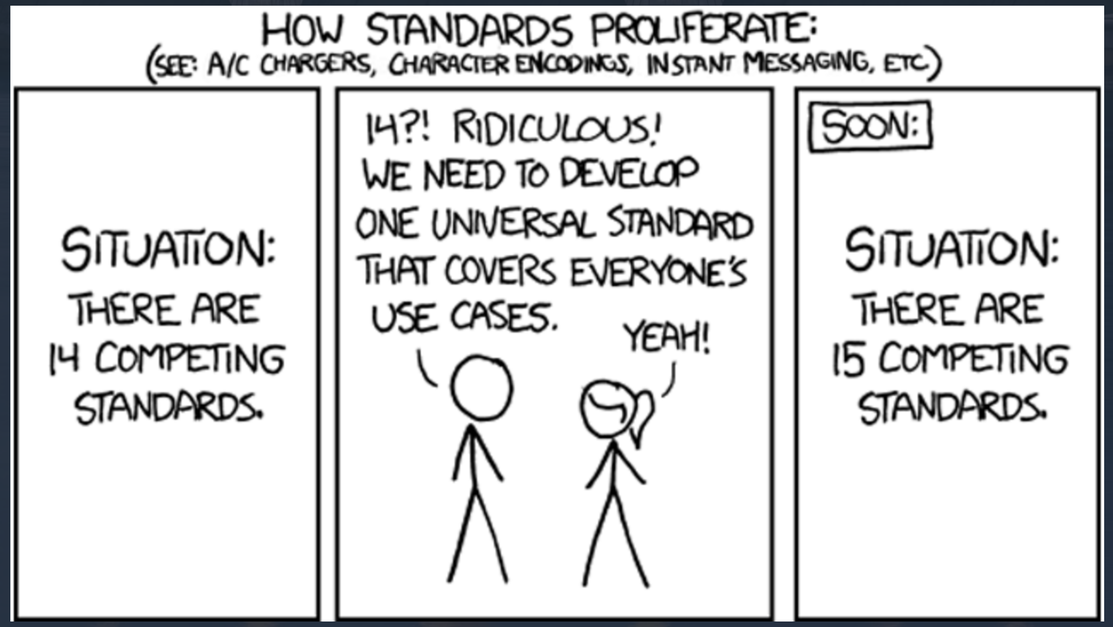
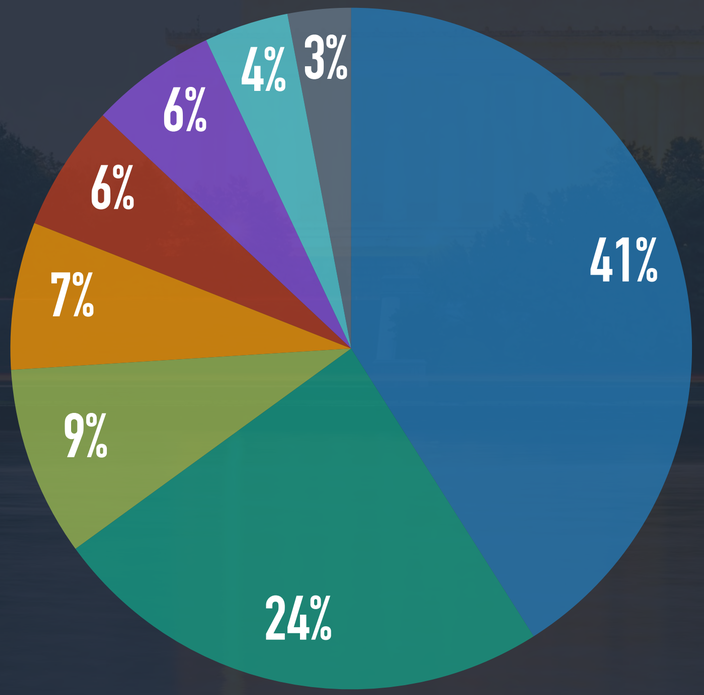
1) HAYSTACK ECOSYSTEM
2) VOLTTRON ECOSYSTEM
3) IMPLEMENTATION PROGRAMS




(IMAGE CREDIT: XKCD)

# THE D.C. MUNICIPAL BUILDING PORTFOLIO

## BY THE NUMBERS



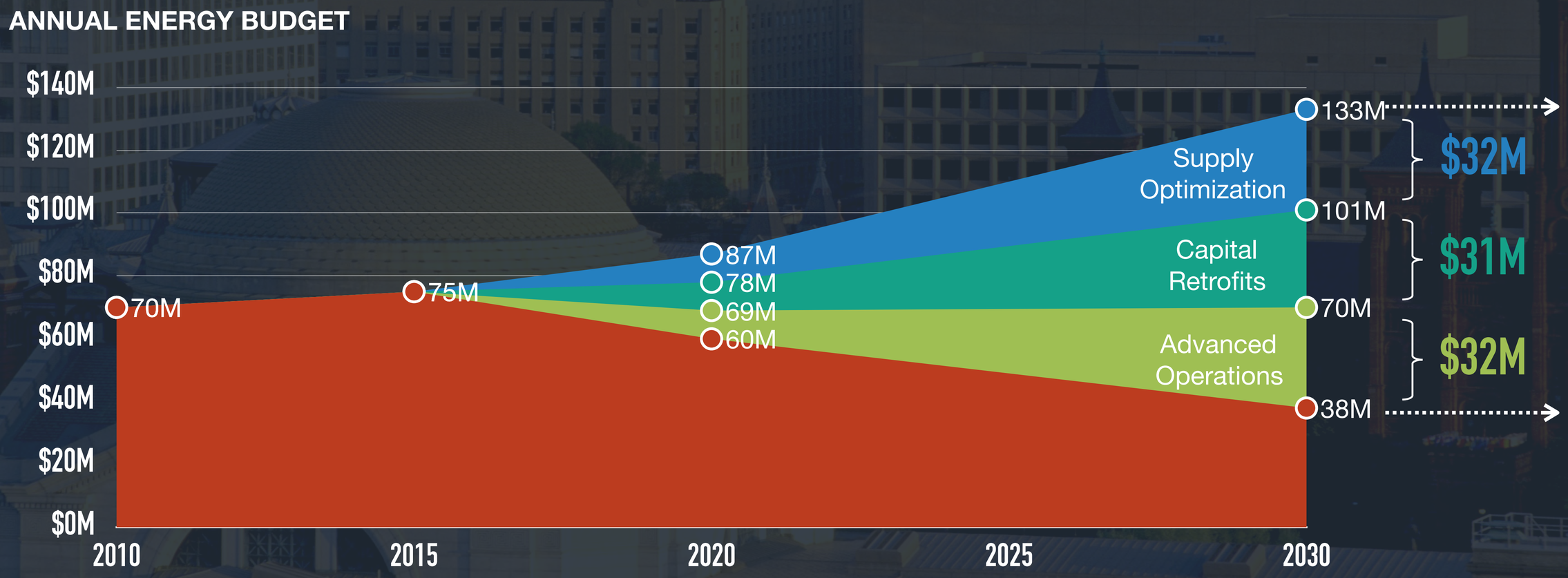

- 115 Schools
- 30 Offices
- 52 Shelters
- 40 Various
- 22 Police Stations
- 59 Recreation Centers
- 23 Libraries
- 37 Fire Stations

**100,000+ PEOPLE DEPEND ON DGS BUILDINGS EVERY DAY**

- **400** BUILDINGS
- **30M** SQUARE FEET
- **$95M** UTILITY BILLS
- **600** STAFF
- **$1B** DGS BUDGET
- **$13B** DC GOV BUDGET

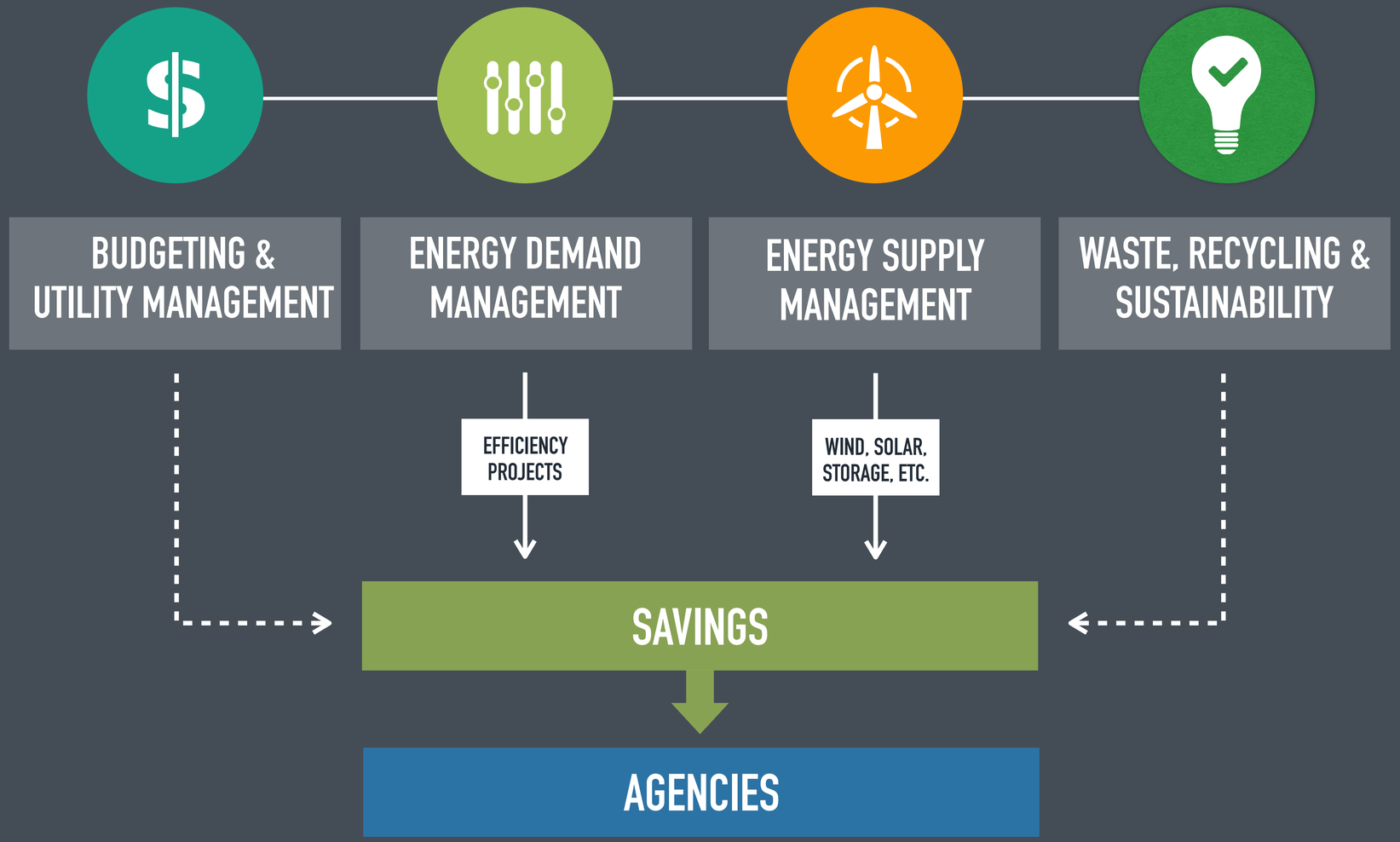
# SUSTAINABILITY & ASSET PERFORMANCE

## 50% COST REDUCTIONS x 2030



# DGS SE RESPONSIBILITIES & PROGRAM AREAS

NEW CITY ENERGY




## 3 BUDGET AREAS

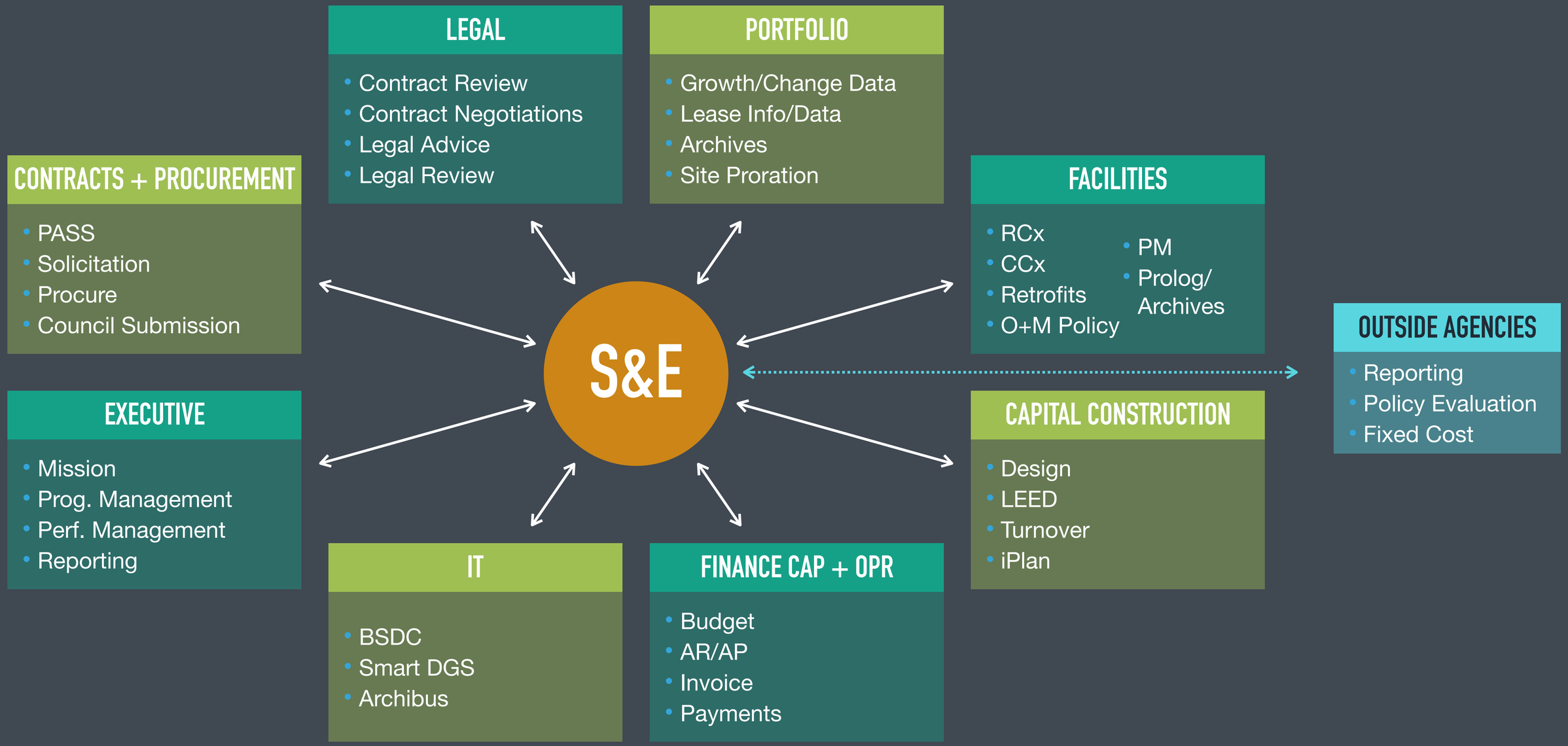
UTILITY COSTS

CAPITAL

OPERATIONS & PROGRAMS

# DGS SE PROGRAM COORDINATION MAP

NEW CITY ENERGY



# ELECTRICITY COSTS: GRANULAR VIEW

NEW CITY ENERGY

## *PJM Supply Charges - 68 Line Items*

| CHARGES | | | | NEGATIVE CHARGES | | |
|---|---|---|---|---|---|---|
| 1205 | Balancing Spot Market Energy | 1,067,425 | | 1376 | Balancing Operating Reserve for Load Response | -1 |
| 1610 | Locational Reliability | 329,296 | | 1230 | Inadvertent Interchange | -19 |
| 1100 | Network Integration Transmission Service | 140,822 | | 1375 | Balancing Operating Reserve | -81 |
| 1365 | Day-ahead Scheduling Reserve | 108,510 | | 1375 | Balancing Operating Reserve | -140 |
| 1611 | CP Transitional Locational Reliability | 106,349 | | 1307 | PJM Scheduling, System Control and Dispatch Servic | -213 |
| 1108 | Transmission Enhancement^ | 63,363 | | 1410 | Load Reconciliation for Transmission Congestion | -403 |
| 1215 | Balancing Transmission Congestion | 54,661 | | 1230 | Inadvertent Interchange | -559 |
| 1225 | Balancing Transmission Losses | 23,625 | | 1220 | Day-ahead Transmission Losses | -2,745 |
| 1375 | Balancing Operating Reserve | 19,210 | | 1210 | Day-ahead Transmission Congestion | -22,016 |
| 1301 | PJM Scheduling, System Control and Dispatch Servi | 8,074 | | 1200 | Day-ahead Spot Market Energy | -473,262 |
| 1330 | Reactive Supply and Voltage Control from Generati | 5,944 | | | | |
| 1340 | Regulation and Frequency Response Service | 4,711 | | | | |
| 1400 | Load Reconciliation for Spot Market Energy | 4,067 | | CREDITS | | |
| 1315 | FERC Annual Recovery | 3,107 | | 2108 | Transmission Enhancement | 38,278 |
| 1380 | Black Start Service^ | 2,388 | | 2510 | Auction Revenue Rights* | 26,590 |
| 1360 | Synchronized Reserve | 2,005 | | 2600 | RPM Auction | 21,275 |
| 1303 | PJM Scheduling, System Control and Dispatch Servi | 1,985 | | 2220 | Transmission Losses | 15,386 |
| 1318 | Reliability First Corporation (RFC) | 959 | | 2640 | Incremental Capacity Transfer Rights | 815 |
| 1320 | Transmission Owner Scheduling, System Control ar | 889 | | 2661 | Capacity Resource Deficiency | 494 |
| 1306 | PJM Scheduling, System Control and Dispatch Servi | 719 | | 2140 | Non-Firm Point-to-Point Transmission Service | 171 |
| 1317 | North American Electric Reliability Corporation (NE | 587 | | 2661 | Capacity Resource Deficiency | 162 |
| 1370 | Day-ahead Operating Reserve | 575 | | 2661 | Capacity Resource Deficiency | 99 |
| 1314 | Market Monitoring Unit (MMU) Funding | 299 | | 2661 | Capacity Resource Deficiency | 43 |
| 1362 | Non-Synchronized Reserve | 251 | | 2420 | Load Reconciliation for Transmission Losses | 38 |
| 1305 | PJM Scheduling, System Control and Dispatch Servi | 245 | | 2140 | Non-Firm Point-to-Point Transmission Service | 10 |
| 1313 | PJM Settlement, Inc. | 213 | | | | 103,361 |
| 1250 | Meter Error Correction | 207 | | | | |
| 1911 | Michigan - Ontario Interface Phase Angle Regulato | 116 | | | | |
| 1243 | Real-Time Load Response Charge Allocation | 69 | | | | |
| 1304 | PJM Scheduling, System Control and Dispatch Servi | 56 | | | | |
| 1440 | Load Reconciliation for PJM Scheduling, System Co | 46 | | | | |
| 1420 | Load Reconciliation for Transmission Losses | 44 | | | | |
| 1375 | Balancing Operating Reserve | 42 | | | | |
| 1460 | Load Reconciliation for Regulation and Frequency F | 40 | | | | |
| 1316 | Organization of PJM States, Inc. (OPSI) Funding | 33 | | | | |
| 1242 | Day-Ahead Load Response Charge Allocation | 25 | | | | |
| 1445 | Load Reconciliation for FERC Annual Recovery | 15 | | | | |
| 1470 | Load Reconciliation for Synchronized Reserve | 7 | | | | |
| 1448 | Load Reconciliation for Reliability First Corporation | 5 | | | | |
| 1442 | Load Reconciliation for Schedule 9-6 - Advanced Se | 4 | | | | |
| 1450 | Load Reconciliation for Transmission Owner Sched | 4 | | | | |
| 1475 | Load Reconciliation for Day-ahead Scheduling Rese | 3 | | | | |
| 1447 | Load Reconciliation for North American Electric Rel | 3 | | | | |
| 1430 | Load Reconciliation for Inadvertent Interchange | 2 | | | | |
| 1444 | Load Reconciliation for Market Monitoring Unit (M | 1 | | | | |
| 1478 | Load Reconciliation for Balancing Operating Reserv | 1 | | | | |

## *PEPCO Distribution - Sample Tariff*

**DISTRICT OF COLUMBIA**

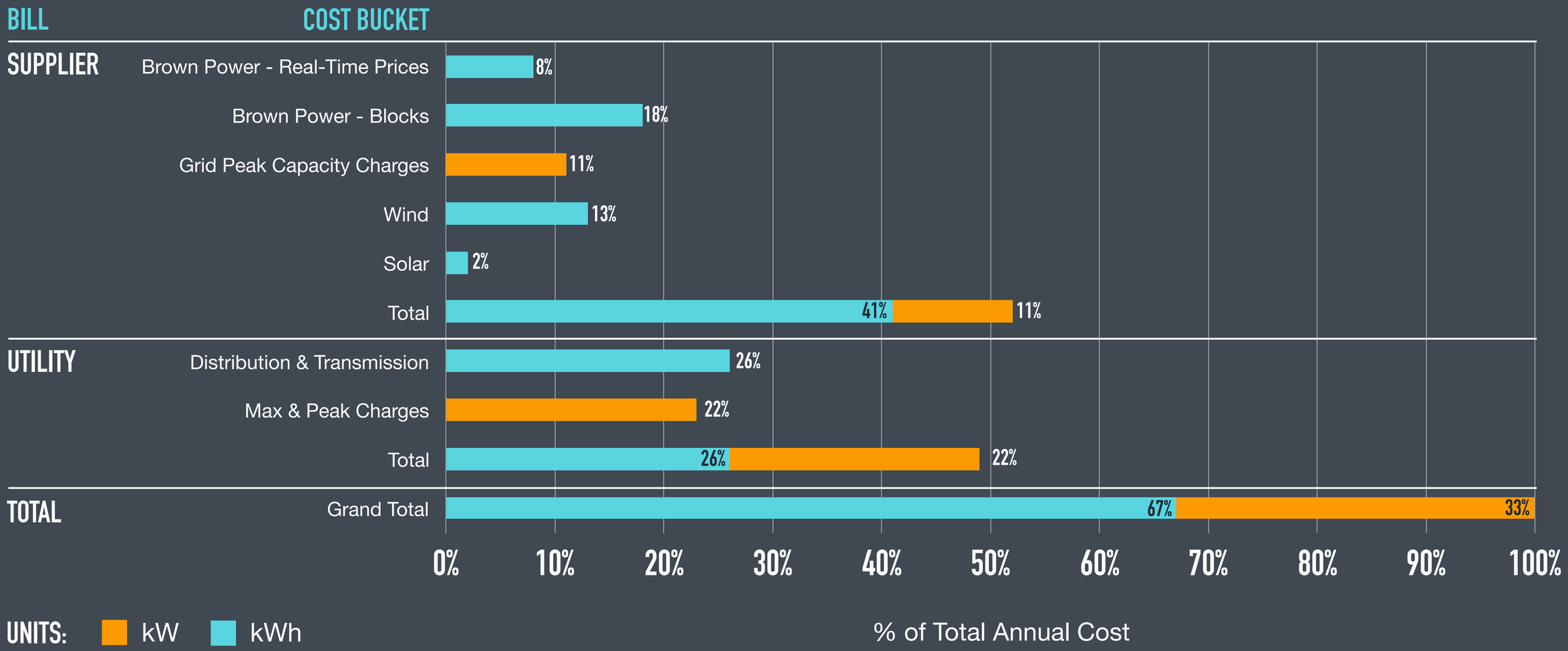
**TIME METERED GENERAL SERVICE – LOW VOLTAGE SERVICE SCHEDULE GT LV**

**UPDATED JUNE 2, 2016**

| | Jun15-Oct15 | Nov15-May16 | Jun16-Oct16 | Nov16-May17 | |
|---|---|---|---|---|---|
| **Generation** 1 | | | | | |
| Kilowatt-hour Charge | | | | | |
| On Peak | $0.08740 | $0.08014 | $0.07783 | $0.06923 | |
| Intermediate | $0.07568 | $0.08081 | $0.06460 | $0.06994 | |
| Off Peak | $0.07075 | $0.07717 | $0.05904 | $0.06622 | |
| Admin Charge * | $0.00500 | $0.00500 | $0.00500 | $0.00500 | |
| Kilowatt Charge | | | | | |
| On Peak Maximum | | | | | |
| | **Jun-Oct** | | **Nov-May** | | Effective |
| **Transmission** 2 | | | | | |
| All kwh | $0.00188 | | $0.00188 | kWh | 2/1/16 |
| On Peak | $1.23 | | | kW | 2/1/16 |
| Maximum | $1.02 | | $1.02 | kW | 2/1/16 |
| **Distribution** 3 | | | | | |
| Customer Charge | $379.03 | | $379.03 | Month | 4/16/14 |
| All kwh | $0.00864 | | $0.00864 | kWh | 4/16/14 |
| Maximum | $9.25 | | $9.25 | kW | 4/16/14 |
| Delivery Tax | $0.0077 | | $0.0077 | kWh | 1/1/05 |
| | | | | | |
| **Public Space Occupancy Surcharge** | $0.00204 | | $0.00204 | kWh | 3/1/16 |
| **Administrative Credit** | Jun-16 | Jul-16 | Aug-16 | | |
| | 0.003361 | 0.00283 | 0.003223 | kWh | |
| **Sustainable Energy Trust Fund** | $0.00150 | | $0.00150 | kWh | 10/1/10 |
| **Energy Assistance Trust Fund** 7 | $0.0000607 | | $0.0000607 | kWh | 10/1/10 |
| **RADS Surcharge**8 | $0.000647 | | $0.000647 | kWh | 7/1/16 |
| Bill Stabilization Adjustment | Jun-16 | Jul-16 | Aug-16 | | |
| | 0.00006 | 0.00006 | 0.000106 | kWh | 1/1/10 |
| **Underground Project Charge**10 | $0.00 | | $0.00 | kWh | 1/1/15 |

# ELECTRICITY COSTS: HIGH-LEVEL SEGMENTATION

*WHEN ENERGY IS CONSUMED MATTERS A LOT!*



# ELECTRICITY COST VARIABILITY: HOURLY REAL-TIME MARKET

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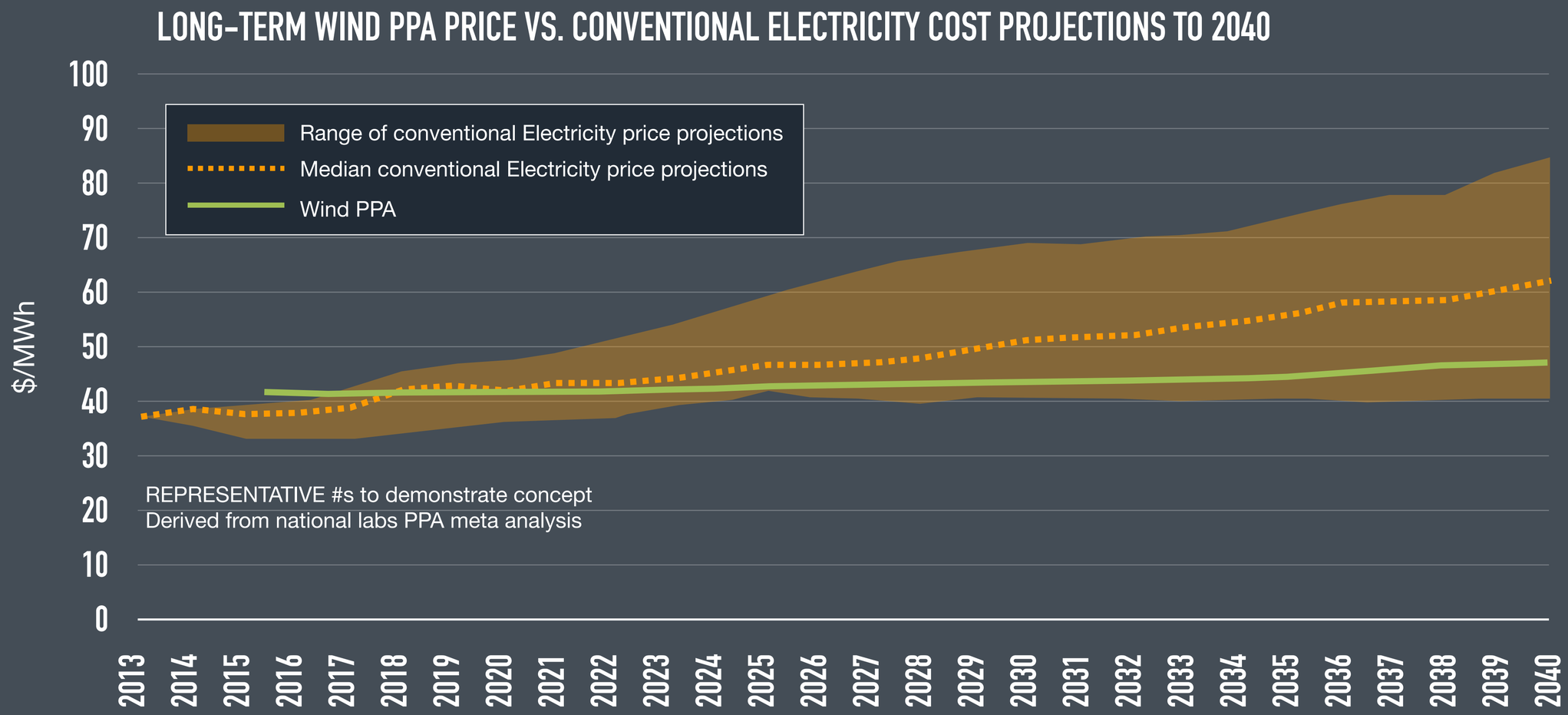
*Representative Real-Time Costs to Operate 200 I Street*

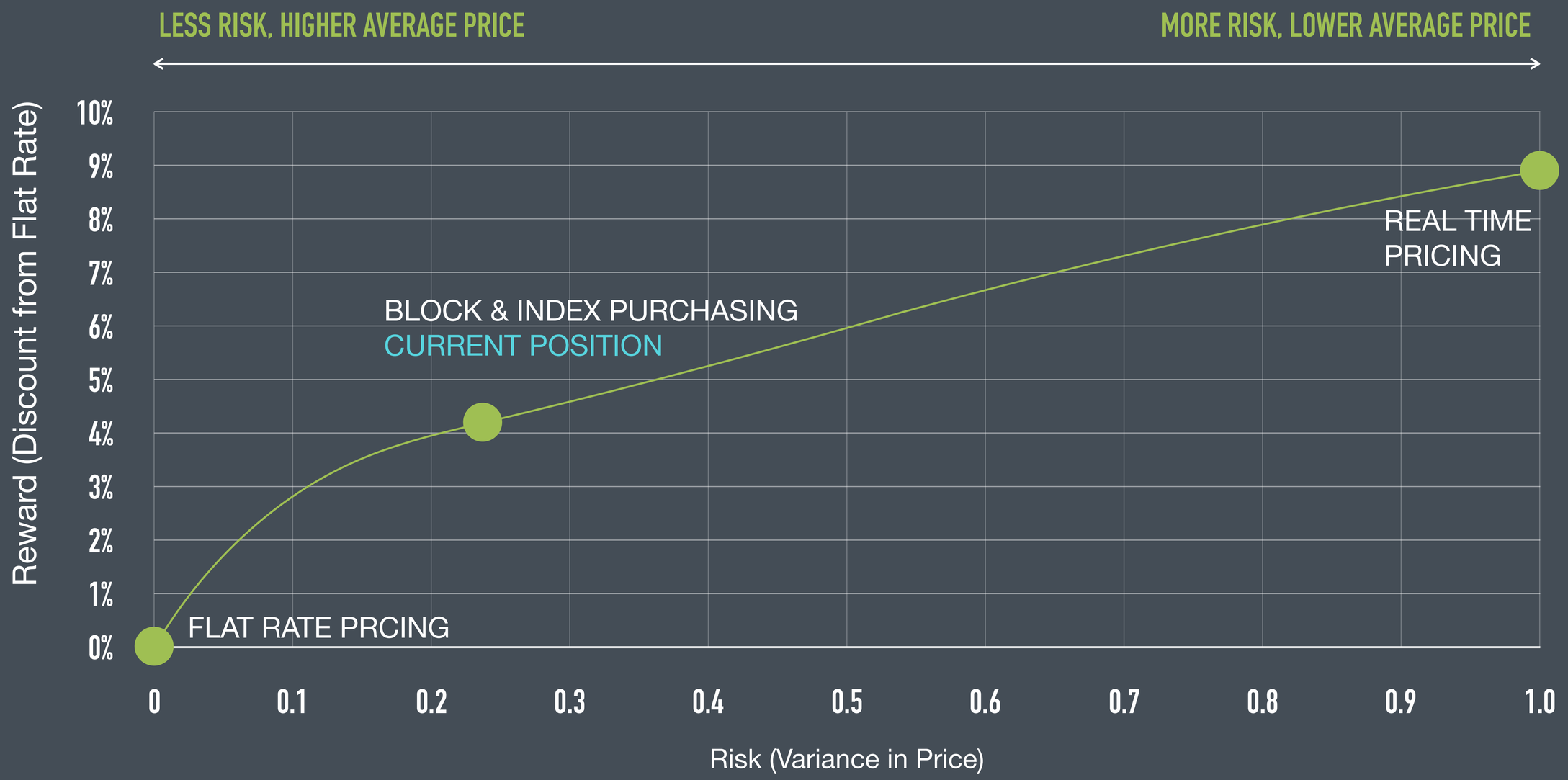
| | 1:00 | 2:00 | 3:00 | 4:00 | 5:00 | 6:00 | 7:00 | 8:00 | 9:00 | 10:00 | 11:00 | 12:00 | 13:00 | 14:00 | 15:00 | 16:00 | 17:00 | 18:00 | 19:00 | 20:00 | 21:00 | 22:00 | 23:00 | 0:00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/13/2016 | 14.66 | 14.62 | 14.26 | 13.67 | 14.10 | 17.66 | 17.19 | 19.84 | 23.82 | 25.69 | 32.49 | 33.20 | 45.81 | 39.68 | 39.35 | 37.11 | 33.49 | 32.82 | 27.40 | 27.59 | 26.06 | 24.17 | 19.47 | 16.65 |
| 7/14/2016 | 14.74 | 13.72 | 12.92 | 11.93 | 12.76 | 16.27 | 18.49 | 20.67 | 21.89 | 26.79 | 35.32 | 39.46 | 93.28 | 32.38 | 41.21 | 35.83 | 31.44 | 40.35 | 44.47 | 28.05 | 27.23 | 23.54 | 19.94 | 17.44 |
| 7/15/2016 | 15.51 | 14.55 | 13.69 | 12.87 | 12.73 | 15.83 | 17.28 | 19.32 | 21.23 | 24.58 | 27.05 | 28.01 | 27.09 | 30.08 | 29.90 | 32.64 | 29.06 | 27.19 | 21.87 | 19.84 | 18.55 | 18.41 | 16.34 | 14.92 |
| 7/16/2016 | 13.60 | 13.53 | 12.90 | 11.50 | 10.35 | 11.05 | 12.21 | 13.54 | 14.78 | 17.06 | 17.97 | 20.14 | 20.06 | 22.53 | 23.69 | 23.94 | 20.67 | 18.84 | 17.46 | 16.93 | 15.34 | 15.91 | 14.93 | 13.01 |
| 7/17/2016 | 11.25 | 10.45 | 8.92 | 8.70 | 7.85 | 6.27 | 1.09 | 7.15 | 11.08 | 14.70 | 16.15 | 17.30 | 19.02 | 19.50 | 24.94 | 20.56 | 33.39 | 23.49 | 39.82 | 40.57 | 32.63 | 33.19 | 17.02 | 14.99 |
| 7/18/2016 | 14.41 | 13.58 | 13.12 | 12.41 | 13.17 | 15.58 | 16.30 | 18.38 | 20.26 | 27.95 | 33.71 | 43.09 | 34.04 | 46.65 | 23.07 | 25.19 | 29.90 | 30.63 | 30.13 | 26.40 | 26.11 | 23.78 | 18.34 | 16.41 |
| 7/19/2016 | 14.82 | 15.40 | 13.84 | 13.49 | 14.54 | 17.33 | 18.48 | 24.94 | 52.34 | 28.75 | 30.47 | 30.28 | 29.58 | 45.33 | 38.89 | 37.69 | 96.40 | 42.25 | 33.57 | 31.20 | 27.87 | 30.13 | 20.78 | 16.66 |
| 7/20/2016 | 15.35 | 15.06 | 13.73 | 12.40 | 14.00 | 16.13 | 18.27 | 22.25 | 27.14 | 29.08 | 28.11 | 28.18 | 31.53 | 32.92 | 31.24 | 53.23 | 42.03 | 40.34 | 63.41 | 46.14 | 23.14 | 23.33 | 20.51 | 16.03 |
| 7/21/2016 | 13.29 | 12.48 | 11.42 | 11.23 | 12.85 | 16.32 | 16.00 | 19.24 | 24.84 | 25.54 | 26.52 | 25.76 | 28.78 | 27.33 | 30.15 | 33.74 | 35.38 | 29.76 | 26.10 | 22.13 | 21.87 | 19.67 | 19.36 | 16.58 |
| 7/22/2016 | 14.93 | 13.66 | 13.12 | 10.54 | 12.13 | 15.23 | 17.19 | 19.14 | 21.31 | 23.75 | 25.10 | 26.46 | 27.10 | 34.08 | 53.78 | 56.03 | 79.16 | 39.78 | 34.33 | 25.44 | 22.19 | 22.39 | 19.67 | 18.29 |
| 7/23/2016 | 16.31 | 15.96 | 15.69 | 14.65 | 13.10 | 12.74 | 13.07 | 15.71 | 18.61 | 19.38 | 22.22 | 25.67 | 26.69 | 26.98 | 40.48 | 32.11 | 30.82 | 25.53 | 23.03 | 22.25 | 21.34 | 22.09 | 20.62 | 19.85 |
| 7/24/2016 | 17.15 | 15.28 | 13.66 | 13.42 | 8.41 | 11.15 | 13.54 | 14.31 | 17.37 | 18.68 | 19.53 | 21.23 | 23.54 | 23.91 | 25.12 | 31.93 | 26.32 | 35.39 | 36.36 | 33.41 | 24.66 | 23.71 | 21.55 | 18.14 |
| 7/25/2016 | 16.87 | 16.58 | 15.94 | 15.44 | 16.00 | 18.62 | 20.26 | 23.55 | 26.95 | 33.91 | 40.25 | 34.24 | 49.74 | 66.54 | 80.89 | 49.58 | 44.34 | 53.71 | 35.15 | 28.69 | 28.96 | 30.87 | 23.05 | 23.02 |
| 7/26/2016 | 17.87 | 16.84 | 16.55 | 15.82 | 16.47 | 19.83 | 21.05 | 22.86 | 28.59 | 30.96 | 35.46 | 37.19 | 36.22 | 41.53 | 45.72 | 42.38 | 49.27 | 63.78 | 36.43 | 29.21 | 30.33 | 26.25 | 20.65 | 19.58 |
| 7/27/2016 | 17.38 | 17.47 | 38.89 | 17.61 | 19.05 | 24.07 | 22.61 | 25.36 | 24.89 | 29.17 | 36.60 | 43.26 | 40.93 | 59.12 | 83.15 | 104.29 | 178.90 | 76.85 | 75.29 | 33.03 | 50.45 | 27.44 | 33.58 | 24.96 |
| 7/28/2016 | 20.12 | 17.54 | 17.19 | 17.34 | 18.76 | 21.68 | 22.90 | 25.79 | 30.68 | 43.57 | 43.63 | 79.36 | 113.34 | 84.83 | 77.90 | 37.30 | 41.95 | 33.98 | 33.21 | 31.73 | 31.10 | 25.87 | 20.43 | 21.99 |
| 7/29/2016 | 19.34 | 16.79 | 16.21 | 15.85 | 17.00 | 19.54 | 20.91 | 19.93 | 21.58 | 29.62 | 29.06 | 34.34 | 33.06 | 35.33 | 38.00 | 45.02 | 55.20 | 58.29 | 33.21 | 36.35 | 28.91 | 23.12 | 18.98 | 17.84 |
| 7/30/2016 | 17.30 | 16.94 | 15.63 | 15.00 | 14.65 | 14.89 | 14.64 | 15.44 | 17.10 | 30.76 | 26.08 | 43.25 | 25.99 | 21.37 | 22.51 | 30.58 | 23.66 | 29.45 | 23.23 | 24.39 | 19.69 | 19.16 | 19.05 | 17.52 |
| 7/31/2016 | 15.81 | 15.27 | 14.67 | 13.83 | 12.97 | 13.75 | 13.93 | 15.70 | 16.68 | 18.08 | 44.36 | 55.15 | 72.73 | 63.01 | 50.33 | 58.72 | 41.29 | 27.14 | 25.63 | 32.14 | 42.53 | 21.12 | 23.58 | 17.31 |
| 8/1/2016 | 15.51 | 15.38 | 14.74 | 14.44 | 15.20 | 17.70 | 18.84 | 19.95 | 23.80 | 30.05 | 72.81 | 76.50 | 51.14 | 78.47 | 66.74 | 58.01 | 49.77 | 37.55 | 29.59 | 28.55 | 30.31 | 29.43 | 20.23 | 19.71 |
| 8/2/2016 | 16.56 | 17.33 | 17.09 | 16.38 | 17.16 | 18.70 | 21.41 | 22.69 | 24.12 | 26.80 | 31.49 | 34.09 | 34.39 | 49.97 | 42.38 | 49.74 | 36.02 | 35.79 | 29.56 | 27.85 | 25.79 | 23.97 | 20.93 | 19.23 |
| 8/3/2016 | 18.15 | 18.59 | 17.56 | 16.98 | 17.55 | 19.30 | 20.62 | 22.16 | 23.47 | 29.72 | 29.28 | 28.93 | 31.45 | 30.80 | 29.75 | 31.79 | 31.06 | 28.91 | 23.61 | 22.74 | 20.50 | 20.58 | 18.48 | 18.49 |
| 8/4/2016 | 16.24 | 17.50 | 15.97 | 15.07 | 15.28 | 18.72 | 19.13 | 22.87 | 23.24 | 25.65 | 29.44 | 125.33 | 36.30 | 39.94 | 30.63 | 31.59 | 33.92 | 35.65 | 25.64 | 21.79 | 22.02 | 21.79 | 18.94 | 17.61 |
| 8/5/2016 | 16.84 | 17.32 | 16.81 | 14.49 | 15.96 | 19.28 | 20.74 | 20.54 | 23.11 | 22.98 | 25.38 | 25.58 | 27.91 | 27.81 | 30.91 | 32.24 | 32.43 | 30.52 | 25.03 | 23.37 | 24.18 | 22.04 | 19.93 | 19.20 |
| 8/6/2016 | 17.40 | 17.46 | 17.91 | 17.06 | 16.30 | 14.15 | 14.29 | 15.94 | 18.35 | 19.87 | 21.63 | 24.87 | 25.16 | 24.43 | 21.39 | 22.50 | 23.32 | 22.84 | 23.28 | 21.18 | 22.27 | 22.31 | 18.88 | 16.92 |
| 8/7/2016 | 15.02 | 14.12 | 10.81 | 10.14 | 9.55 | 9.41 | 8.37 | 11.86 | 16.89 | 16.73 | 15.33 | 17.39 | 20.41 | 21.68 | 22.59 | 21.96 | 26.52 | 39.36 | 24.46 | 20.74 | 18.97 | 18.58 | 17.50 | 13.75 |

# RENEWABLE POWER PURCHASES AS A LONG-TERM STRATEGY



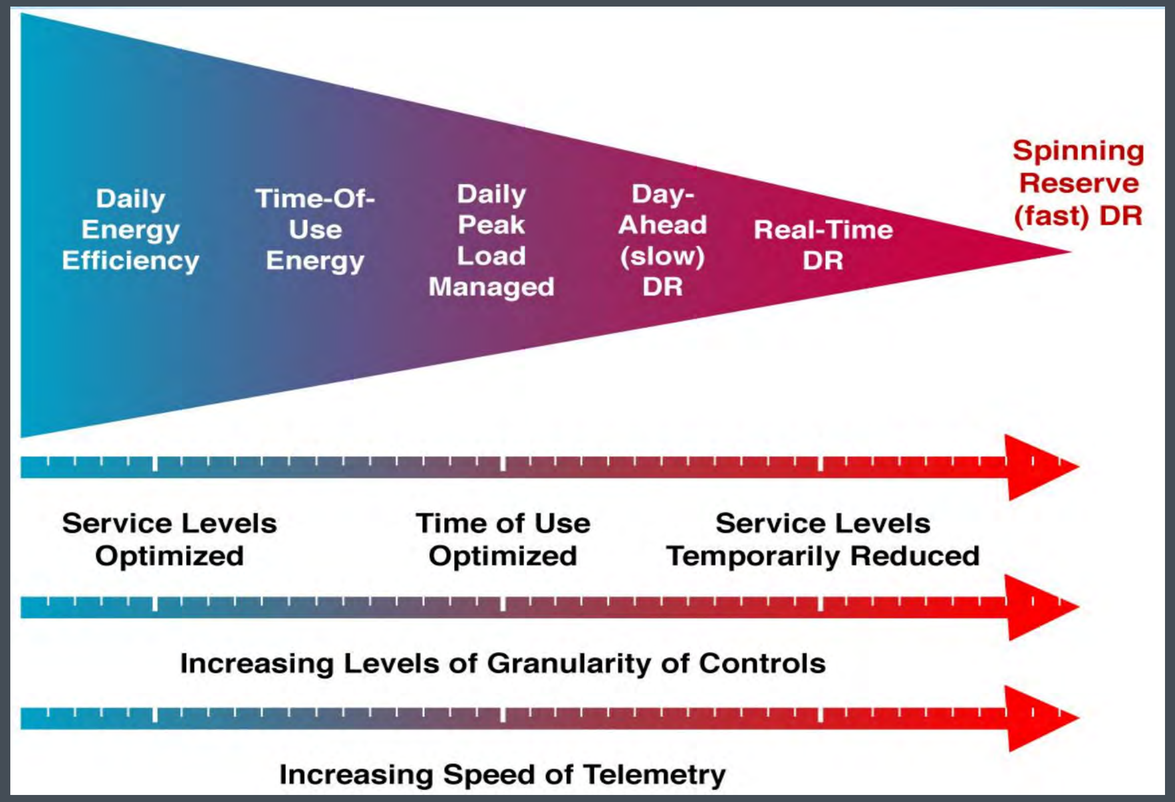
# DGS SE SUPPLY STRATEGY

*Market Exposure Reduces Average Prices*

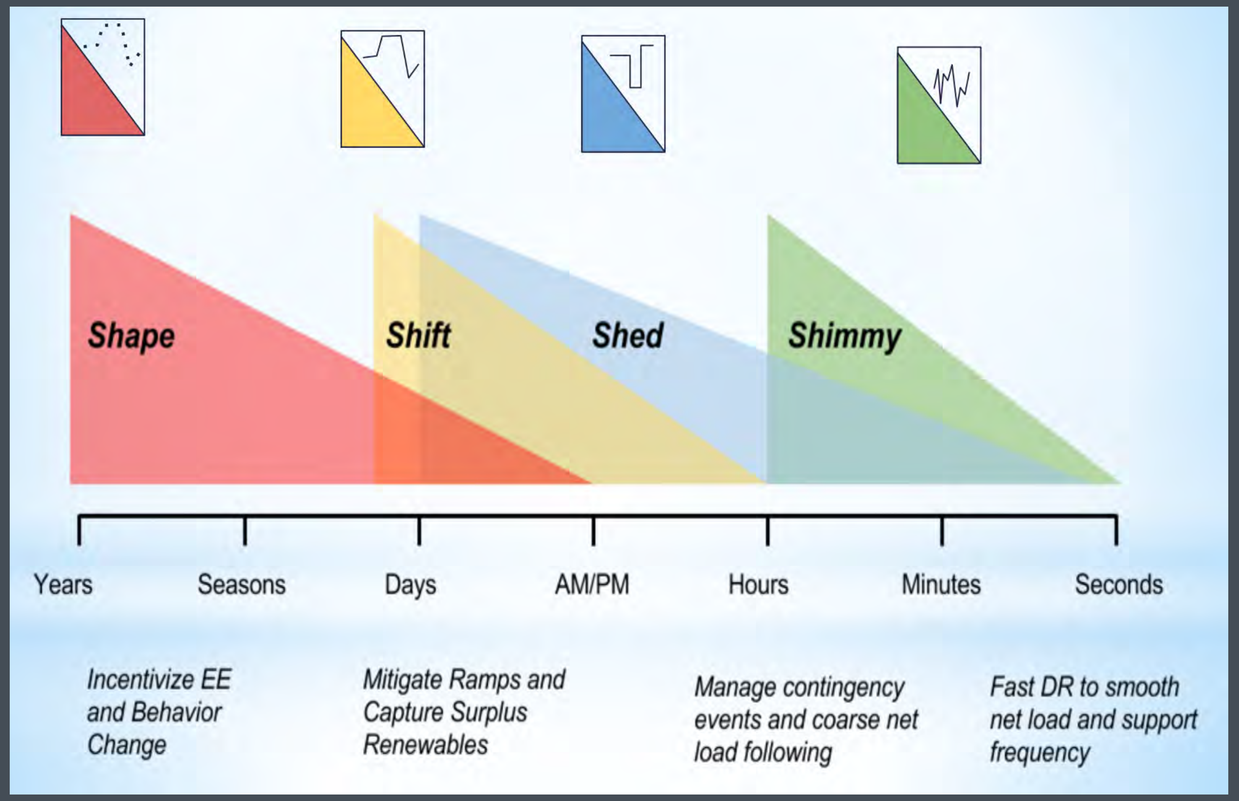


# DGS SE SUPPLY STRATEGY

*GRID INTERACTIVE ENERGY EFFICIENT BUILDINGS (GEB)*




(IMAGE CREDIT: DOE)




(IMAGE CREDIT: DOE)

# DGS SE SUPPLY STRATEGY

*GRID INTERACTIVE ENERGY EFFICIENT BUILDINGS (GEB) WITH ECLIPSE VOLITION*

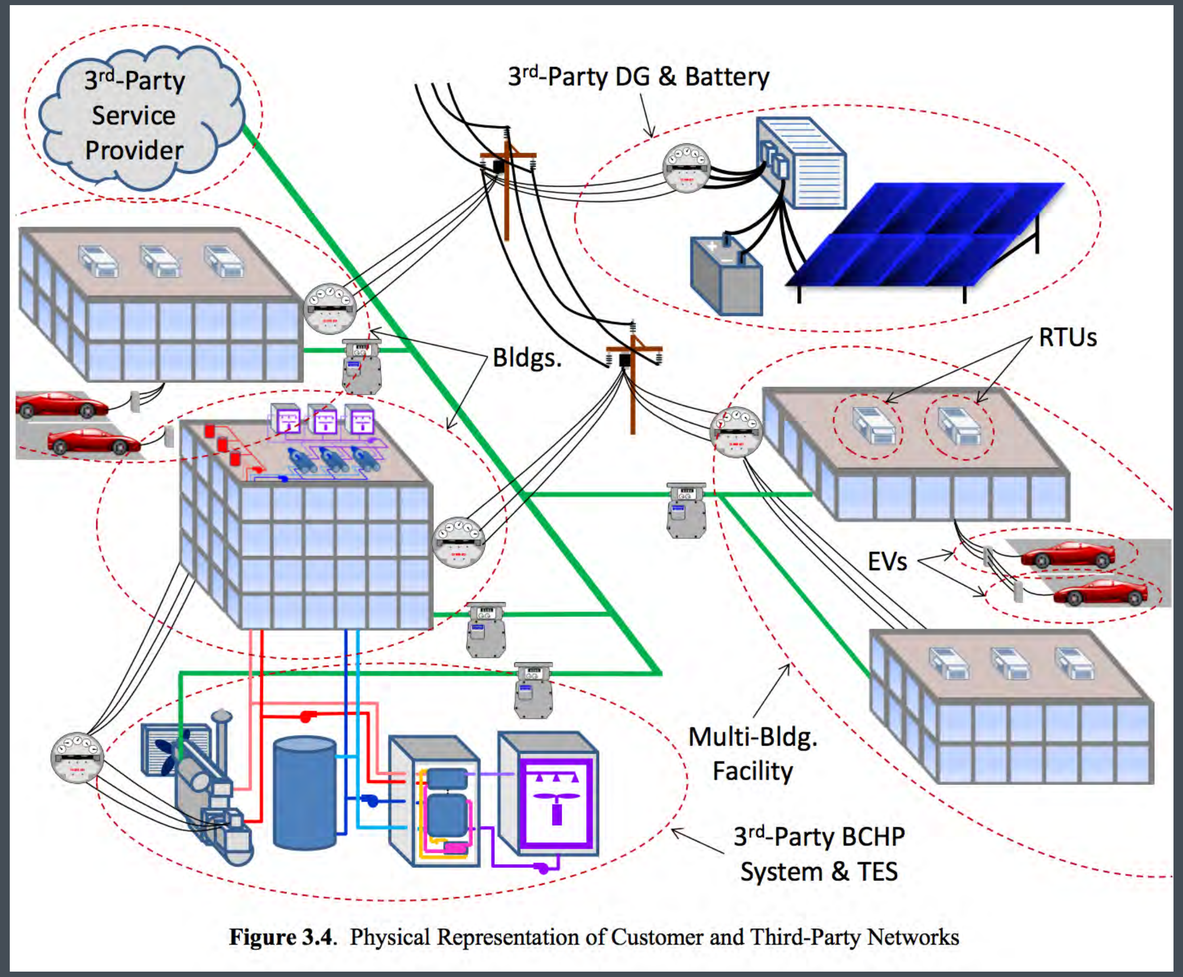
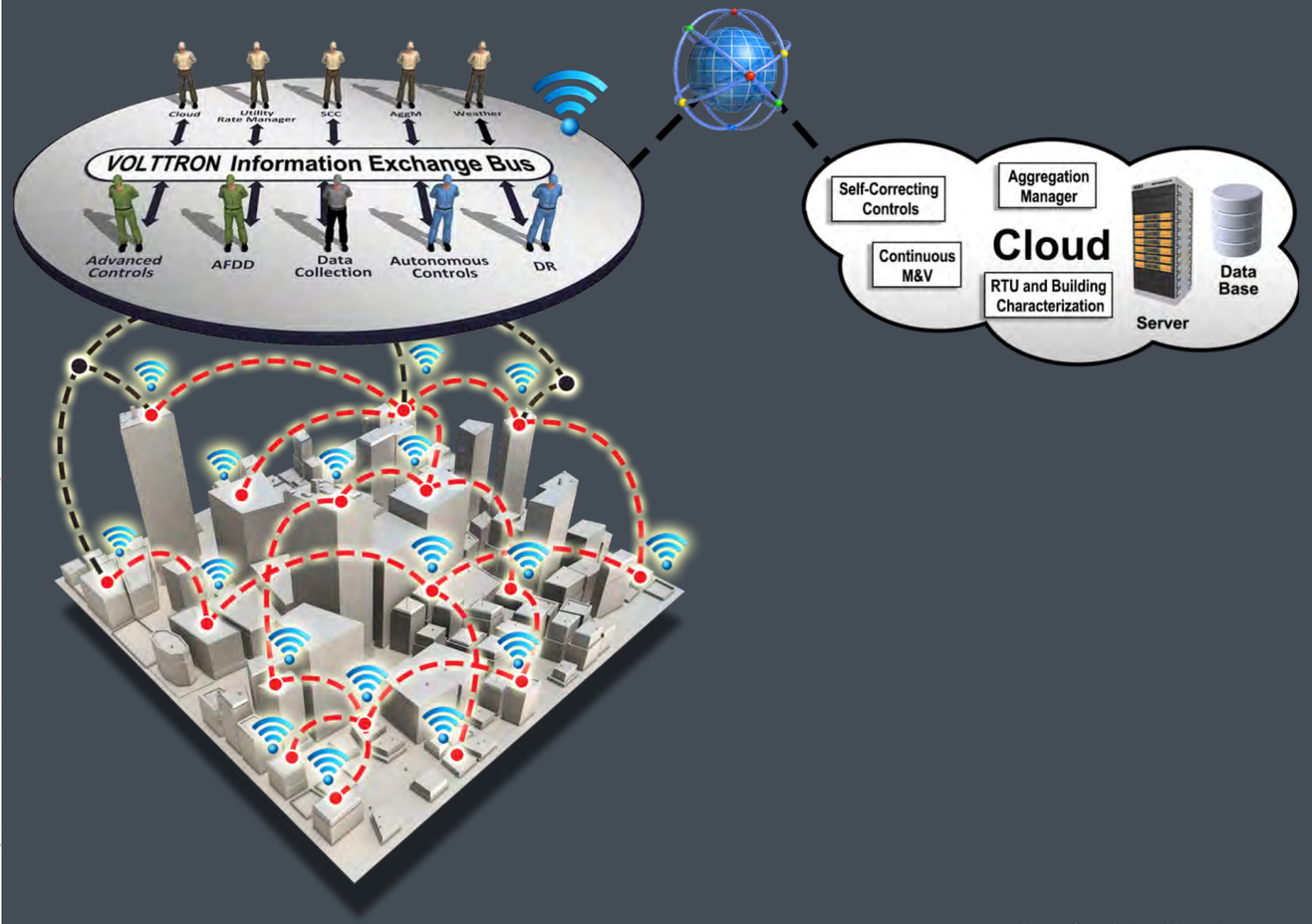



**Figure 3.4.** Physical Representation of Customer and Third-Party Networks

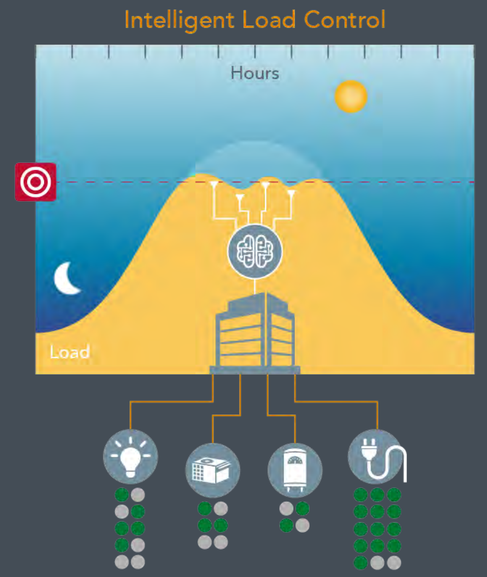
(IMAGE CREDIT: DOE)



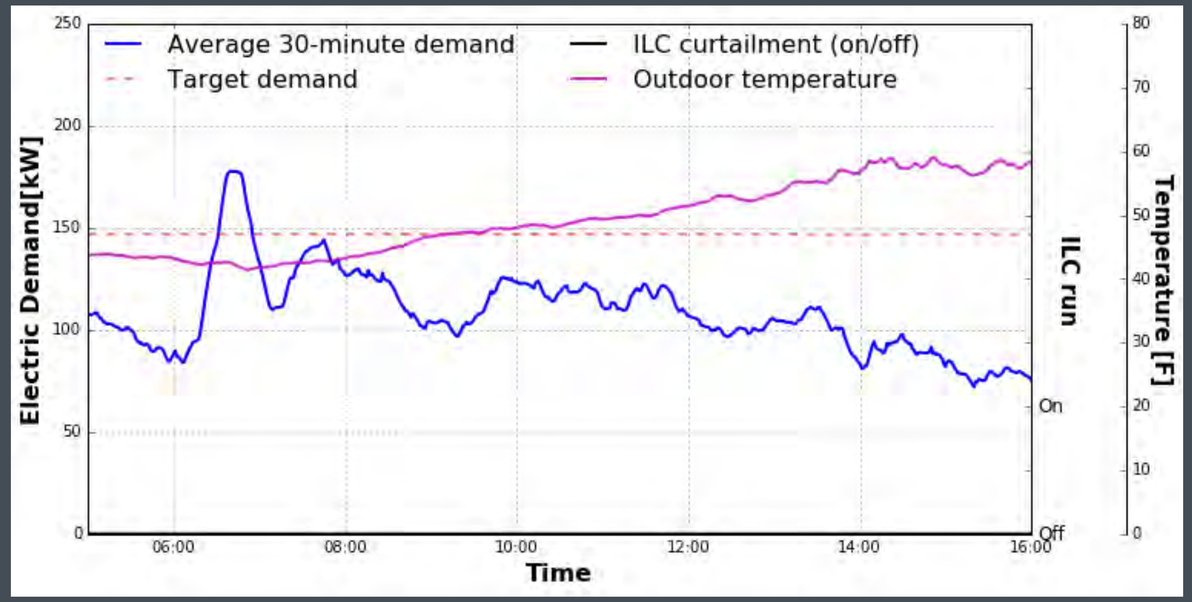

(IMAGE CREDIT: PNNL)

# DGS SE SUPPLY STRATEGY

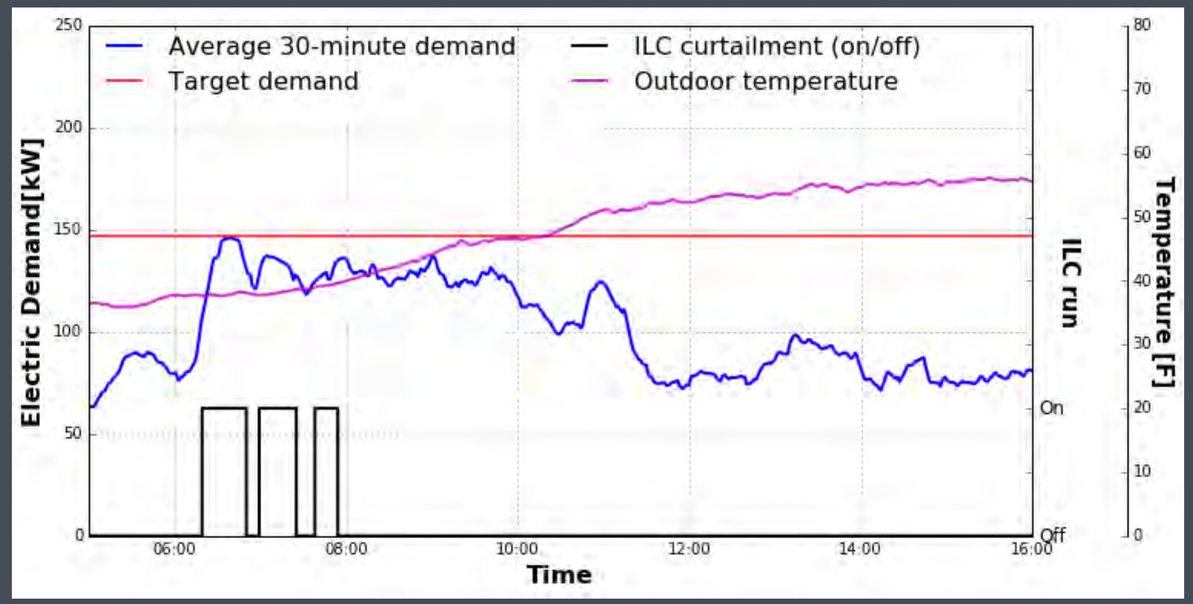
*INTELLIGENT LOAD CONTROL (ILC) WITH ECLIPSE VOLITION*




**Example No ILC: March 14**




**Example with ILC: March 15**

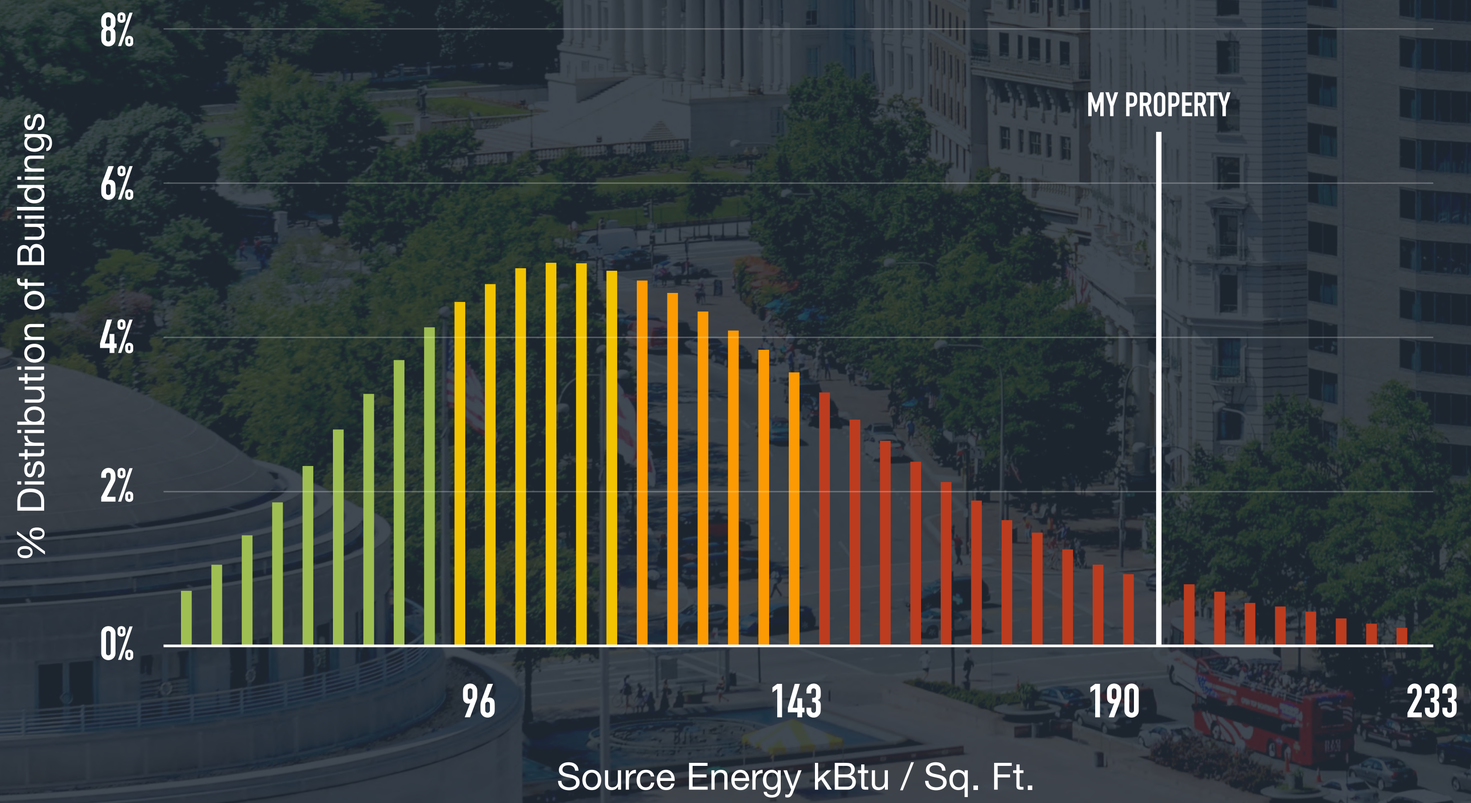



(IMAGE CREDIT: PNNL)

# SITE PERFORMANCE BENCHMARKING

## COMPARISON

How My Property compares to Similar Properties



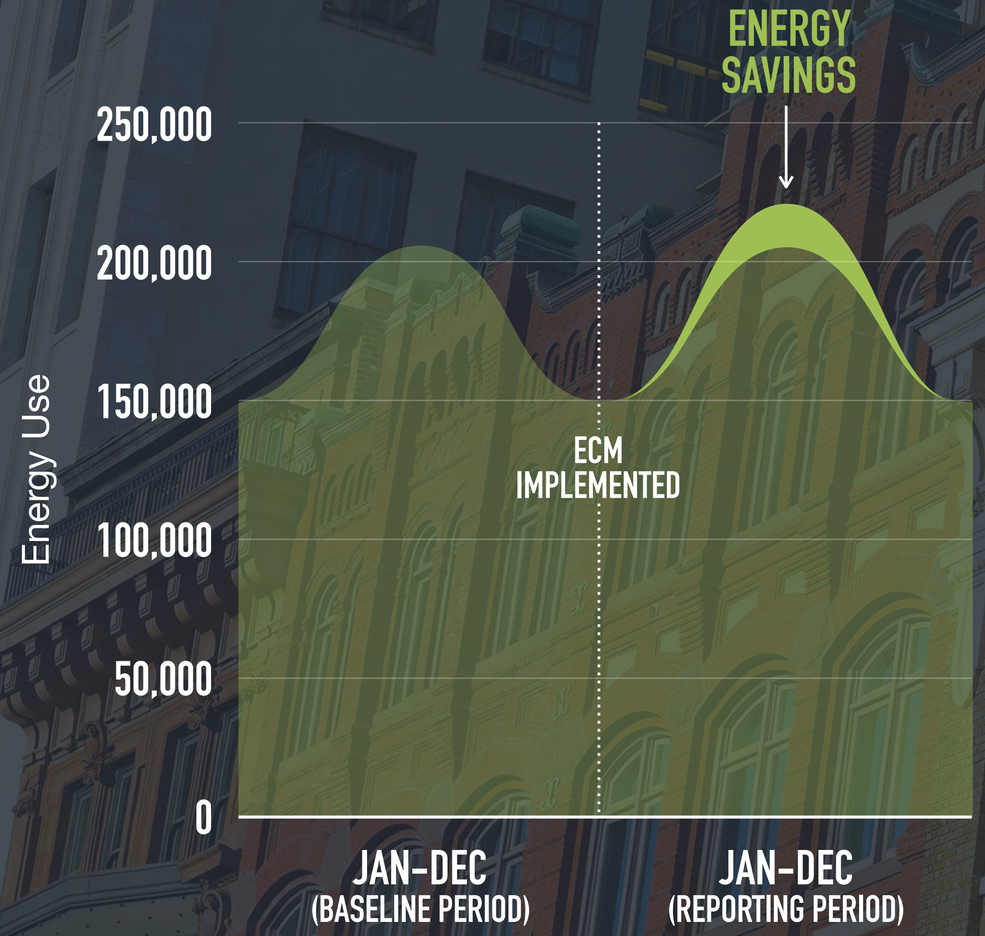

## OPPORTUNITY

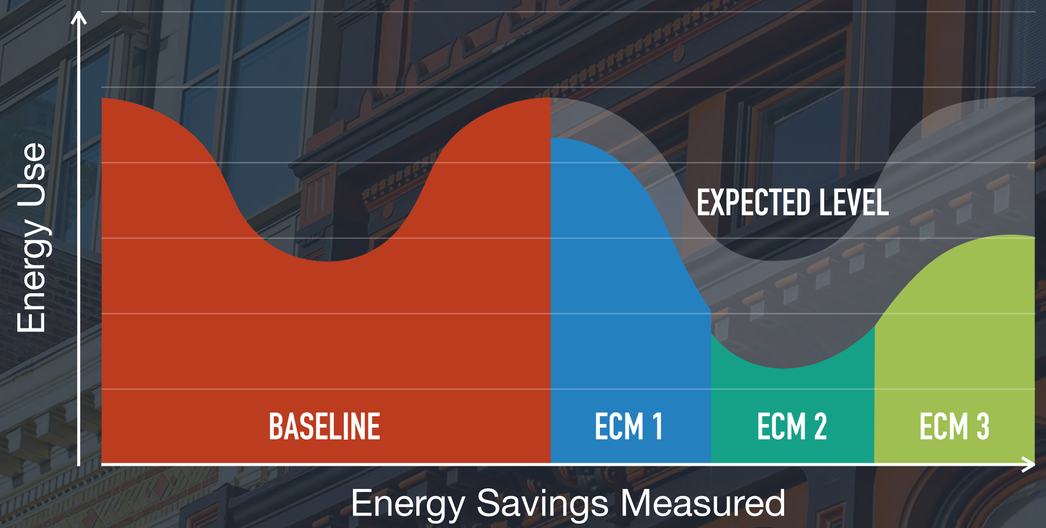
Potential Savings

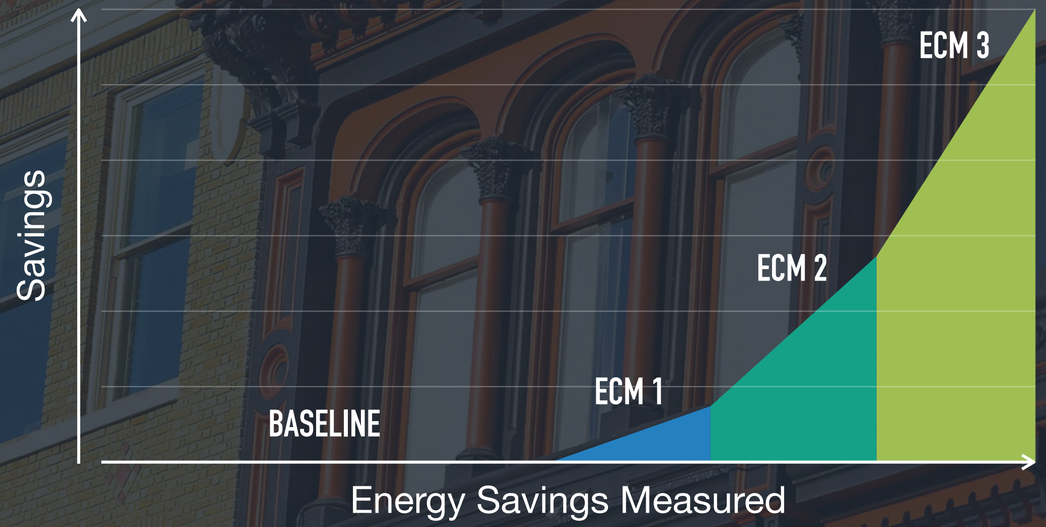
| | ANNUAL USAGE | DELTA | % DELTA |
|---|---|---|---|
| MY BUILDING | 203.1 | | |
| TARGET 1 | 123.7 | 79.4 | 39% |
| TARGET 2 | 94.3 | 108.8 | 54% |

| ENERGY TYPE | ANNUAL COST | S/Sq. Ft. |
|---|---|---|
| NATURAL GAS | $84,539 | $0.77 |
| ELECTRICITY | $164,478 | $1.50 |
| TOTAL | $249,070 | $2.26 |

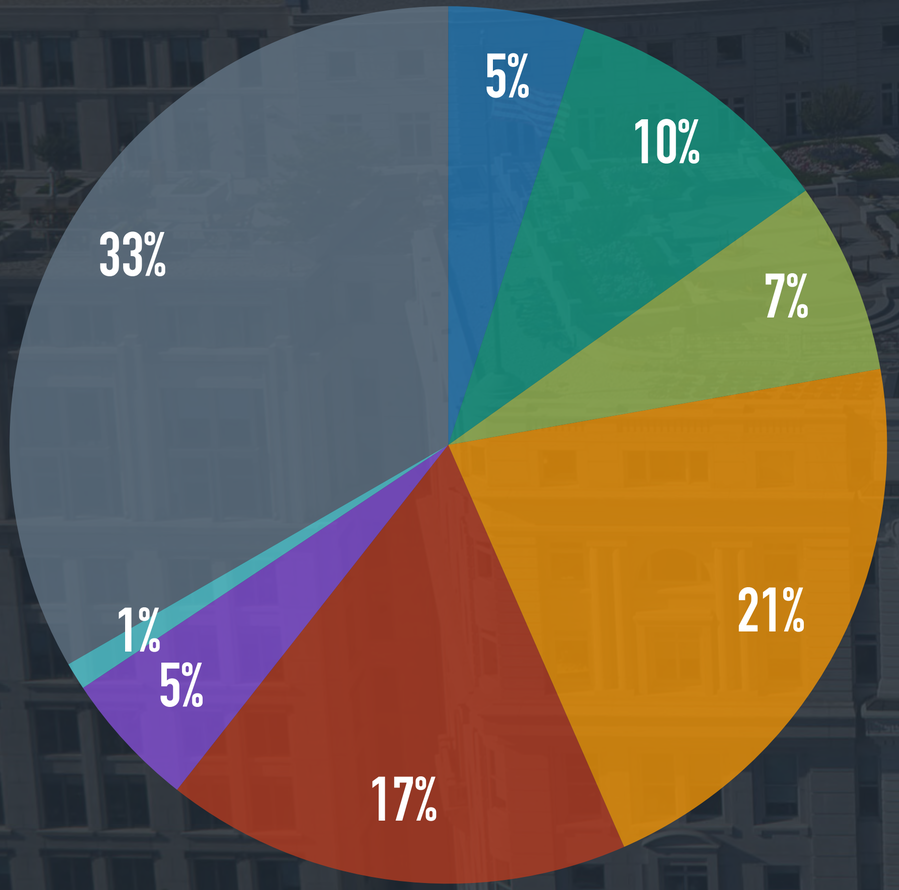
# ENERGY SAVINGS



# NON-ENERGY BENEFITS
## WITH MONITORING BASED COMMISSIONING



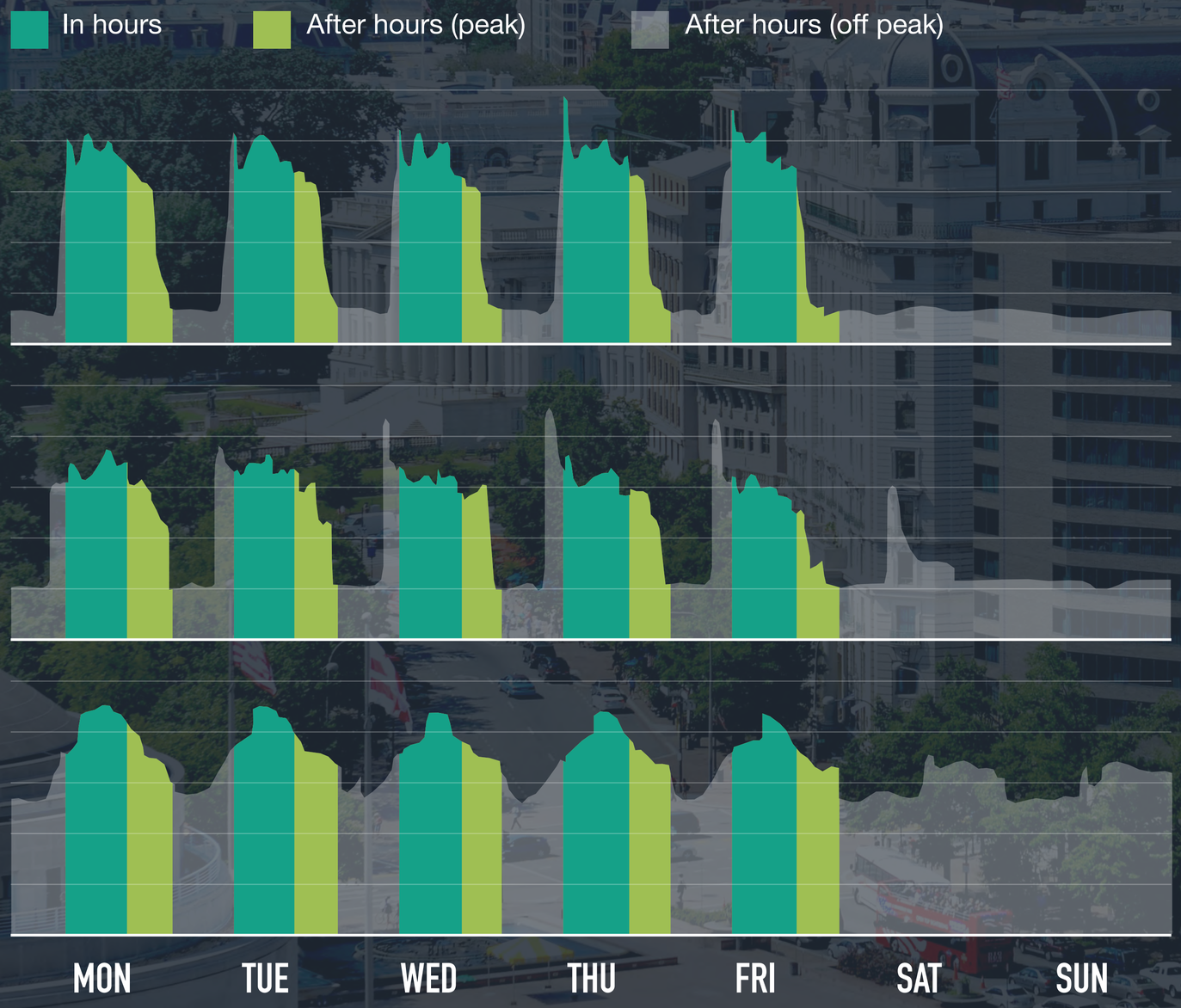

- Change Orders and Warranty Claims
- Other First Cost
- Ongoing Labor Cost
- Thermal Comfort
- Indoor Air Quality
- Productivity/Safety
- Liability
- Equipment Life

**MEDIAN VALUE = $0.18 / SF**

**RANGE = $0.10 - $0.45 / SF**

SIGNIFICANT WHEN COMPARED WITH THE ENERGY SAVINGS POTENTIAL OF **$0.15 – $0.30 / SF**

NEW CITY ENERGY




| Energy used after hours: | Annual after hours cost: |
|---|---|
| 38% | 109K |
| 55% | 131K |
| 63% | 182K |

# OPTIMAL START STOP

*Weather-driven operations for comfort and savings*

NEW CITY ENERGY

## Overview

- BAS learns the building's performance and how it responds to weather, thus controlling HVAC equipment according to occupancy and outside conditions
- Schedules are organized around occupancy, not mechanical run-time
- As system learns building, operations tighten, saving money on energy and repairs
- Creates opportunity for strategic, data-driven building envelope work identifiable when the system takes longer than expected to reach temp

## The Challenges

- Getting occupancy schedules from building occupants
- Getting building staff to cooperate with new mode of operations
- Often reveals latent mechanical problems, which cascade into potential comfort problems

# THE FIVE STEPS TO BUILDING PERFORMANCE

1 COLLECT DATA & TRACK PERFORMANCE

2 DETECT PERFORMANCE ISSUES

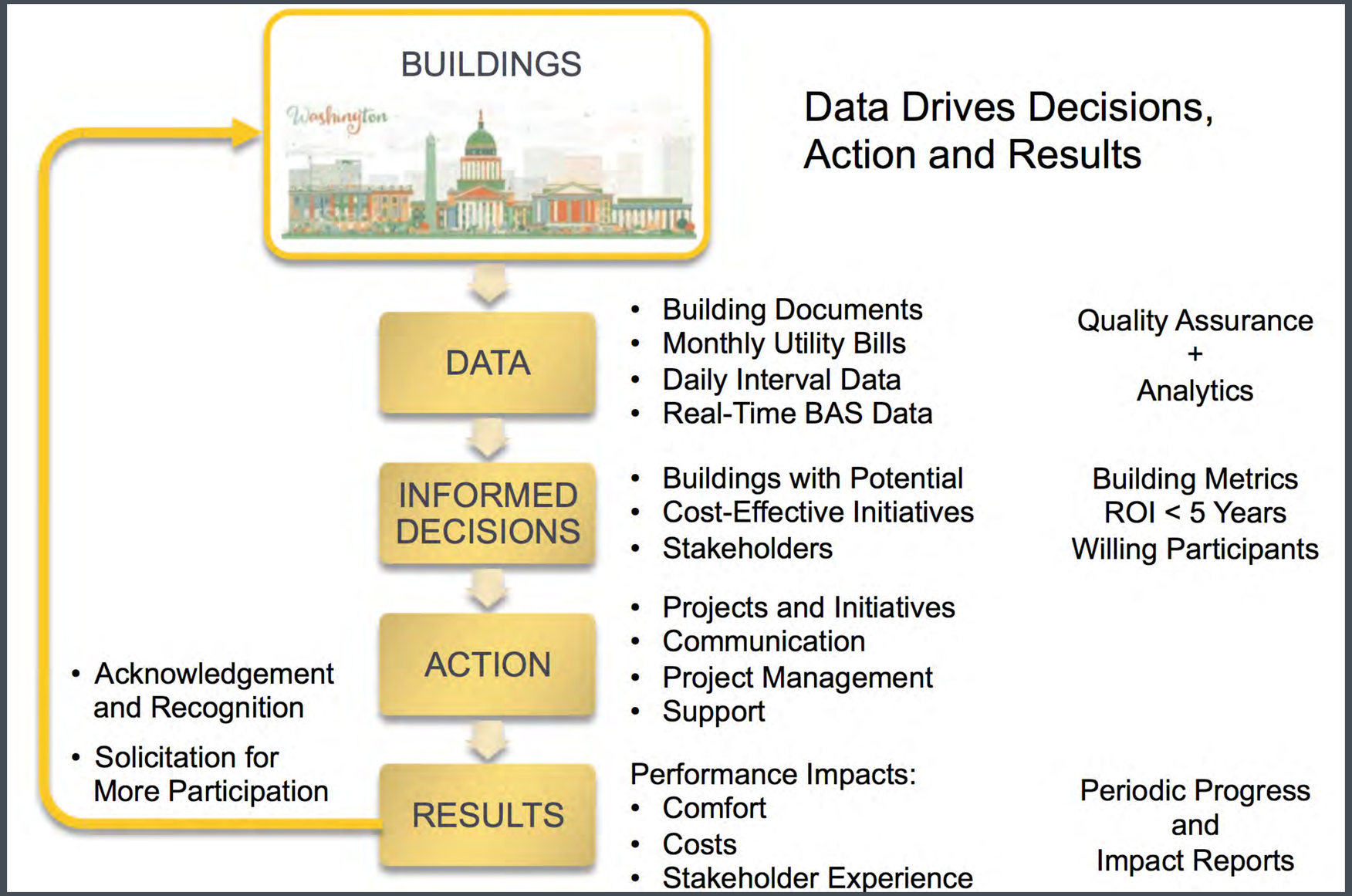
3 DIAGNOSE ISSUES & IDENTIFY SOLUTIONS

4 FIX ISSUES & VERIFY RESULTS

5 SUSTAINED PERFORMANCE

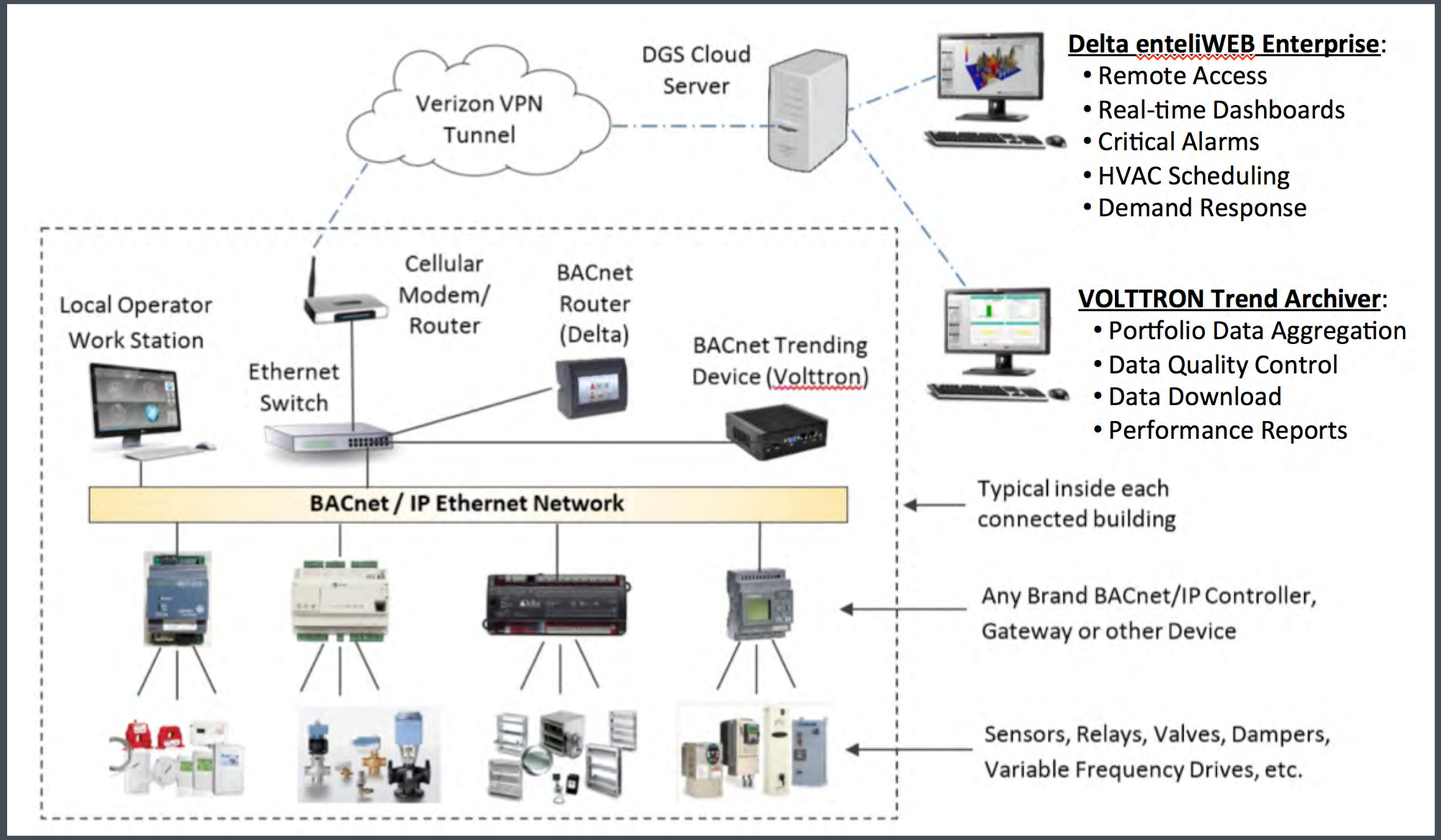
# DGS SE DATA & PROGRAM ARCHITECTURE

*Conceptual Overview*



# DGS SE DATA & PROGRAM ARCHITECTURE

*Network Overview*



# DGS SE DATA & PROGRAM ARCHITECTURE

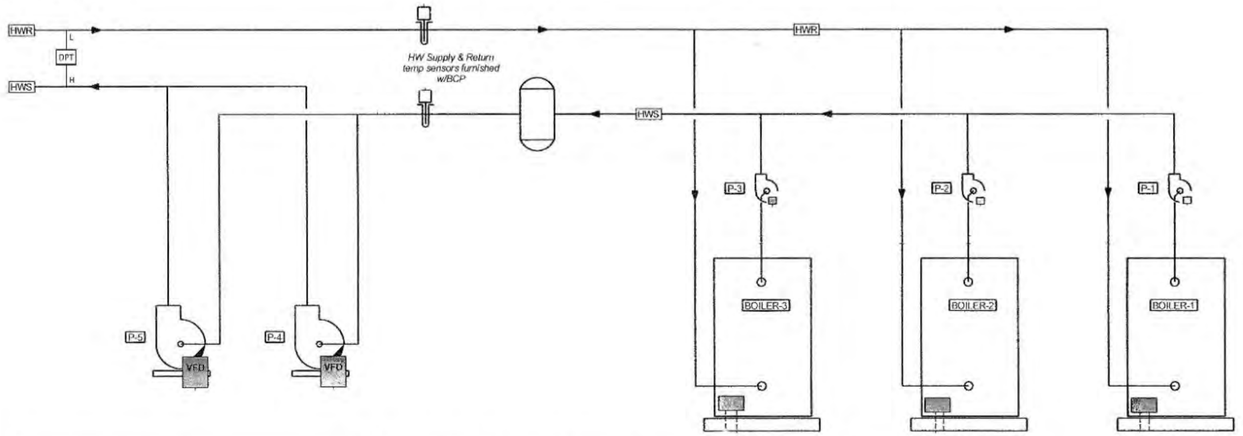
*Trending & Tagging 1*

## 4 Specific Trending and Tagging Examples

This section provides specific tagging examples for a variety of common system types. Since it is not possible to cover all potential configurations, this section is more of a guide to assist the person doing the tagging with "getting the hang of it". Engineering judgement will always play a role in selecting the points to trend and tag.

### 4.1 Hot Water System

The diagram below and associated trend schedule depict a fairly typical hot water system with three boilers, and primary/secondary pumping.




| Hot Water System Trend Schedule | Enable | Start/Stop | Status | % Speed | Deg. F | PSI | Setpoint |
|---|---|---|---|---|---|---|---|
| Hot Water System | 1 | | | | | | |
| Boiler | | 3 | 3 | | | | |
| Primary HW Pumps | | 3 | 3 | | | | |
| Secondary HW Pumps | | 2 | 2 | 2 | | | |
| HW Supply Temperature | | | | | 1 | | 1 |
| HW Return Temperature | | | | | 1 | | |
| HW Differential Pressure | | | | | | 1 | 1 |

# DGS SE DATA & PROGRAM ARCHITECTURE

*Trending & Tagging 2*

**Hot Water System Tag Entry Table**

| mech drawing equip id | system acronym | system suffix | component acronym | component suffix | load size | load type | load units | point acronym | point suffix | point units | point operating range lo | point operating range hi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HWS | | | | | | | ENA | | Enabled/Disabled | | |
| Boiler 1 | HWS | | B | 1 | 2500 | constant | MBH | SS | | Start/Stop | | |
| Boiler 2 | HWS | | B | 2 | 2500 | constant | MBH | SS | | Start/Stop | | |
| Boiler 3 | HWS | | B | 3 | 2500 | constant | MBH | SS | | Start/Stop | | |
| | HWS | | B | 1 | 2500 | constant | MBH | Status | | ON/OFF | | |
| | HWS | | B | 2 | 2500 | constant | MBH | Status | | ON/OFF | | |
| | HWS | | B | 3 | 2500 | constant | MBH | Status | | ON/OFF | | |
| P1 | HWS | | PHWP | P1 | 1 | constant | HP | SS | | Start/Stop | | |
| P2 | HWS | | PHWP | P2 | 1 | constant | HP | SS | | Start/Stop | | |
| P3 | HWS | | PHWP | P3 | 1 | constant | HP | SS | | Start/Stop | | |
| | HWS | | PHWP | P1 | 1 | constant | HP | Status | | ON/OFF | | |
| | HWS | | PHWP | P2 | 1 | constant | HP | Status | | ON/OFF | | |
| | HWS | | PHWP | P3 | 1 | constant | HP | Status | | ON/OFF | | |
| P4 | HWS | | SHWP | P4 | 10 | variable | HP | SS | | Start/Stop | | |
| P5 | HWS | | SHWP | P5 | 10 | variable | HP | SS | | Start/Stop | | |
| | HWS | | SHWP | P4 | 10 | variable | HP | Status | | ON/OFF | | |
| | HWS | | SHWP | P5 | 10 | variable | HP | Status | | ON/OFF | | |
| | HWS | | SHWP | P4 | 10 | variable | HP | VFD | | % Speed | | |
| | HWS | | SHWP | P5 | 10 | variable | HP | VFD | | % Speed | | |
| | HWS | | | | | | | HWST | | Deg. F | 100 | 180 |
| | HWS | | | | | | | HWRT | | Deg. F | | |
| | HWS | | | | | | | HWSTSP | | Deg. F | | |
| | HWS | | | | | | | HWDP | | PSI | 5 | 20 |
| | HWS | | | | | | | HWDPSP | | PSI | | |

# DGS SE DATA & PROGRAM ARCHITECTURE

*Trending & Tagging 4*

NEW CITY ENERGY

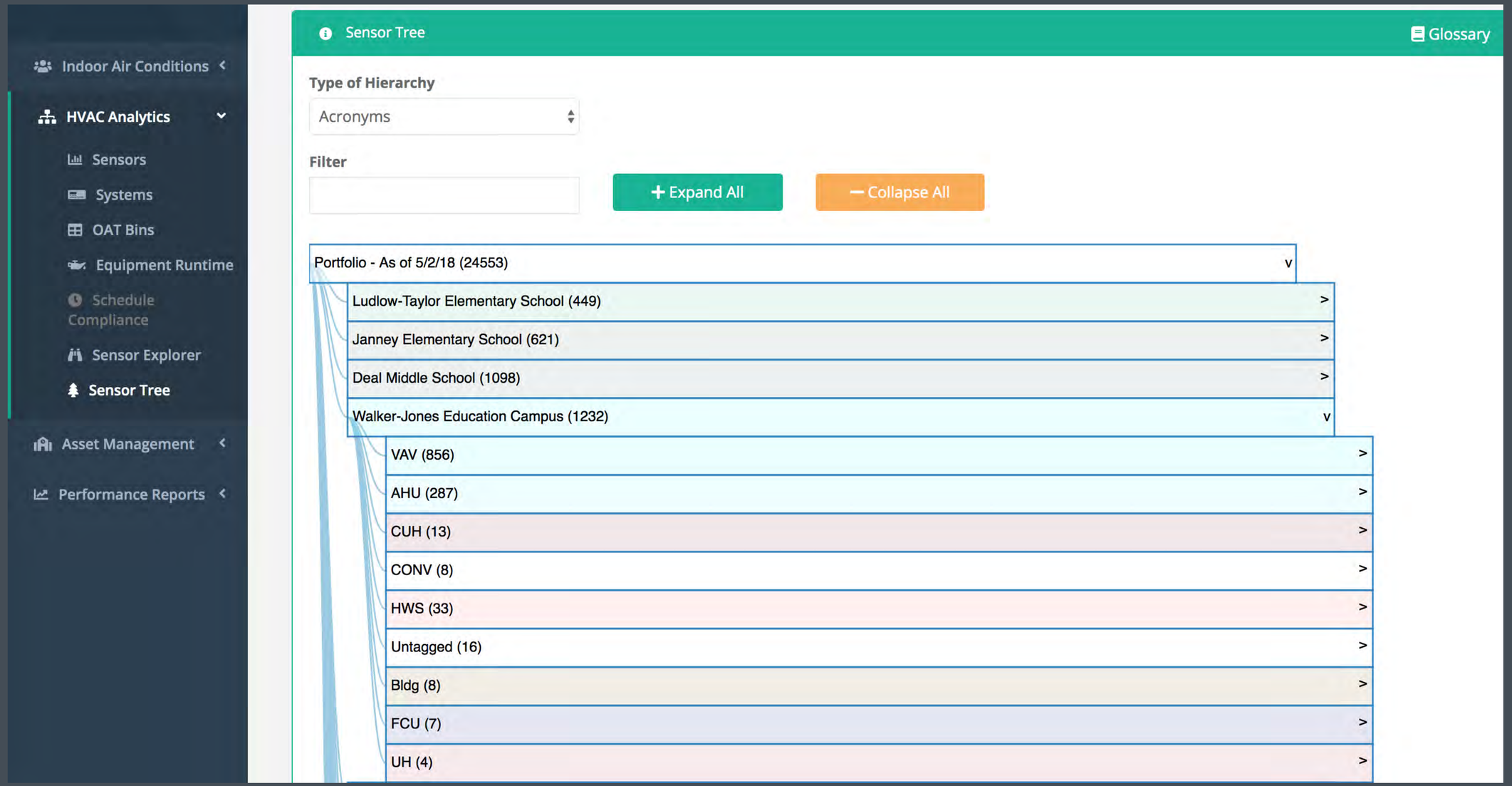
Glossary

System Tags | Component Tags | Point Tags | Tag Types

| Acronym | Acronym Expanded | Valid Component Acronyms | Valid Point Acronyms | Notes |
|---|---|---|---|---|
| AC | Split System AC Unit | Comp, ElecHt, GasBurn, RF, SF, null | AveSPT, ClgEna, ClgO, ClgSP, ClgStg, EconEna, Ena, HCV, HtgO, HtgSP, HtgStg, MAD, MAT, MOADpr, Mode, OADpr, OccClgSP, OccHtgSP, OccStat, PctClg, PctHtg, Rat, SAT, SATSP, SPCO2, SPRH, SPT, SS, Status, VFD | |
| AHU | Air-Handling Unit | Comp, EF, ElecHt, GasBurn, HCCP, HRW, Mode, PHCP, RF, SF, null | AveSPT, AveSPT, BldgP, BldgPSP, BldgSP, BldgSPSP, CCLAT, CCV, CFM, ClgEna, ClgO, ClgSP, ClgStg, DprO, EADpr, EAFlowSW, EAT, EconEna, Ena, FaceDpr, HCCCV, HCEAT, HCLAT, HCV, HXBypDpr, HtgEna, HtgO, HtgSP, HtgStg, LAT, MAD, MADpr, MAT, MOADpr, MOADprPos, Mode, OACO2, OADpr, OAFlow, OAFlowSP, OARH, OAT, OccClgSP, OccHtgSP, OccStat, OccStatus, PHCLAT, PHCV, PRDpr, PctClg, PctHtg, RACO2, RADpr, RAFlow, RARH, RAT, RHCV, SAFlow, SAFlowSP, SAFlowSw, SARH, SASP, SASPSP, SAT, SATSP, SAVP, SPCO2, SPRH, SPT, SPTSP, SPTu, SPTz, SS, Status, Stg, VFD, null | |
| BCU | Blower Coil Unit | EF, HtgF, SF, null | CCV, ClgSP, DTInlet, DTPos, DTSAT, EF, Ena, HCV, HtgO, HtgSP, Mode, OCCStat, OccClgSP, OccHtgSP, OccStat, OccStatus, SAT, SPT, SS, Status, VFD, null | |
| Bldg | Building | EF, ElecHt, LHEF, Ltng, RF, SF, null | AveSPT, BldgP, BldgPSP, BldgSP, BldgSPSP, ClgSP, Ena, HtgEna, HtgSP, LoSpdS, Mode, OACO2, OADpr, OARH, OARHwu, OAT, OATwu, OAWBT, OccClgSP, OccHtgSP, SAFlow, SASP, SAT, SPCO2, SPRH, SPT, SPTSP, SPTu, SPTz, SS, Sched, Status, VFD, kW | |
| CAV | Constant Air Volume Unit | Comp, EF, ElecHt, SF, null | ActSP, ClgO, ClgSP, DprO, Ena, FanO, HCV, HtgO, HtgSP, HtgStg, Mode, OccClgSP, OccHtgSP, OccStatus, SAFlow, SAFlowSP, SASP, SAT, SATSP, SAVP, SPCO2, SPRH, SPT, SPTSP, SPTu, SS, Status, Stg, TermLoad, VFD, null | |
| CHWS | Chilled Water System | CH, CHWP, CTF, CWP, Comp, MultiStack, PCHWP, SCHWP, SprayPmp, StandbyP, null | AveSPT, CHDPSP, CHWBV, CHWBVStatus, CHWDP, CHWDPSP, CHWFlow, CHWIVStatus, CHWRT, CHWST, CHWSTSP, CTBV, CTBVSP, CTIV, CTIVStatus, CTST, CTSTSP, CWBV, CWDP, CWDPSP, CWRT, CWRTSP, CWST, CWSTSP, Cap, ChwFlow, ClgEna, ClgLoad, ClgO, ClgSP, ClgStg, CondDP, DTSP, EWT, Ena, EvapDP, HXEntT, HXLT, HiSpdCmd, HiSpdS, HtgSP, ISOV, LAT, LoSpdCmd, LoSpdS, Mode, OARH, OAT, PCHWRT, PCHWST, PHWRT, PHWST, SCHWRT, SCHWST, SHWRT, SPRH, SS, Status, VFD, kW, null | |

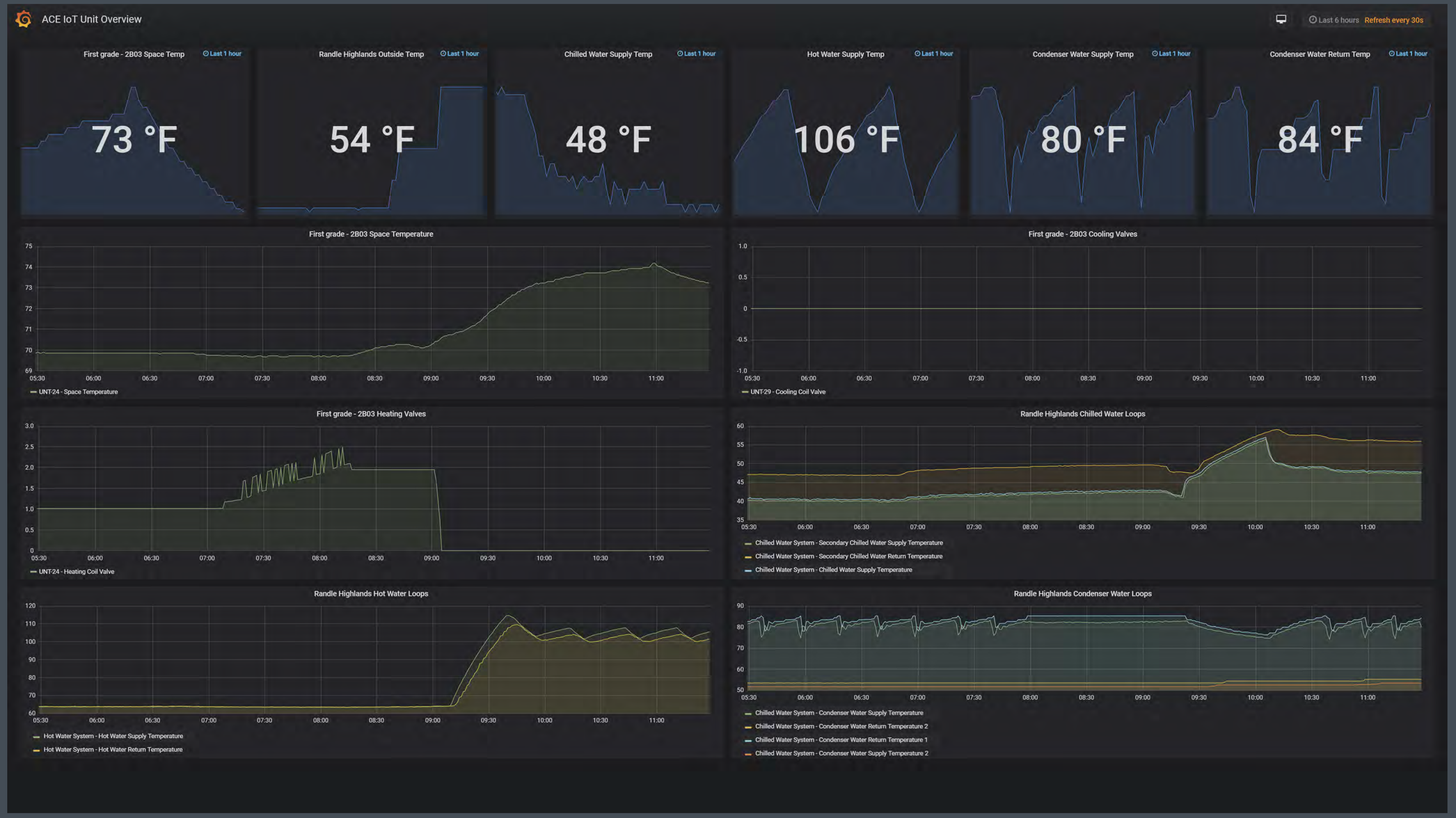
# DGS SE DATA & PROGRAM ARCHITECTURE

*Trending & Tagging 5*



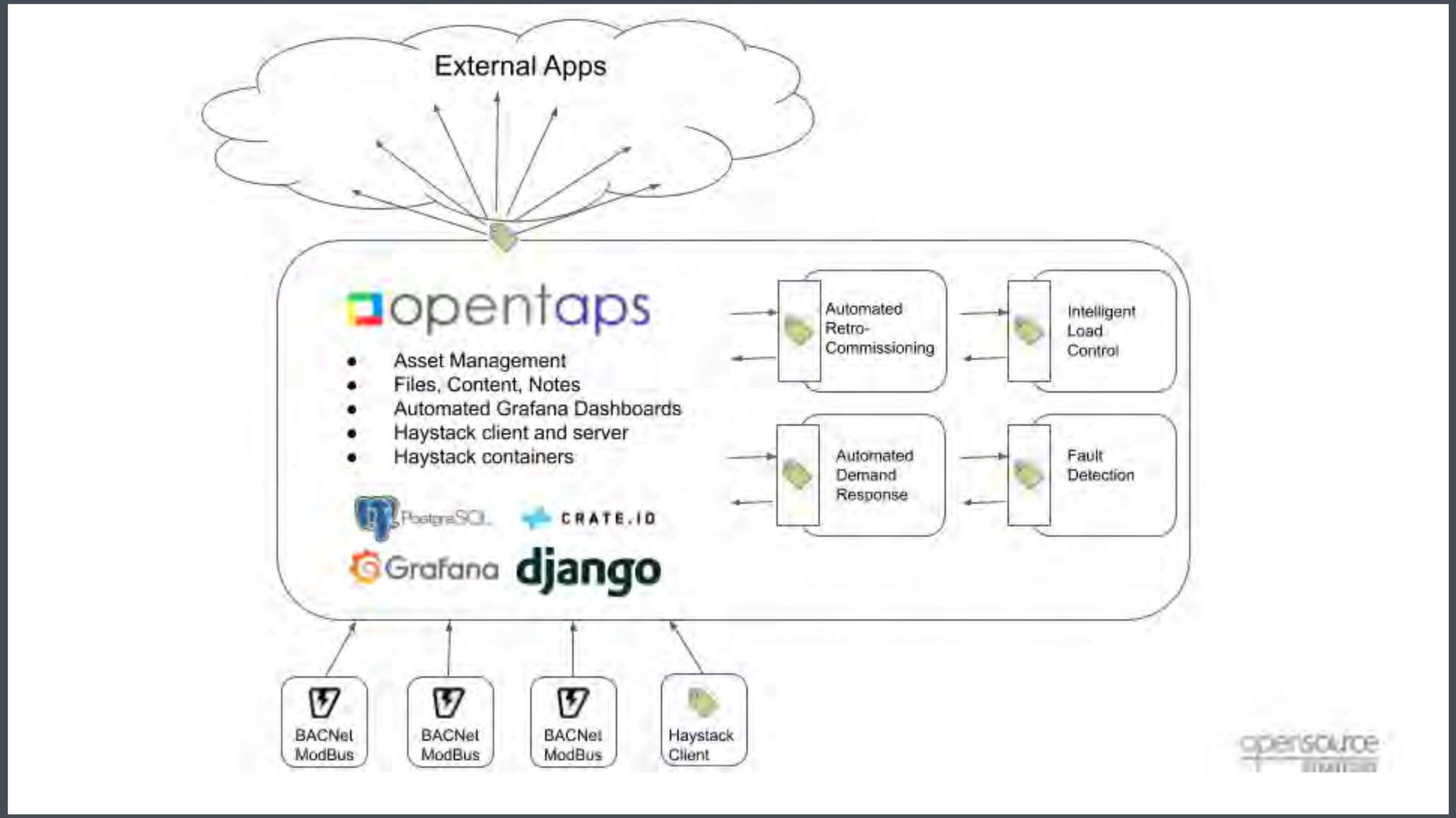
# DGS SE DATA & PROGRAM ARCHITECTURE

*Trending & Tagging 7*



# DGS SE DATA & PROGRAM ARCHITECTURE

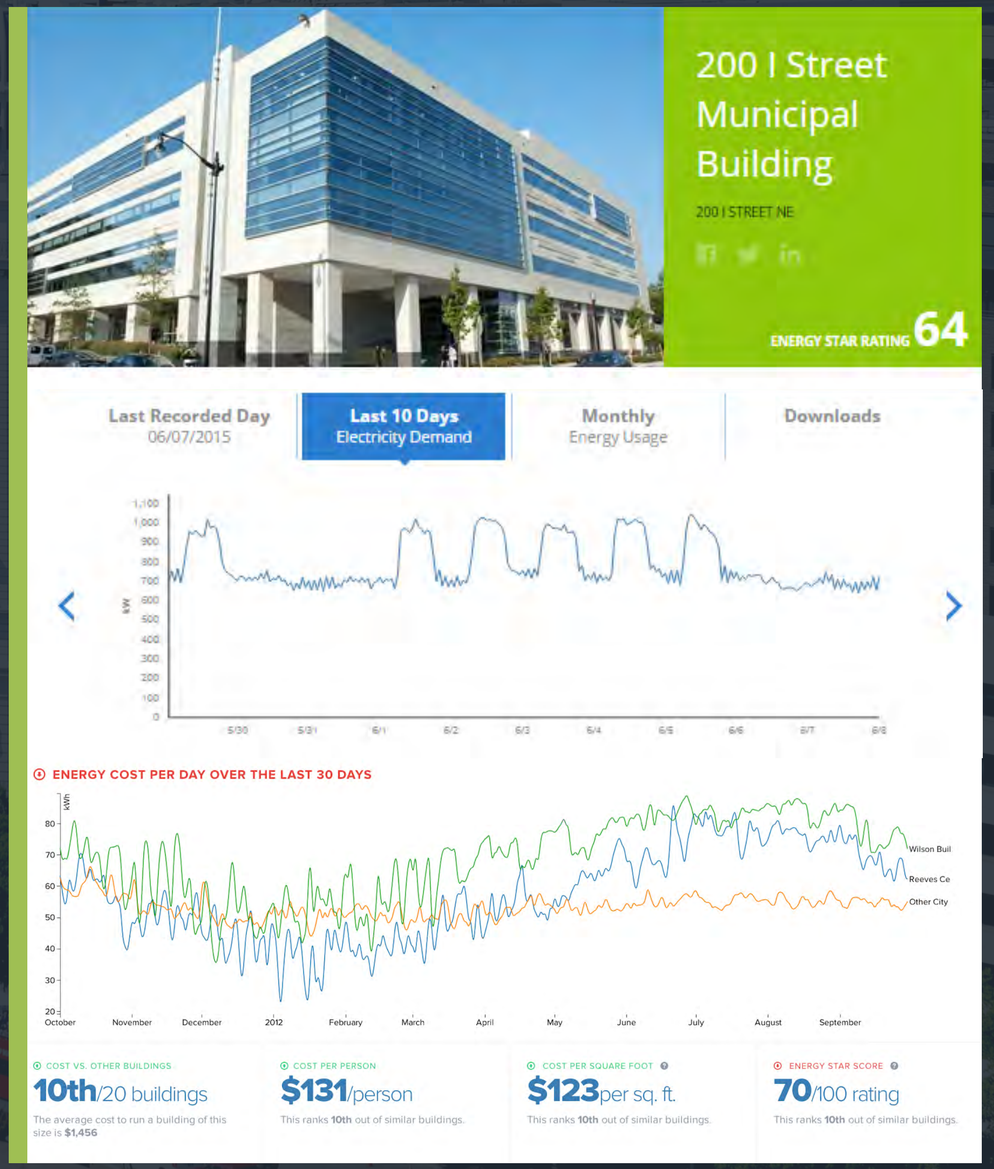
*Trending & Tagging 7*



# #1: DECIDE TO RELY ON DATA

## OPEN DATA DRIVES PERFORMANCE IMPROVEMENTS

- *Benchmarking*
- *Downloadable utility billing data*
- *15-minute metering and sub metering*
- *Solar, Wind, Generator, Battery monitoring*
- *Open, vendor-neutral building automation systems*
- *Standardized assessment & retrofit programs*
- *Constant commissioning framework to support for perpetual building performance optimization*
- *Smart grid to smart buildings platform*



# #2: CLEAN AND FOCUS ALL DATA FLOWS

NEW CITY ENERGY

## WHAT DATA FLOWS REALLY MATTER?

PORTFOLIO & BUILDING ATTRIBUTES DATA

UTILITY BILLING DATA

UTILITY AND RENEWABLES INTERVAL DATA

BUILDING AUTOMATION & SENSOR DATA

PROJECT TRACKING METADATA

## NEARLY EVERYONE IS A DATA USER AND CREATOR

# #3: EMPOWER PEOPLE WITH DATA

## RECOGNIZE ALL PROGRAM STAKEHOLDERS AS DATA USERS AND CREATORS

- OPERATORS
- OCCUPANTS
- TECHNICIANS
- MECHANICS
- CUSTODIANS
- IT MANAGERS
- PROGRAM FACILITATORS
- PROJECT LEADERS
- EXECUTIVES

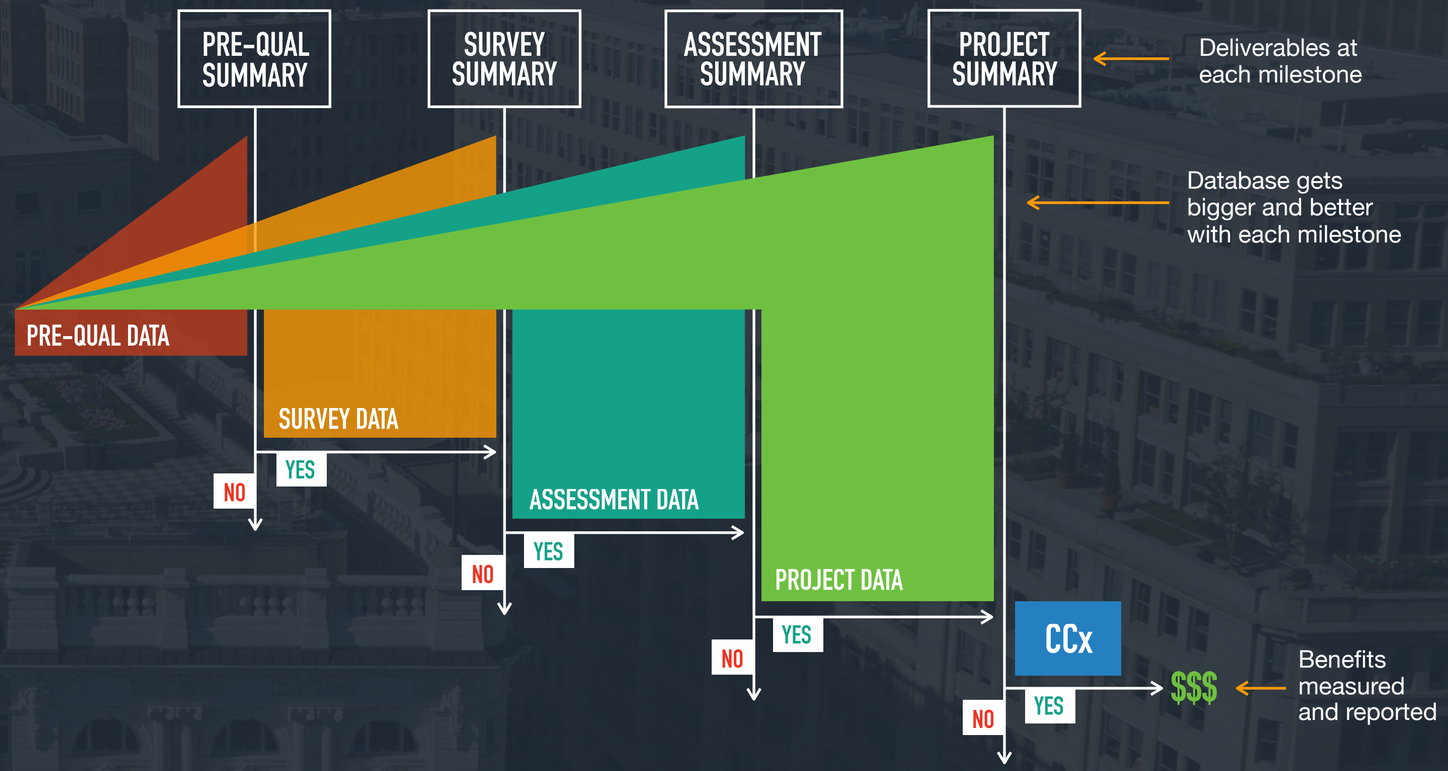
# #4: DESIGN SCALABLE PROGRAMS

NEW CITY ENERGY

## SCALABLE PROGRAMS RELY ON SCALABLE INFORMATION ARCHITECTURE

*Representative Program Docs:*

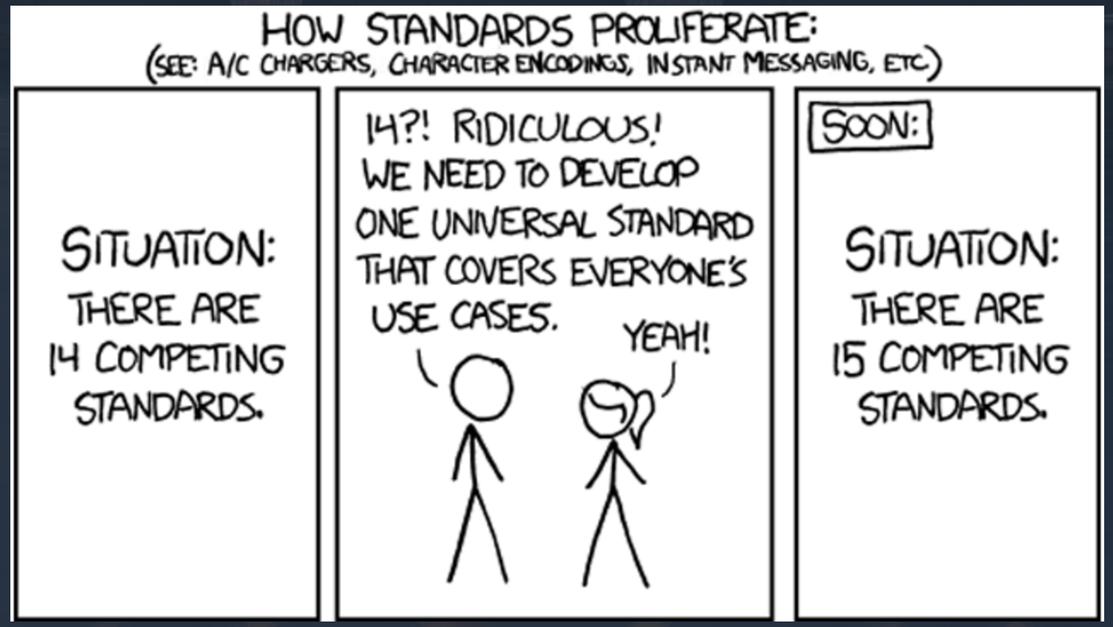
- *Data Enablement Tracker*
- *Construction Guidespec*
- *Connectivity Dashboard*
- *Trending & Tagging Guidelines*
- *Zoning & Scheduling Playbook*
- *Critical Alarm Framework*
- *Savings M&V Template*
- *Sensor Upgrade Decision Tree*



# THE MINIMUM NECESSARY SOLUTION SET TO CREATE SUSTAINABILITY & OPTIMAL ASSET VALUE

NEW CITY ENERGY

1) HAYSTACK ECOSYSTEM
2) VOLTTRON ECOSYSTEM
3) IMPLEMENTATION PROGRAMS




(IMAGE CREDIT: XKCD)

# THANK YOU

Zach Wilson | 202.669.6116