DIGITAL TWINS TO DELIVER 'SMART' ENERGY SYSTEMS

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WHY BE SMART IN THE CONTEXT OF

Accelerating the journey to net zero



Because it ensures that all elements of your system work in harmony to achieve priorities whilst producing least amount of carbon



WHAT IS A SMART ENERGY SYSTEM (SES)

In this definition the 'systems' aspect is the most important word and it assumes the 'smart' is the underpinning process. A smart energy system has four cores features which are defined below





BEFORE YOU BUILD SMART, YOU MUST DESIGN SMART

Digital engineering is critical

- Develop digital twin using existing known data sets
- Cross-reference historical data to confirm accuracy
- Dynamic assessment of multiple scenarios
- Accurate sizing of assets or identification of oversizing
- Build a digital roadmap understand impact of different design decisions
- Evaluate actual operation vs assumed operation (i.e. efficiency, duration, response time)
- Lifetime monitoring which will make future retrofits easy and extend system life









WHAT ARE WE INTERESTED IN?





METERS ARE REALLY IMPORTANT

- Request data for free from Data Collection and Data Aggregator (electricity)
- Pulse Reader ask gas/water suppliers to install as part of contract
- Use Modbus/Bacnet connections on heat and electrical meters to get all characteristics (i.e. Voltage or Flow)
- · Sometimes more reliable to connect meters to dedicated data logger with 4g connectivity
- Ensure that the data is going into a Measuring and Targeting platform or BMS trending and exporting logs

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Consumption	on	Multiple Location	ons		🗑 Mon 14/03/22	4 Multiple Utilities	۰ ا			
Dataset 1 📕 Cons. 💻 OAT			D	Dataset 2 📕 Cons. 🗕 OAT		Dataset 3 🗏 Cons. 🗕 OAT				
 ◎ndale Council REFIT 1/Shay Stadium/PV Meter ◎ Mon 14/03/22 § Electric / KVh 	(This is a drill-down chart area Simply click on a graph bar below to displa data	lay a detailed view of the	× E	의erdale Council REFIT 1/Shay Stadium/Meter 2 원 Mon 14/03/22 ∮ Eliectric / KWh	$\ensuremath{\overline{\mbox{this}}}$ is a drill-down chart area $$\times$$ Simply click on a graph bar below to display a detailed view of the data	©derdale Council REFIT 1,/Shay Stadium/Bollers ☺ Mon 14/03/22 ὦ Gas / KWh	$\ensuremath{\widehat{\mbox{\rm CThis}}}$ is a drill-down chart area $$\times$$ Simply click on a graph bar below to display a detailed view of the data			
2022 > Mar > w/c 14/3/2022 > 14/3/2022							Intervals v			
New Wey Wey										



IDENTIFYING DIFFERENCES









THE POWER OF DIGITAL TWINS

A digital twin is a precise representation of a building in the digital space



FIRST STEP IN DESIGN

The work carried out so far has enabled us to calibrate models within 90% accuracy

Calculate actual heating and cooling loads considering solar, occupants and equipment heat gains

Understand the amount of electricity used by all equipment

Review the amount of daylight and artificial (electric) light needed in space

Evaluate control strategies



GUN WHARF Main Ventilation System Upgrade





- Building is heated via an air system
- Main Ventilation Systems serve offices on all levels
 - Specific fan power (SFP) of 3.5W/l/s
 - High pressure drop due redundant components
 - Extra exhaust fan (6.3kW)
- Our proposal is to remove the main ventilation plant and install four new AHUs Heat recovery 65% efficient
 - Upgrade fans; SFP of 1 -0.8W/l/s
 - Remove exhaust fan



WORK FLOW

Static Data	Dynamic Data	Model Variables	Model Data
Fabric Building Dimensions Heating Zones Monthly Gas Bills Desk Layouts Fan Size Lighting Layout	Electricity Half Hourly Data Weather File	Boiler Seasonal Efficiency Infiltration Ventilation Rates Specific Fan Power Small Power	Monthly Gas Consumption Monthly Electrical



CALIBRATION PROCESS: FACTUAL DATA SOURCES









MEDWAY PARK

- Existing system
 - Installed boiler capacity is 2.4MW (seasonal efficiency of about 65%)
 - A 115kWe/175kWth combined heat and power (CHP)
- The new system will consist of:
 - Heat Upgrade 3 x 318kW condensing gas boilers with a reconfiguration of the plant room
 - Renewable Generation 200kW Rooftop Solar PV array
 - Energy Storage System 100kW/375kWh Energy Storage System (ESS)
 - Smart Control System to optimise building services and energy assets





COMPLEX ENERGY FLOWS

Digital Twin segregates consumptions and loads



Month Online Manti Conception Online Manti Conceptin Manti Manti Manti Manti Manti Manti Manti Manti Ma														Hours		CHP Average		CHP Average		
Image: Note that the constraint of the fact (NM) Constant (NM) For Case (NM) Constant (NM) Con														Uthilisati	CHP Heat	Heat Power	CHP Average Flec	Gas Power	CHP Heat	CHP Elec
01/12/2018 v 48,015 28,416 72,155 985,617 04,608 31,559 202,313 38,673 84,166 256 456 156 155 157 157,75	Month	CHP Instal	Main Elec	CHP elec (kWh)	Total Elec (kWh	Main Gas (kW)	CHP Gas (kWH)	Boiler Gas	Boiler Heat (kWh) @55% eff	CHP Heat (kWH)	Total Heat	Actual Ho	Max Hour	on	Delivered	(kW)	Power (kW)	(kW)	Efficiency	Efficiency
0_10_12/2019 9_56,47 357,20 94,37 220,344 124,88 164,456 164,75 381 558 645 3355 135.1 139.81 137.77 46,445 226,77 0_10/2/2019 51,664 552,20 557,081 652,502 547,55 547 564 657 131,64 333,42 127,77 46,445 224,77 101,04 558 685 1355 114,44 303,52 46,445 224,77 101,04 106 558 685 117,46 113,23 376,7 46,445 224,77 101,04 107 540 555 111,44 306,95 46,445 224,7 101,04 108,59 685 685 177,6 46,455 224,7 101,04 113,33 308,31 46,465 224,7 101,07 113,42 30,03 46,465 224,7 101,07 117,73 101,33 308,31 46,465 224,7 117,72 112,28 30,043 46,465 224,7 117,714 447	01/12/2018	Y	48,015	24,140	72,155	396,167	84,608	311,559	202,513	38,673	241,186	256	558	46%	16%	151.07	94.30	330.50	45.71%	28.53%
01/02/2019 9 93.64 33.20 65.93 44.688 122.774 82.264 200.22 57.08 266.20 347 59.4 69.97 215 18.4.7 101.64 33.3.2 46.468 22.74 01/03/2019 34.065 53.627 63.72 63.74 69.75 69.75 69.75 111.44 30.69 46.464 22.74 01/05/2019 44.939 - <td>01/01/2019</td> <td>Y</td> <td>58,647</td> <td>35,740</td> <td>94,387</td> <td>289,344</td> <td>124,888</td> <td>164,456</td> <td>106,896</td> <td>57,879</td> <td>164,775</td> <td>381</td> <td>558</td> <td>68%</td> <td>35%</td> <td>151.91</td> <td>93.81</td> <td>327.79</td> <td>46.34%</td> <td>28.62%</td>	01/01/2019	Y	58,647	35,740	94,387	289,344	124,888	164,456	106,896	57,879	164,775	381	558	68%	35%	151.91	93.81	327.79	46.34%	28.62%
Du/D/DIP Me85 58,11 92,26 595,88 197,640 122,28 202,07 24,773 467 546 255,68 117,12 37,77 46,85 224,713 0/10/2019 43,560 53,647 86,107 20,137 181,303 52,862 10,131 476 546 855 855 111,44 380,83 46,465 22,2 0/10/7019 45,321 45,127 93,861 10,129,79 46,464 23,8 865,9 955 111,44 380,83 46,4645 26,5 0/10/7019 43,807 55,317 38,411 11,324 11,328 380,43 46,4645 26,4 0/10/7019 41,307 53,525 93,42 - 117,28 - 65,59 450 555 855 1005 11,342 385,07 46,645 24,3 0/10/2019 41,107 35,255 93,42 - 117,228 10,106 10,170 10,106 51,110,407 540 955 10,	01/02/2019	Y	51,654	35,269	86,923	444,638	122,774	321,864	209,212	57,038	266,250	347	504	69%	21%	164.37	101.64	353.82	46.46%	28.73%
Di/U/D2019 B3.060 B3.047 B3.107 210,387 B13,305 29.02 B3.030 B4.227 101,110 476 540 B55 E25 17.9.5 11.1.4 B3.09 46.495 23.2 D/U/S7/2019 41.539 - </td <td>01/03/2019</td> <td>Y</td> <td>34,085</td> <td>58,211</td> <td>92,296</td> <td>509,889</td> <td>197,640</td> <td>312,249</td> <td>202,962</td> <td>91,817</td> <td>294,779</td> <td>497</td> <td>540</td> <td>92%</td> <td>31%</td> <td>184.74</td> <td>117.12</td> <td>397.67</td> <td>46.46%</td> <td>29.45%</td>	01/03/2019	Y	34,085	58,211	92,296	509,889	197,640	312,249	202,962	91,817	294,779	497	540	92%	31%	184.74	117.12	397.67	46.46%	29.45%
01/05/2039 41,939 . 44,939 . 44,939 . 44,939 . <th< td=""><td>01/04/2019</td><td>Y</td><td>35,060</td><td>53,047</td><td>88,107</td><td>210,387</td><td>181,305</td><td>29,082</td><td>18,903</td><td>84,227</td><td>103,130</td><td>476</td><td>540</td><td>88%</td><td>82%</td><td>176.95</td><td>111.44</td><td>380.89</td><td>46.46%</td><td>29.26%</td></th<>	01/04/2019	Y	35,060	53,047	88,107	210,387	181,305	29,082	18,903	84,227	103,130	476	540	88%	82%	176.95	111.44	380.89	46.46%	29.26%
01/07/2039 / 443,12 94,48 160,09 4,278 2,794 76,092 78,886 424 540 795 995 172,46 113,33 38,31 46,465 23,5 01/07/2039 // 43,570 53,12 57,886 - 166,490 - 75,713 460 556 855 1005 177,73 112,88 380,43 46,465 23,6 01/07/2039 // 32,107 53,25 52,324 - 187,72 - 75,713 460 556 82,57 1005 177,23 113,78 383,73 464,465 23,4 01/07/2039 // 35,841 55,82,50 95,103 536 556 505 505 505 505 510,055 113,78 383,77 464,465 23,3 01/1/2039 // 35,841 55,820 95,801 158,385 536,556 505 556 556 556 556 556 518 518 518,558 383,93947 464,465 23,3 01/1/2039 // 35,421 53,458<	01/05/2019	Y	41,939		41,939			-				480	558	86%						
$ \begin{array}{ c c c c c c c c c c c c c$	01/06/2019	Y	45,321	48,137	93,458	168,094	163,796	4,298	2,794	76,092	78,886	424	540	79%	96%	179.46	113.53	386.31	46.46%	29.39%
01/07/2039 /r 43.07 50.58 94.87 38.416 171,28 1.07,32 109.36 171,29 109.36 171,31 46.46% 23.4 01/07/2039 /r 37,10 55,235 92,342 - 187,128 - 97,110 97,117 87,117	01/07/2019	Y	42,574	55,312	97,886		186,409			86,599	86,599	490	558	88%	100%	176.73	112.88	380.43	46.46%	29.67%
01/07/2019 37.107 55.25 92.42 . 187.52 . 97.117 487 540 90% 100% 113.42 38.507 46.46% 24.33 0/1/0/2019 36.604 60.072 99.678 . 20.47.21 . 97.10 51.00 51.0 55.0 556 50% 110.078 113.42 385.77 46.46% 23.3 0/1/1/2019 36.681 55.942.00 97.681 310.718 20.657 60.020 77.618 113.678 113.842 385.096 46.46% 23.3 0/1/1/2019 50.65 50.61 51.0	01/08/2019	Y	43,807	50,580	94,387	38,416	171,584			79,713	79,713	460	558	82%	100%	173.29	109.96	373.01	46.46%	29.48%
01/10/2029 86.60 60,074 96,078 - 202,721 - - 95,105 538 95% 100% 113.78 33.7.73 46.46% 23.3.73 0/1/1/2029 / 35,851 55,822.00 95,803 365,851 556,851 506 506 556 95% 45% 113.78 38.7.73 46.46% 23.3.73 0/1/2/2019 / 10,659 60,502.00 70,961 317.48 266,665.00 110.77 77.00 96,070.0 558 556 556 556 556 556 518 558 538 558 131.205 393.939471 46.46% 23.3.73 0/10/2020 / 37.52 54.658 96.656 126.656 126.656 130.666 130.466 127.656 540 6% 6% 113.878 393.939471 46.46% 23.3 01/02/2020 / 32.123 45.23 55.777 55.777 52.232 55.8 6% 6% 6% 6% 6% 6% 6%	01/09/2019	Y	37,107	55,235	92,342		187,528			87,117	87,117	487	540	90%	100%	178.89	113.42	385.07	46.46%	29.45%
01/1/2019 V 36.81 55.942.00 99.801 363.780 194,332.01 19.328 110.10 90.77.00 200,478 500 540 955 455 180.746 113.884 385.056 46.465 22.1 0/1/1/2019 V 10.659 60.0200 77.04 300.000 160.01 510 556 955 557 181.14056 113.77815 383.3952.01 46.445 22.1 0/10/2020 V 35.471 61.881 96.856 114.773536 955 555 181.205250 113.82393 393.994247 46.445 22.9 0/10/2020 V 23.531 45.456 13.686 45.456 11.777356 11.67737 46.445 22.9 44.55 181.2079776 11.4017974 46.465 22.9 0/10/2020 V 23.213 41.213 44.08 150.757 42.213 7.757 22.134 7.757 22.134 2.756 45.576 45.577 22.234 25.46 66.96 45.571 27.5304 24.943544 27.35796 <td>01/10/2019</td> <td>Y</td> <td>36,604</td> <td>60,074</td> <td>96,678</td> <td></td> <td>204,721</td> <td></td> <td></td> <td>95,105</td> <td>95,105</td> <td>528</td> <td>558</td> <td>95%</td> <td>100%</td> <td>180.12</td> <td>113.78</td> <td>387.73</td> <td>46.46%</td> <td>29.34%</td>	01/10/2019	Y	36,604	60,074	96,678		204,721			95,105	95,105	528	558	95%	100%	180.12	113.78	387.73	46.46%	29.34%
01/12/2019 10.659 69.09.20.0 70.961 317.418 206.665.00 10.77 77.00 99.09.00 10.80.10 558 95% 57% 581.440556 11.777385 38.9339421 46.46% 23.3 0/10/12/200 /r 35.471 61.388 56.59 558 559 559 559 559 559 559 </td <td>01/11/2019</td> <td>Y</td> <td>36,861</td> <td>56,942.00</td> <td>93,803</td> <td>363,926</td> <td>194,533.00</td> <td>169,393</td> <td>110,105</td> <td>90,373.00</td> <td>200,478</td> <td>500</td> <td>540</td> <td>93%</td> <td>45%</td> <td>180.746</td> <td>113.884</td> <td>389.066</td> <td>46.46%</td> <td>29.27%</td>	01/11/2019	Y	36,861	56,942.00	93,803	363,926	194,533.00	169,393	110,105	90,373.00	200,478	500	540	93%	45%	180.746	113.884	389.066	46.46%	29.27%
01/01/2020 /r 35.471 61.88 96.585 346.662 212.256 134.569 67.74 96.656 158.05 57.8	01/12/2019	Y	10,659	60,302.00	70,961	317,435	206,665.00	110,770	72,001	96,009.00	168,010	530	558	95%	57%	181.1490566	113.7773585	389.9339623	46.46%	29.18%
01/07/2020 Y 37,522 54,654 91,656 91,656 91,656 93,467 125,83 81,499 84,421 (97,911 478 504 946; 315 142,207777 11,017974 92,408,122 46,466 20, 01/07/2020 Y 32,123 14,123 46,246 166,283 93,447 107,048 95,737 27,537 97,077 257 540 456; 245 01/07/2020 Y 32,123 14,123 46,246 166,283 93,447 107,048 95,737 27,538 97,097 257 540 456; 245 01/07/2020 Y 52,528 55,72 55,72 542,233 558 66; 05 01/07/2020 Y 57,528 16,420 72,148 20,608 54,521 - 82,524 20,648 540 66; 05 01/07/2020 Y 44,770 37,163 81,870 17,692 113,777 - 64,931 64,931 503 558 906; 105 01/07/2020 Y 44,770 37,163 81,870 17,692 113,777 - 64,931 64,931 503 558 906; 105 01/07/2020 Y 23,948 54,548 64,568 54,518 - 82,520 42,520 45,508 546 108,677 36,693 46,568 22,3 01/07/2020 Y 44,770 37,163 81,870 17,692 113,777 - 64,931 64,931 503 558 506 546 105,777596 246,468; 27,3 01/07/2020 Y 23,948 54,548 64,586 64,618 186,779 - 84,593 64,931 503 558 506 546 105,77516 105,77596 46,658; 27,3 01/07/2020 Y 23,948 52,548 64,516 186,779 - 84,593 64,591 503 558 506 546 105,170 45,948 103,09370 97,983,94329 46,658; 23,3 01/1/2020 Y 23,948 52,548 64,518 151,640 98,560 98,560 558 546 056 558 546 105,100 97,983,94329 42,3154 30,77 01/1/2020 Y 23,528 65,781 81,600 128,472 21,3548 11,998 95,522 10,538 551 558 546 056 558 546 105,569832 122,49767 384,4233 42,3154 30,7 01/1/2020 Y 25,228 65,781 81,600 128,778 11,638 11,998 95,522 10,538 558 556 555 555 555 555 555 555 555 55	01/01/2020	Y	35,471	61388	96,859	346,862	212,356	134,506	87,429	98,656	186,085	539	558	97%	53%	183.0352505	113.8923933	393.9814471	46.46%	28.91%
01/03/2020 /r 28,651 28,651 300,086 300,086 197,656 197,656 540 0% 0% 0% 01/04/2020 /r 31,223 42,823 538 0% </td <td>01/02/2020</td> <td>Y</td> <td>37,582</td> <td>54,054</td> <td>91,636</td> <td>311,390</td> <td>186,007</td> <td>125,383</td> <td>81,499</td> <td>86,412</td> <td>167,911</td> <td>474</td> <td>504</td> <td>94%</td> <td>51%</td> <td>182.3037975</td> <td>114.0379747</td> <td>392.4198312</td> <td>46.46%</td> <td>29.06%</td>	01/02/2020	Y	37,582	54,054	91,636	311,390	186,007	125,383	81,499	86,412	167,911	474	504	94%	51%	182.3037975	114.0379747	392.4198312	46.46%	29.06%
01/04/2020 / 41,22 44,23 46,246 169,231 95,272 62,732 27,534 97,077 257 540 485 285 207,0727263 543,9327373 20,3337737 46,465 23.8 01/05/2020 / 65,572 65,727 642,231 65,223 556 566 676	01/03/2020	Y	28,651		28,651	304,086		304,086	197,656		197,656		540	0%	0%					
OL/65/2020 /r 62,328 66,378 95,727 95,727 62,223 62,223 558 0% 0% OL/66/2020 /r 67,857 61,757 13,766 31,766 20,464 540 0% 0%	01/04/2020	Y	32,123	14,123	46,246	166,283	59,247	107,036	69,573	27,524	97,097	257	540	48%	28%	107.0972763	54.95330739	230.5330739	46.46%	23.84%
01/07/2020 Y 67,357 67,557 81,768 31,766 31,769 20,648 20,648 540 0% 0% 0% 0% 0% 0% 0% 0% 0% 0% 0% 0% 0%	01/05/2020	Y	62,928		62,928	95,727		95,727	62,223		62,223		558	0%	0%					
01/07/2020 /r 57.28 14.80 72.148 20.608 54.251 - 25.204 151 558 34% 100% 131.558112 77.5785234 284.056692 46.46% 27.3 01/07/2020 /r 28.992 54.58 83.76 10.769 137.772 - 66.931 64.931 56.93 90% 100% 123.08713 73.887204 284.036692 46.45% 27.3 01/07/2020 /r 28.992 54.594 83.366 46.105 136.77 - 86.075 505 540 91% 100% 120.877.07 388.207.09 398.349659 46.45% 27.3 01/07/2020 /r 23.048 131.610 151.610 151.610 95.500 558 56% 6% - 66 - 66 - 66 - 66 - 66 - 66 - 66 - 66 - 66.91 66.71 70.646 90.052 102.50 537 540 9% 885	01/06/2020	Y	67,957		67,957	31,766		31,766	20,648		20,648		540	0%	0%					
0/1/0/2020 Y 44,777 37,163 81,870 17,672 139,772 - 64,931 64,931 503 538 90% 100% 129.087451 73.8270378 77.77396 46,65% 25.5 0/1/0/2020 Y 22,948 54,594 85,586 46,16 186,778 - 86,578 86,75 86,75 56 546 94% 100% 129.087451 73.8270378 95.8354054 66.65% 25.5 0/1/1/2020 Y 22,048 52,048 51,600 124,274 21,354 18,458 11,98 95,522 10,526 545 0% 0% 0% 0% 0% 0% 0% 0% 0% 0% 0% 0% 0%	01/07/2020	Y	57,328	14,820	72,148	20,680	54,251		-	25,204	25,204	191	558	34%	100%	131.9581152	77.59162304	284.0366492	46.46%	27.32%
01/07/2020/v 28,992 54,598 83,586 46,105 186,775 - 86,075 505 540 94% 100% 177,0455546 10.009307 280,384039 46,055 23.2 01/07/2020/v 23,048 151,610 151,610 95,500 958 0% 0% -	01/08/2020	Y	44,707	37,163	81,870	17,692	139,772			64,931	64,931	503	558	90%	100%	129.0874751	73.88270378	277.8767396	46.45%	26.59%
0/1/3/2020 / 22,048 22,048 133,600 133,600 98,500 98,500 585 0% 0% 0/1/3/2020 / 15,220 65,781 81,00 232,422 233,94 18,458 11,998 95,522 10,526 537 540 95% 885 186,5698324 122,4972067 986,44320 42,315 30.7 0/1/3/2020 / 15,221 60,302 75,523 326,786 206,668 120,071 78,046 96,009 174055.2 530 558 95% 55% 88,1480566 113,777358 389,9339623 46,46% 23.1	01/09/2020	Y	28,992	54,594	83,586	46,105	186,779		· · · ·	86,075	86,075	505	540	94%	100%	170.4455446	108.1069307	369.8594059	46.08%	29.23%
0/11/2020 /v 15,269 65,781 88,050 222,422 213,864 18,458 11,998 99,522 102,520 537 540 99% 88% 188,5698324 122,497,067 398,442,031 42,31% 30.7 01/12/2020 /v 15,221 60,302 75,523 326,786 206,665 100,071 78,046 96,009 174055.2 536 95% 55% 181.1490566 111.7773585 389,3339622 46,46% 29.1	01/10/2020	Y	23,048		23,048	151,630		151,630	98,560		98,560		558	0%	0%					
0//12/2020 Y 15,221 60,302 75,523 326,736 206,665 120,071 78,046 96,009 174055.2 530 558 95% 55% 181.14490566 113.7773585 389.9339623 46,46% 29.1	01/11/2020	Y	15,269	65,781	81,050	232,422	213,964	18,458	11,998	90,522	102,520	537	540	99%	88%	168.5698324	122.4972067	398.443203	42.31%	30.74%
	01/12/2020	Y	15,221	60,302	75,523	326,736	206,665	120,071	78,046	96,009	174055.2	530	558	95%	55%	181.1490566	113.7773585	389.9339623	46.46%	29.18%



COMPLEX ENERGY FLOWS

Digital Twin allows analysis of complex interactions









WORKFLOW





BRING DATA TOGETHER

To understand system characteristics



HYDRO COOLING

Data suggest chilled water flow rates need recommissioning

OAT not driving load

Baseload by increase by 50%

Chilled water send out temperature cycling





SOFTWARE OPTIONS





THANK YOU

Feel free to drop me an email for any questions or if you are looking for the next challenge.... Tunde.Olaoye@sse.com

JOIN OUR TEAM

We are driven by our purpose: to provide energy needed today while building a better world of energy for tomorrow. As a leading generator of renewable electricity and one of the largest electricity networks in the UK, we need a diverse range of talent to help us lead in a low carbon world both now and in the future.



