DIGITAL TWINS
TO DELIVER ‘SMART’ ENERGY SYSTEMS

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Smart Energy System Sector Director

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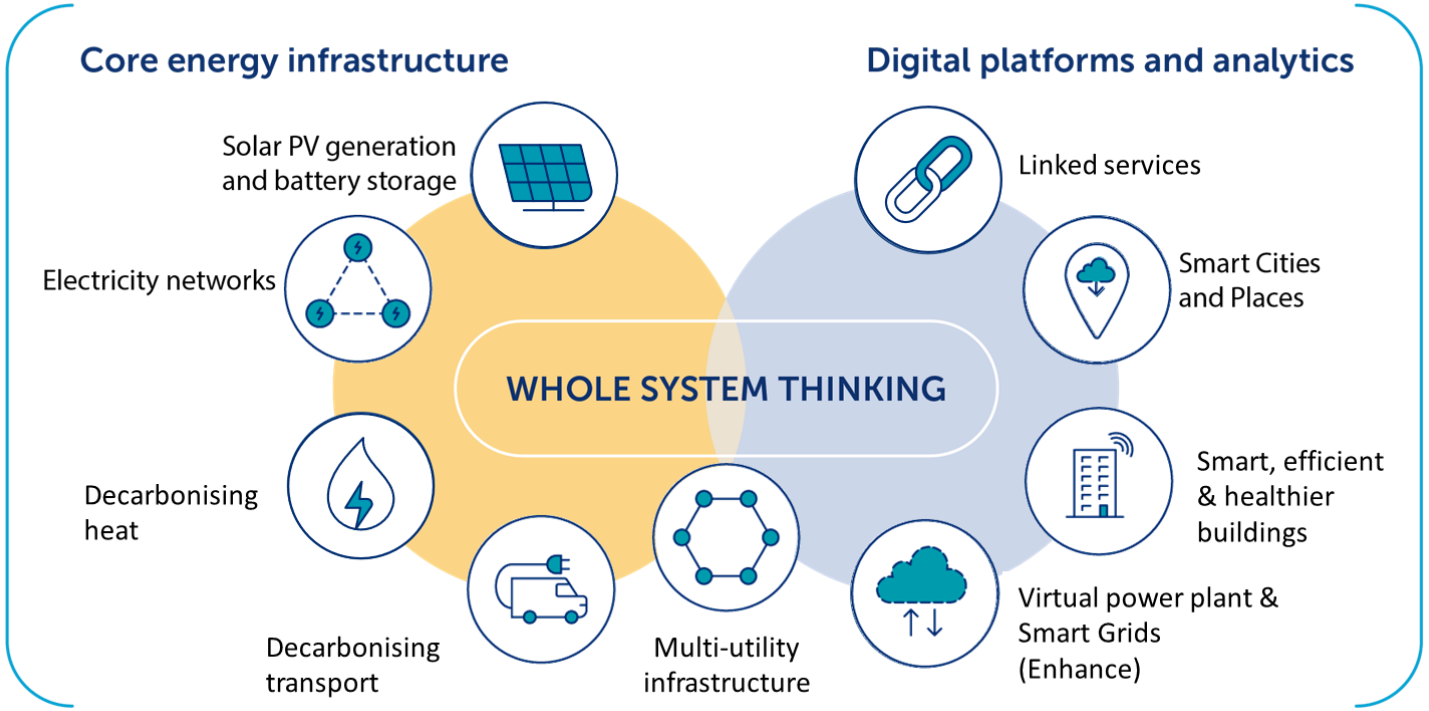
WHY BE SMART IN THE CONTEXT OF….

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

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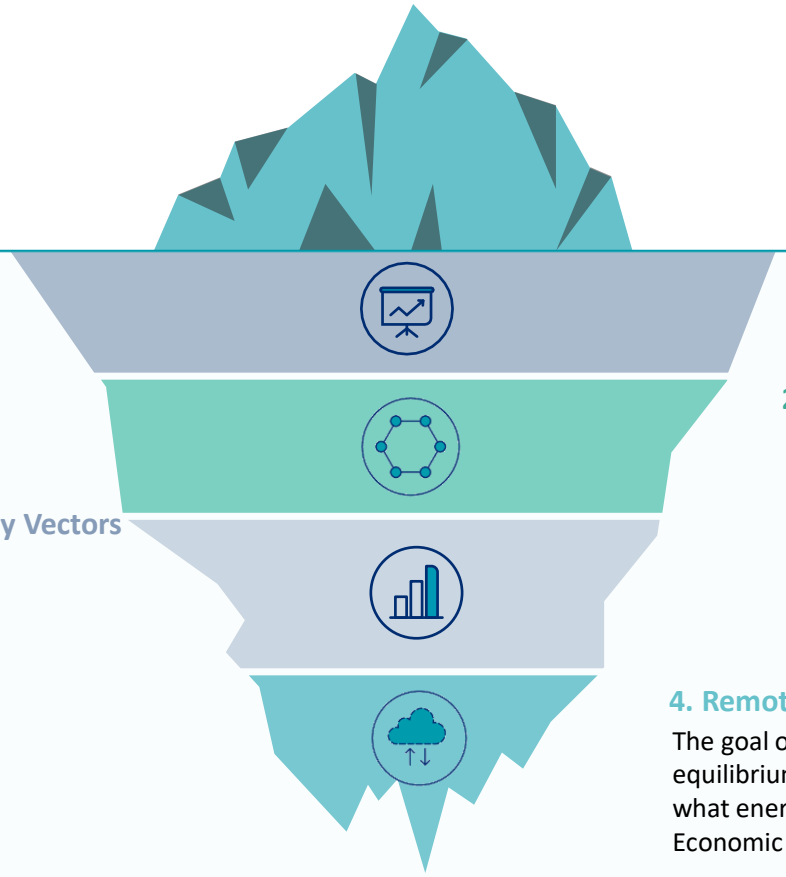
WHAT IS A SMART ENERGY SYSTEM (SES)

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



1. Multiple Economic & Sustainability Priorities

SES seeks to optimise the inherent trade-offs. These are defined as: Capex ,Opex, Revenue, Carbon, Social, Environment.

2. Integrates two or more sectors

Sectors in regards to SSE DE are:

- Private Networks (Smart Grids)
- Distributed Generations and Storage
- Heat Networks
- Smart Buildings
- Electric Vehicles

3. Digitally Integrate, Monitor, and Analyse Energy Vectors

- Sector – Vector
- Private Networks – Electricity
- Distributed Generation and Storage – Electricity
  - Future- Bio-gas, Hydrogen
- Heat Networks – Heat (for heating or cooling)
- Smart Buildings – Electricity, Heat, Bio-gas, Hydrogen, Vehicles
- Electric Vehicles – Electricity, Vehicles

4. Remotely control and optimize Assets

The goal of system control is to ensure supply reaches an equilibrium with demand. How the system behaves depends on what energy vectors are available, as well as the ranking of the Economic & Sustainability Priorities.

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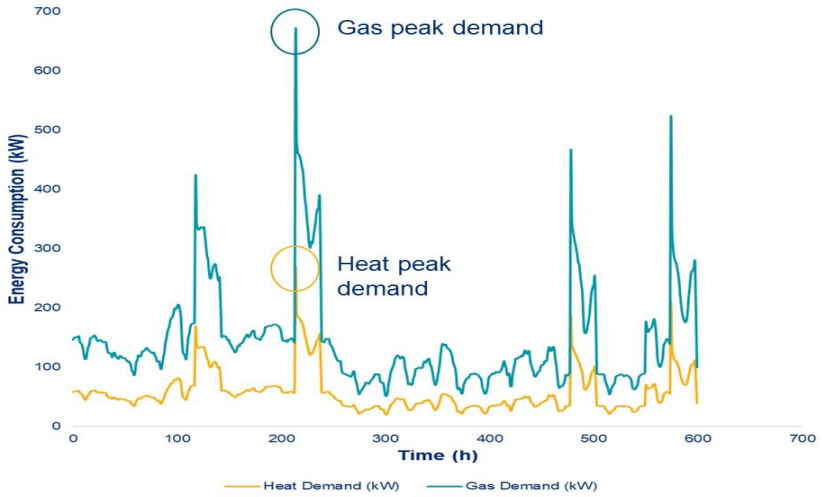
BEFORE YOU BUILD SMART, YOU MUST DESIGN SMART

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



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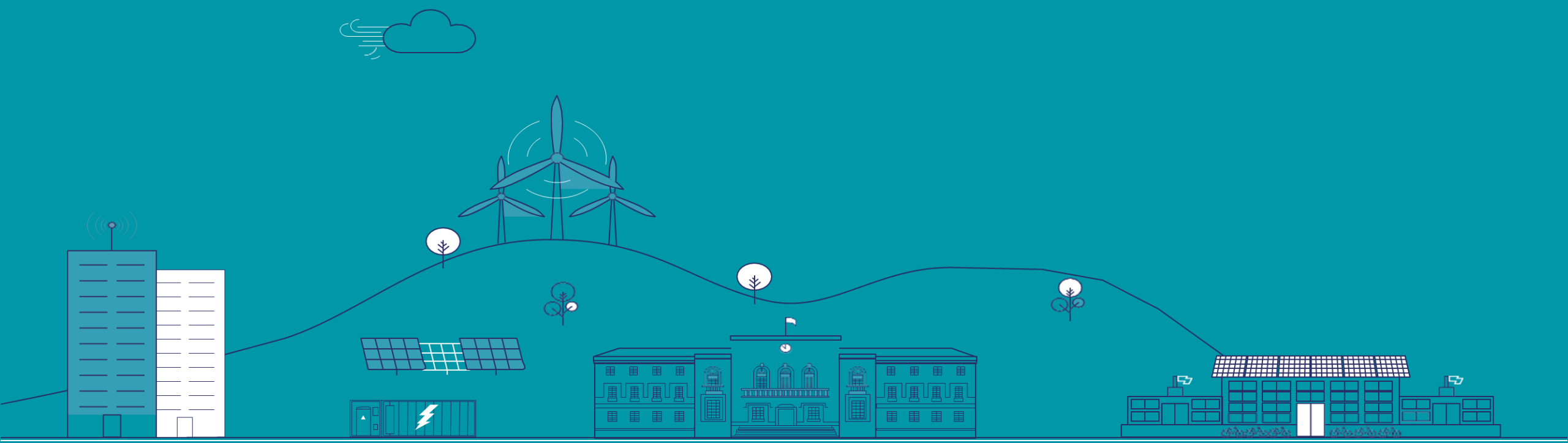
CAPTURING DATA &
CALIBRATION BASELINE



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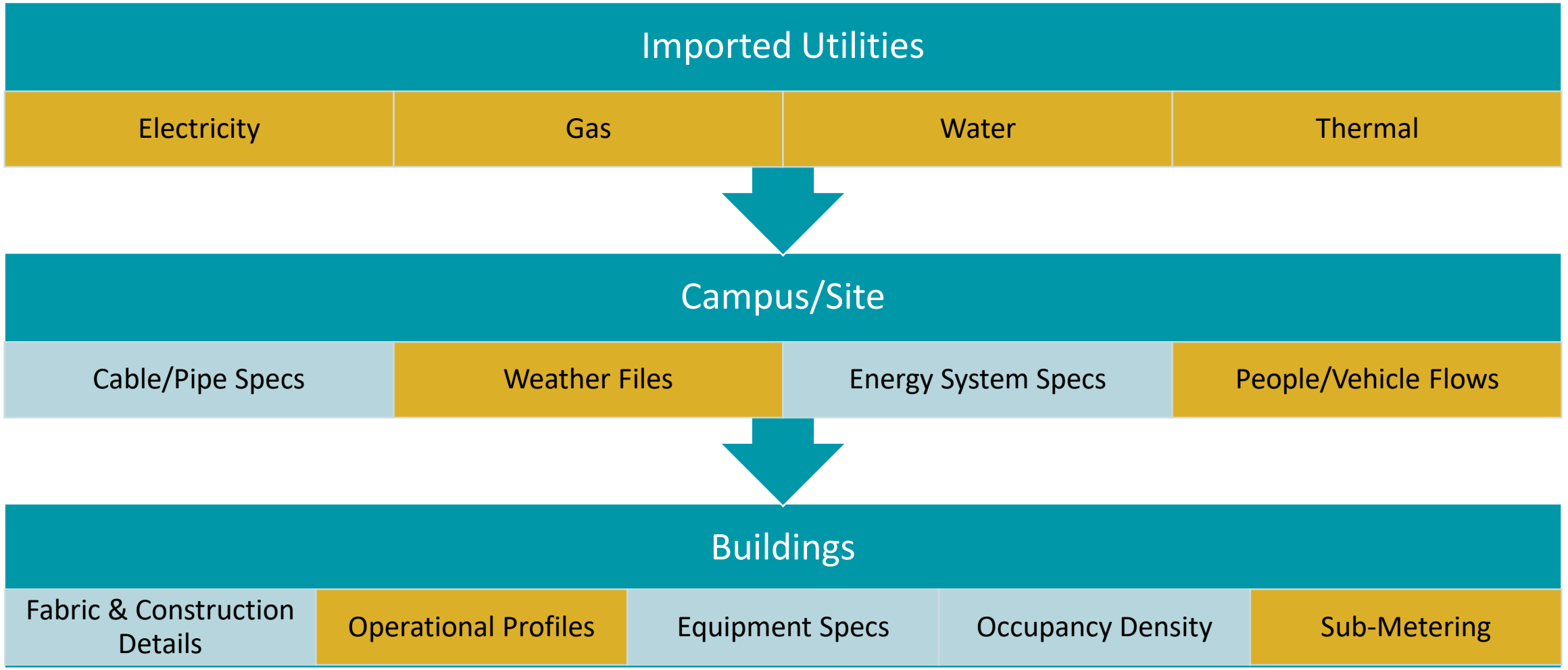
WHAT ARE WE INTERESTED IN?

Model Properties | Model Inputs



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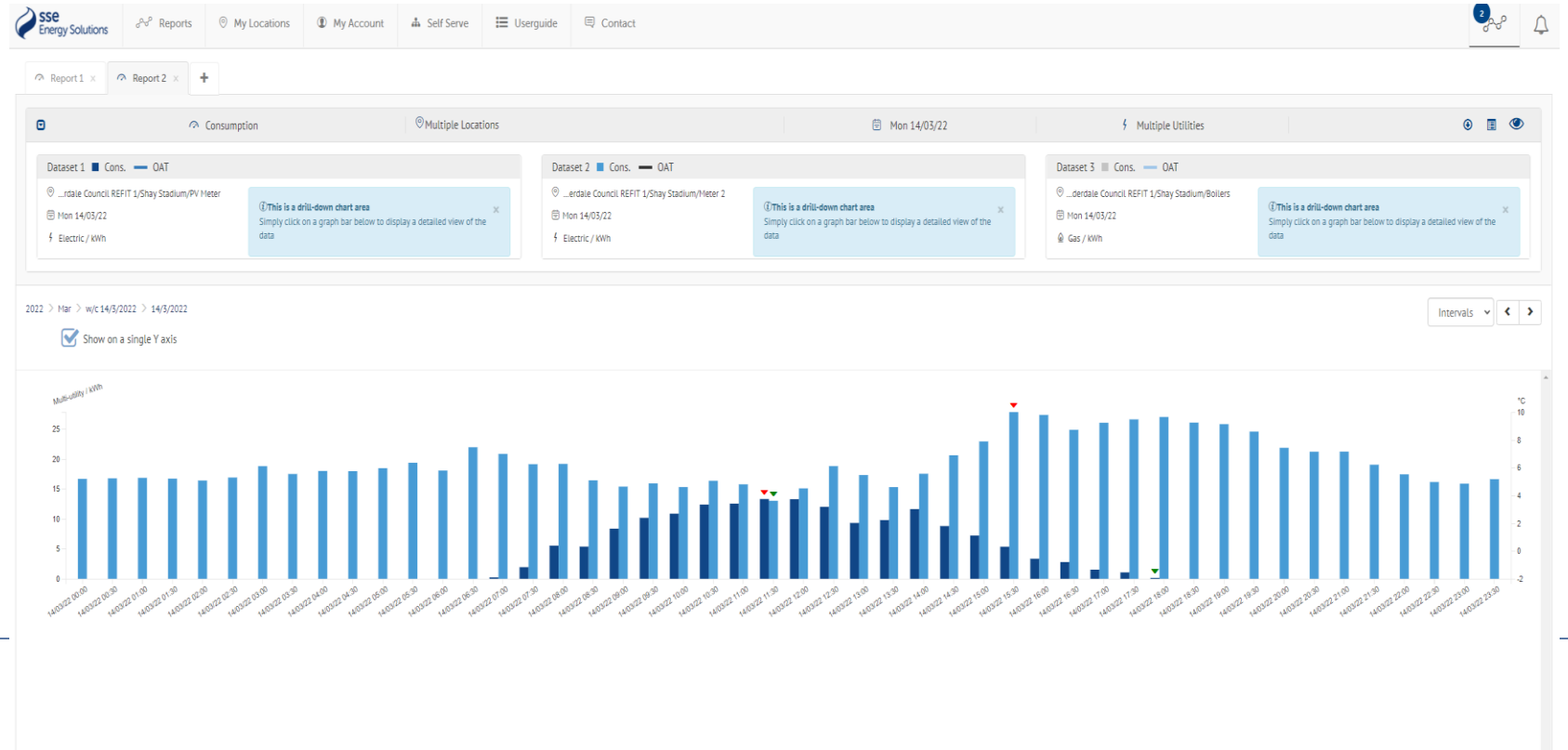
METERS ARE REALLY IMPORTANT

- 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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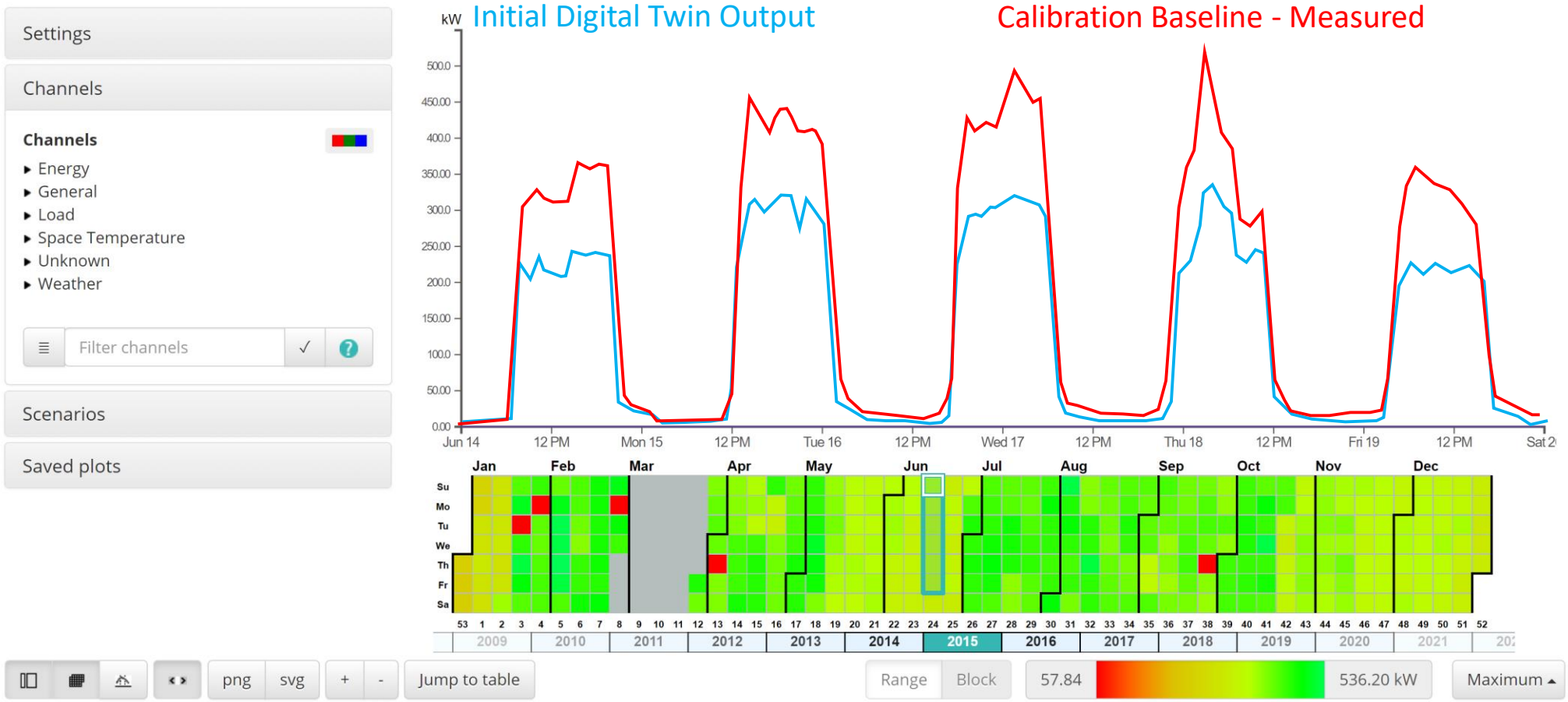
IDENTIFYING DIFFERENCES



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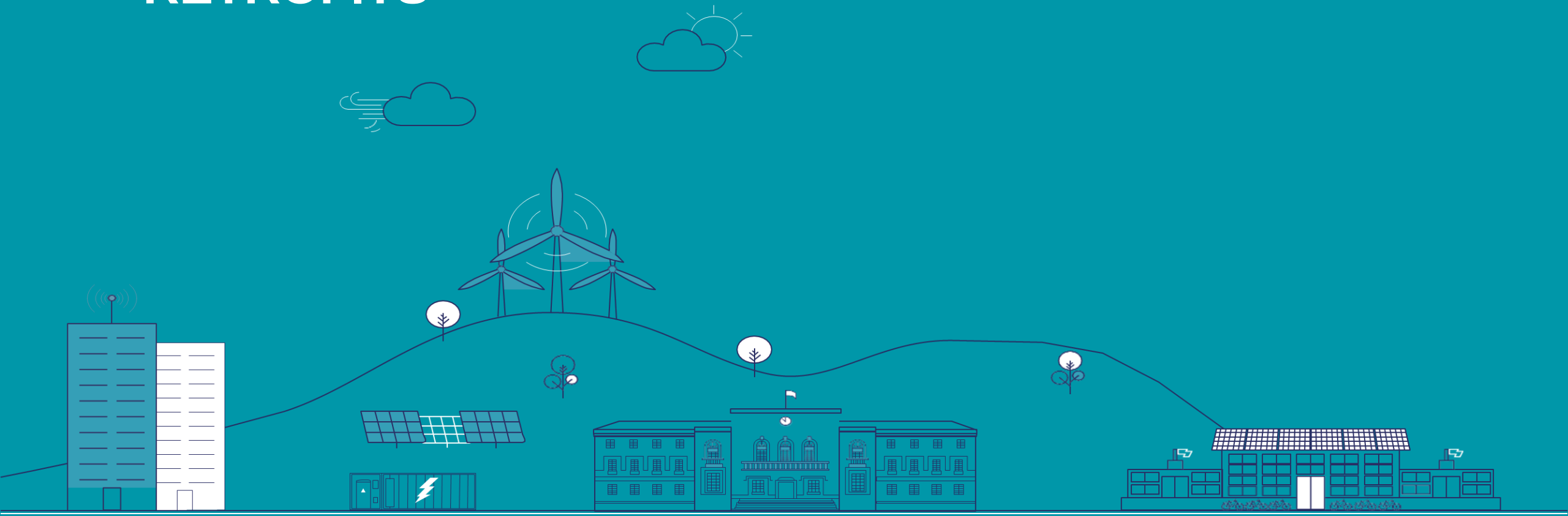
DIGITAL TWINS FOR **RETROFITS**



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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

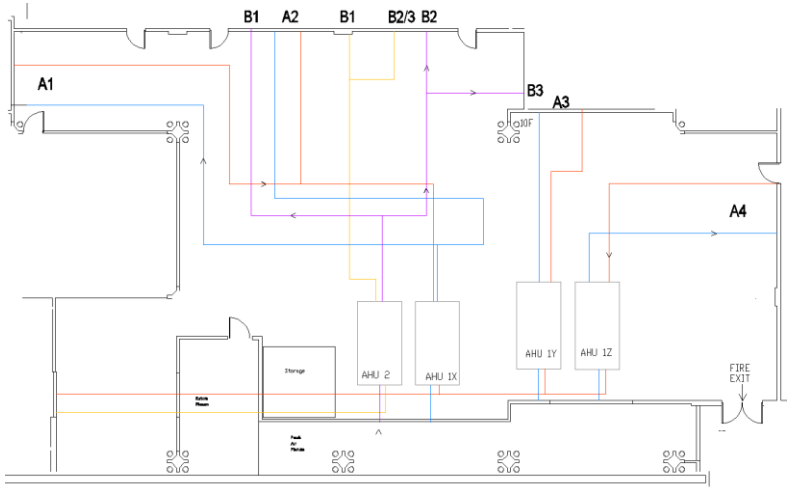
Understand the amount of electricity used by all equipment

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

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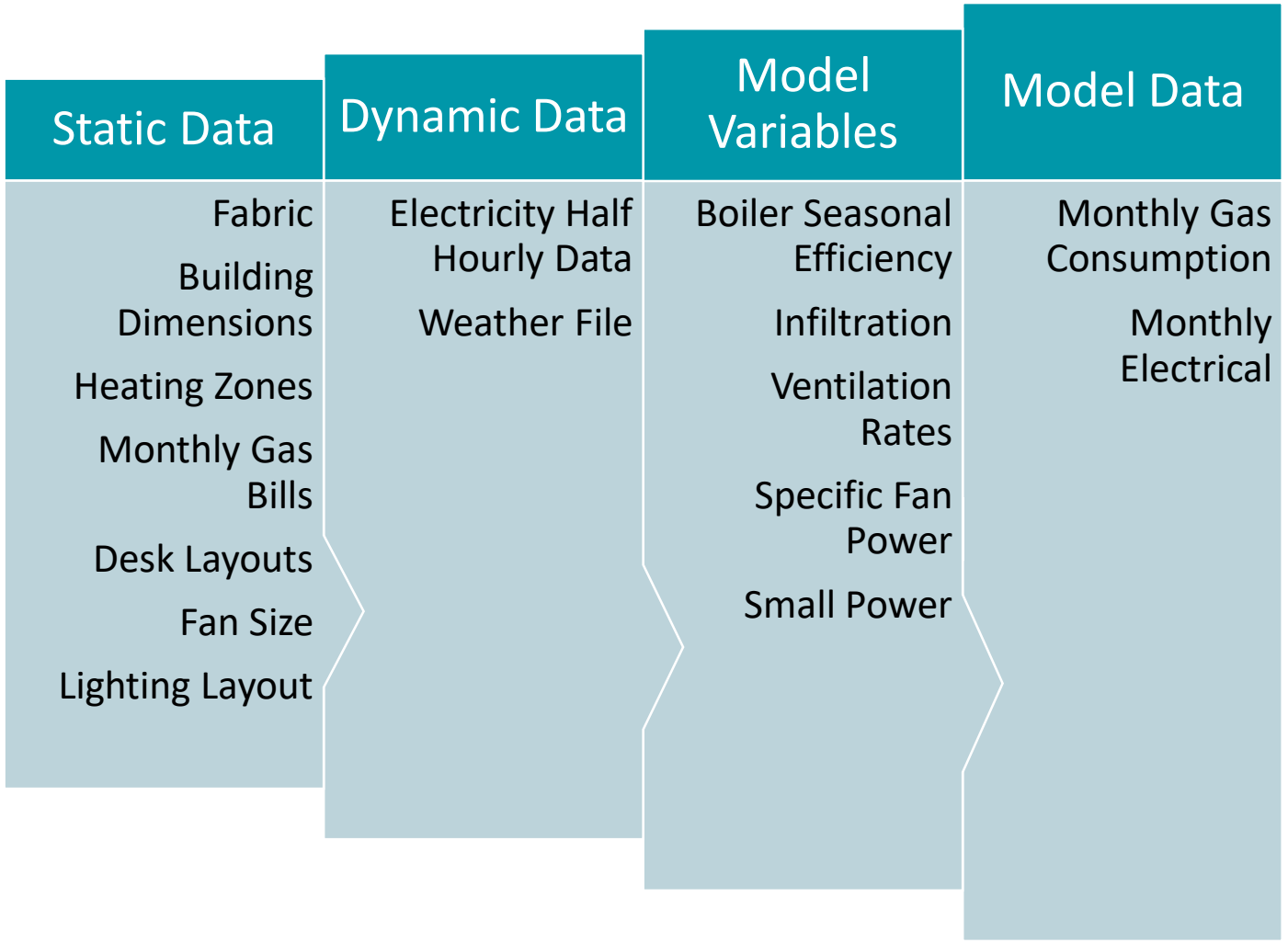
WORK FLOW



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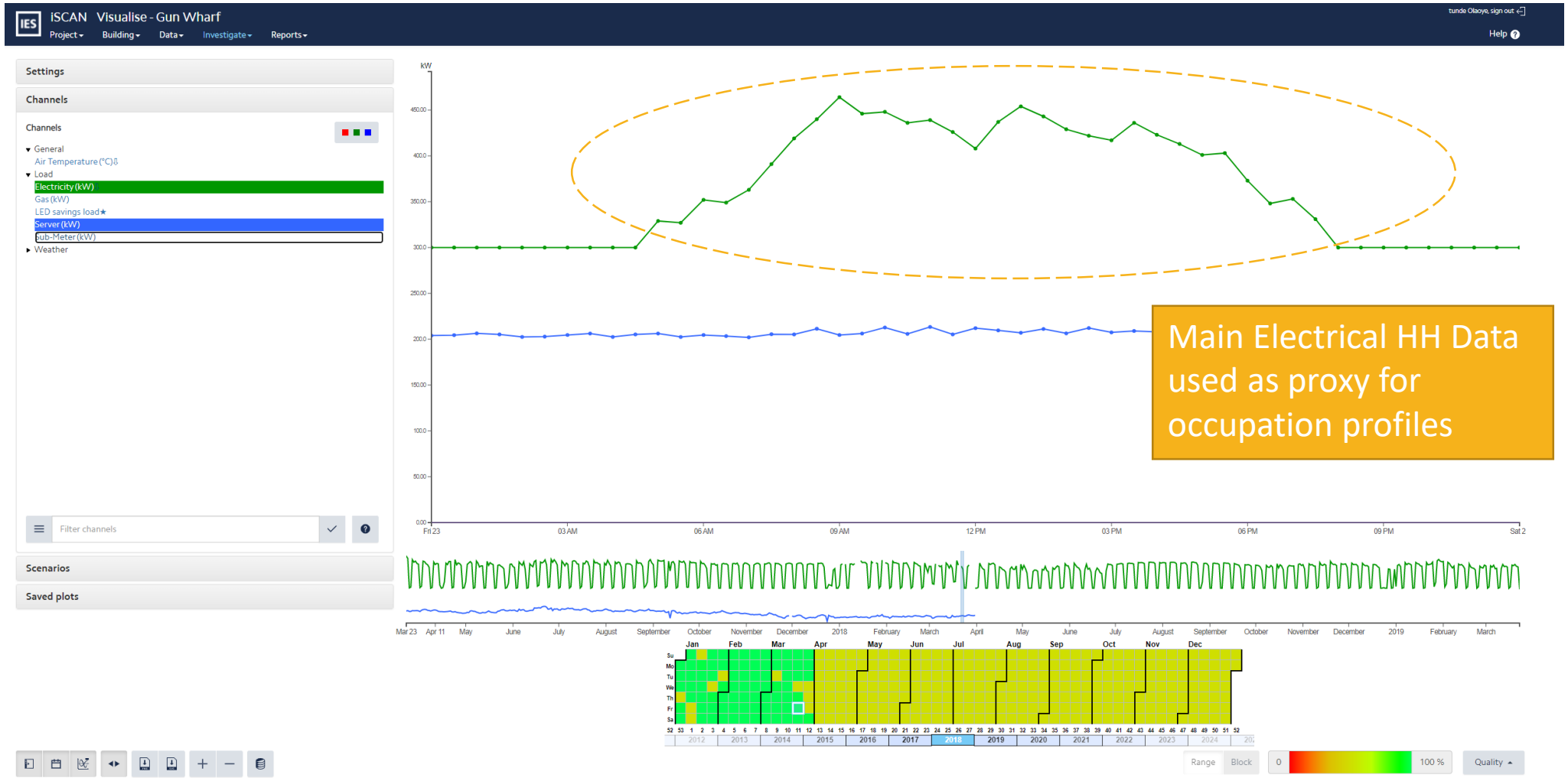
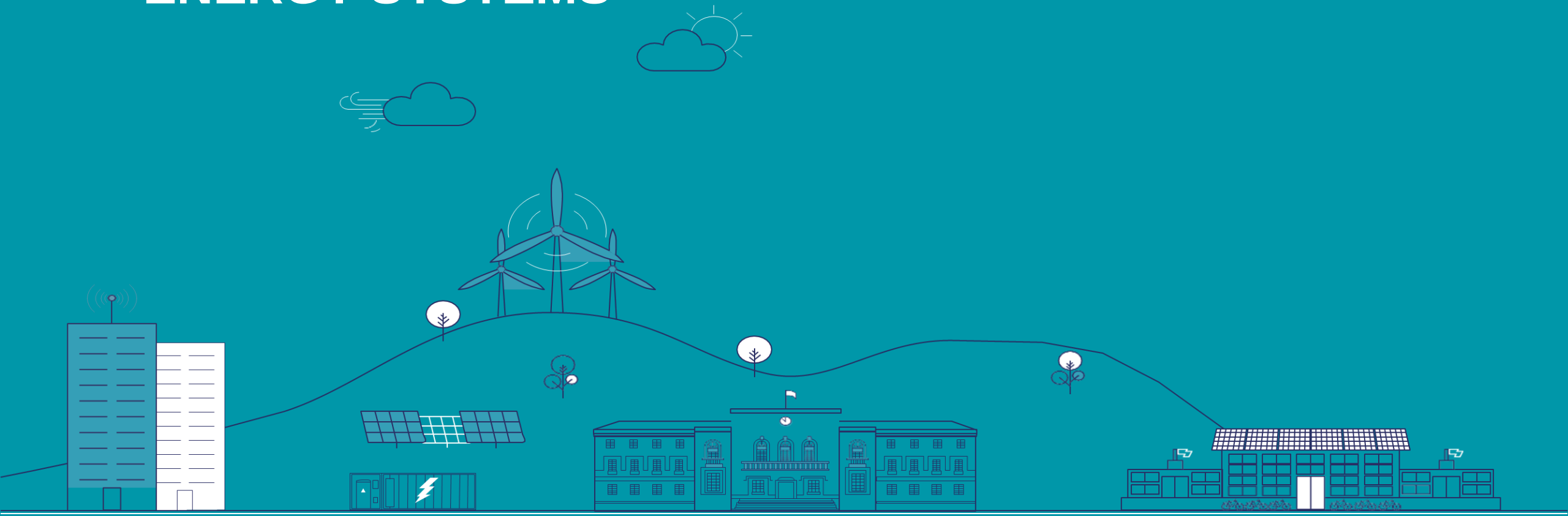
CALIBRATION PROCESS: FACTUAL DATA SOURCES



DIGITAL TWINS FOR **ENERGY SYSTEMS**



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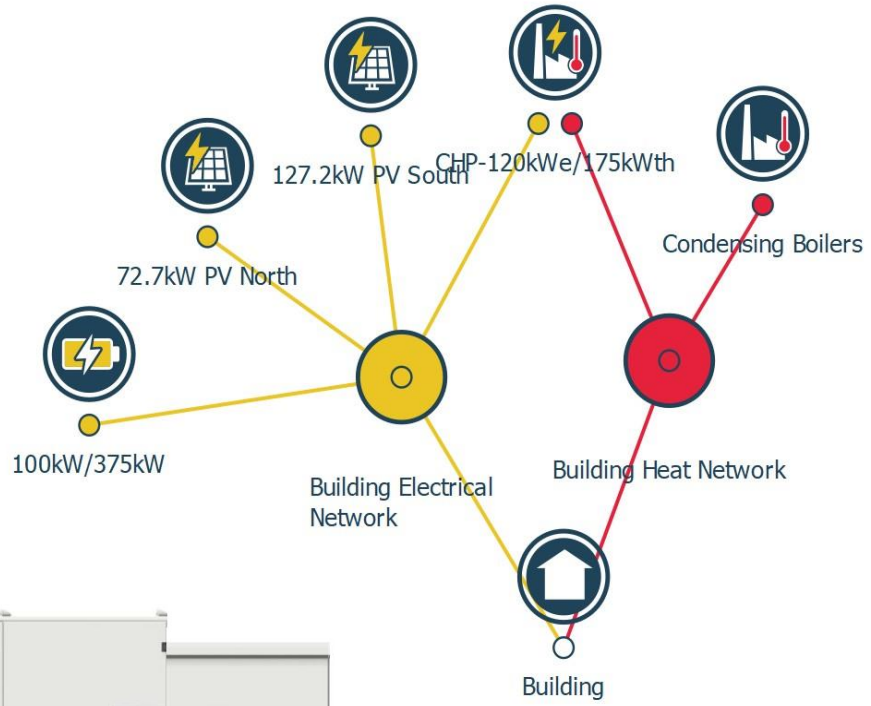
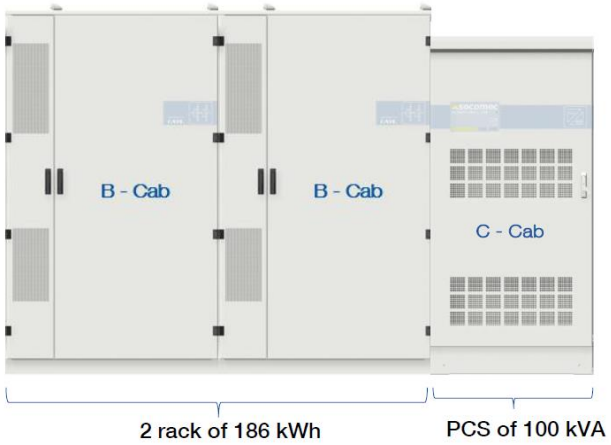
MEDWAY PARK

Smart Energy System

- 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





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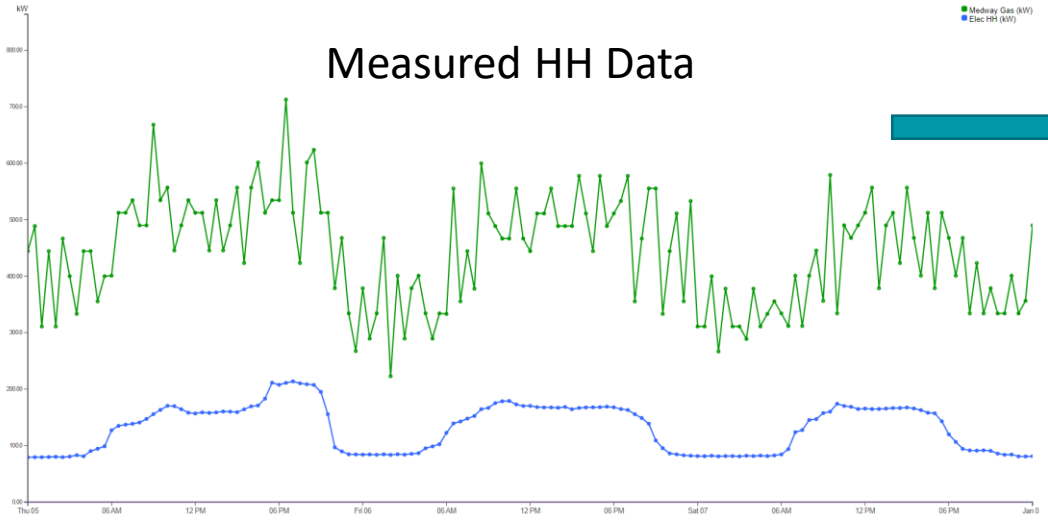
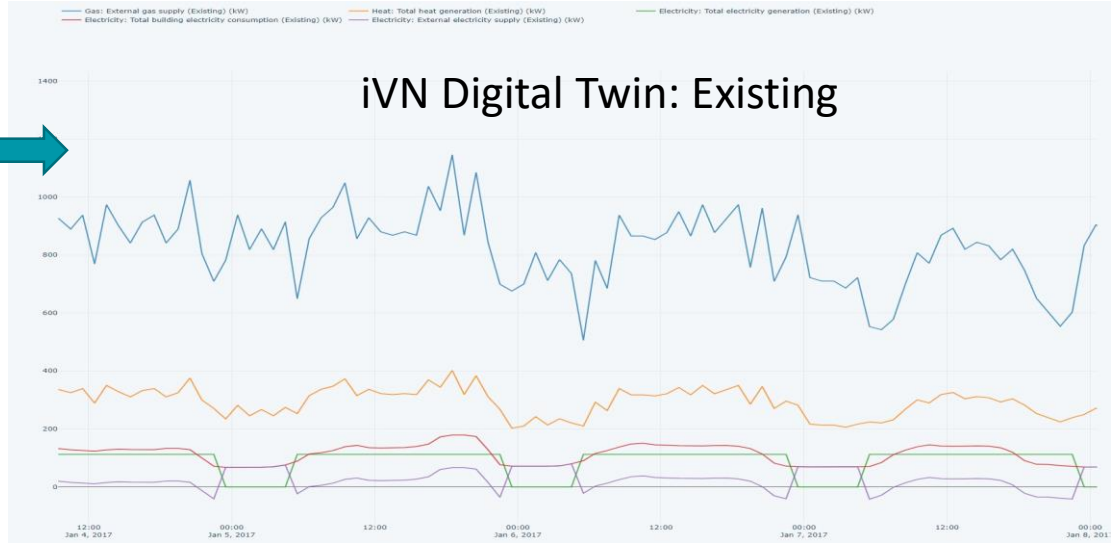
COMPLEX ENERGY FLOWS

Digital Twin segregates consumptions and loads

Measured HH Data



iVN Digital Twin: Existing



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	Hours Utilisati on	CHP Heat Delivered	CHP Average Heat Power (kW)	CHP Average Elec Power (kW)	CHP Average Gas Power (kW)	CHP Heat Efficiency	CHP Elec Efficiency
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%
01/01/2019	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%
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%
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%
01/04/2019	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%
01/05/2019	Y	41,939	-	41,939		-	-	-	-	-	480	558	86%			-	-		
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%
01/07/2019	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%
01/08/2019	Y	43,807	50,580	94,387	38,416	171,594		-	79,713	79,713	460	558	82%	100%	173.29	109.96	373.01	46.46%	29.48%
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%
01/10/2019	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%
01/11/2019	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%
01/12/2019	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%
01/01/2020	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%
01/02/2020	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%
01/03/2020	Y	28,651		28,651	304,086		304,086	197,656		197,656		540	0%	0%					
01/04/2020	Y	32,123	14,123	46,246	186,283	59,247	107,036	69,573	27,524	97,097	257	540	48%	28%	107.0972763	54.95330739	230.5330739	46.46%	23.84%
01/05/2020	Y	62,928		62,928	95,727		95,727	62,223		62,223		558	0%	0%					
01/06/2020	Y	67,957		67,957	31,766		31,766	20,648		20,648		540	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%
01/08/2020	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%
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%
01/10/2020	Y	23,048		23,048	151,630		151,630	98,560		98,560		558	0%	0%					
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%

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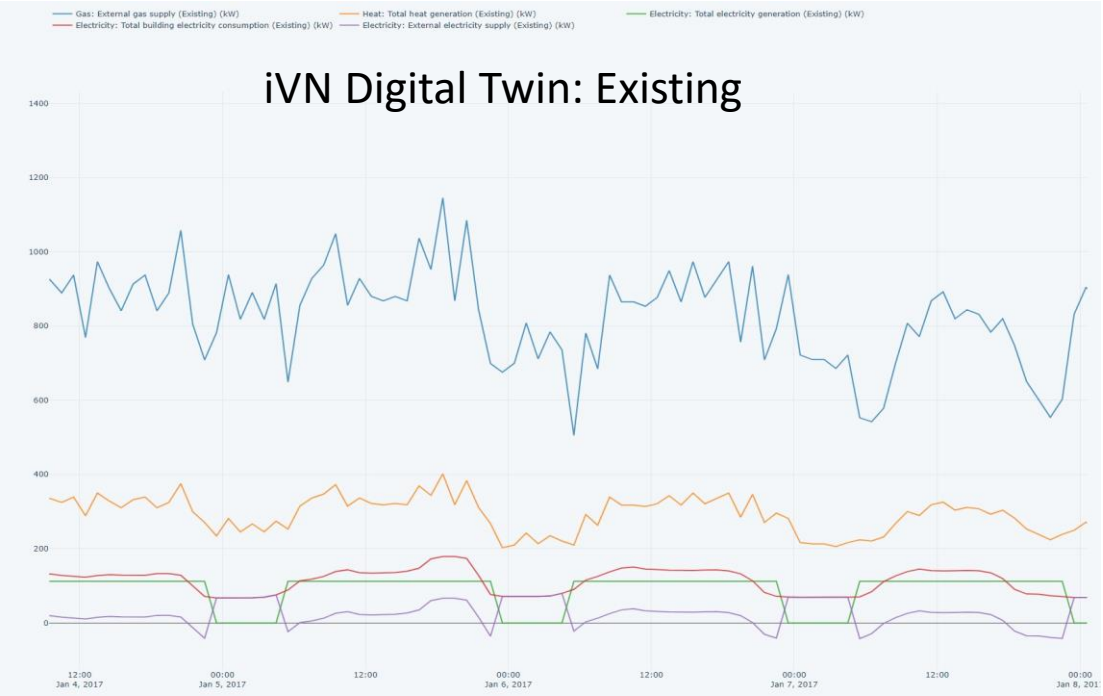
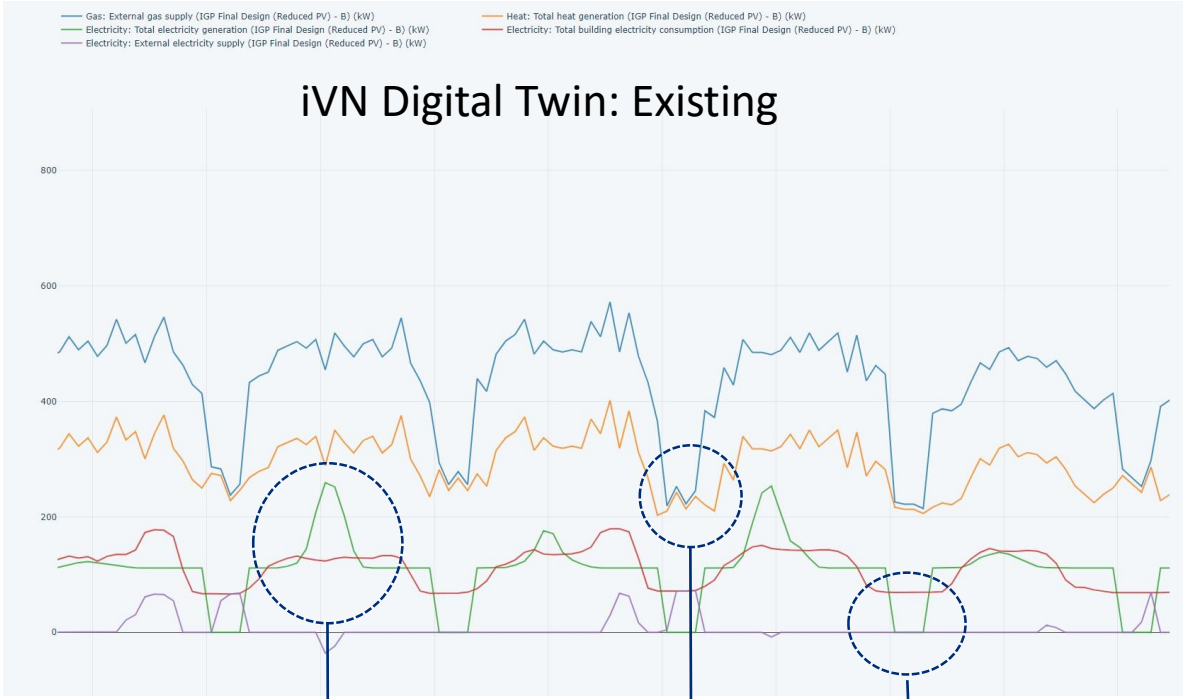
COMPLEX ENERGY FLOWS

Digital Twin allows analysis of complex interactions





Contribution of PV

High Efficiency & Correctly Sized Boiler

Optimised Import with Storage

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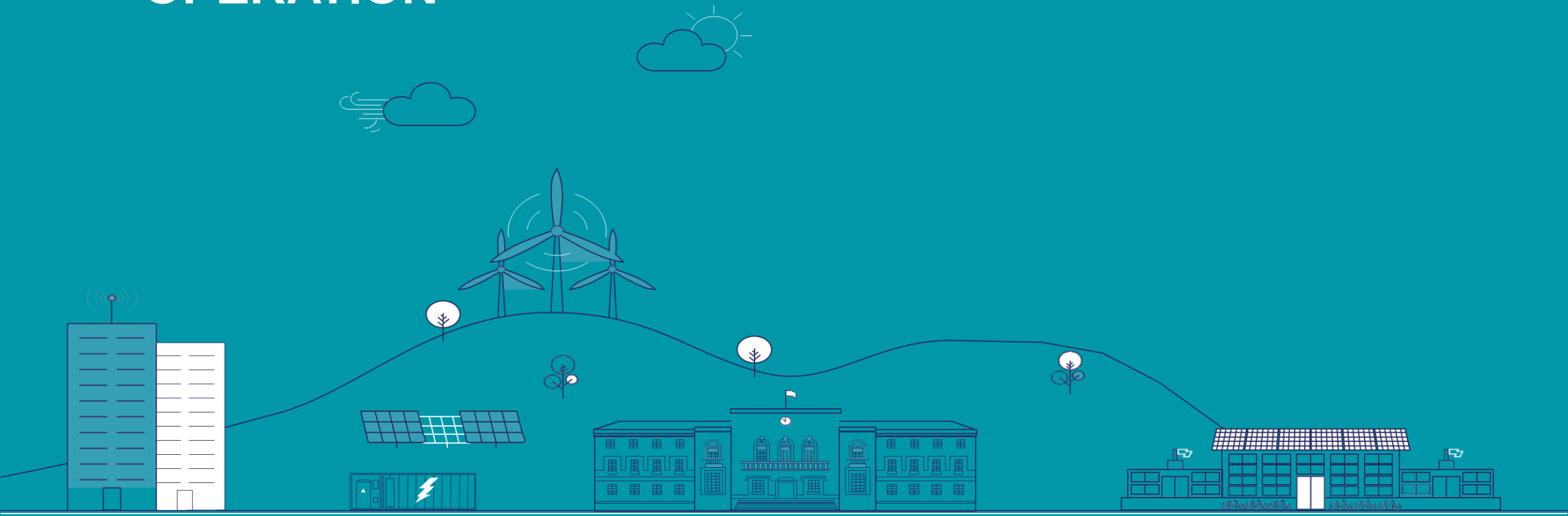
DIGITAL TWINS FOR **OPERATION**



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WORKFLOW

BMS & Metering

- Identify key energy flows
- Ensure meter or measured (LORA environmental sensors really useful)
- Ensure logging data

iSCAN

- Check data quality
- Analyse and manipulate data
- Pull in weather files

VE

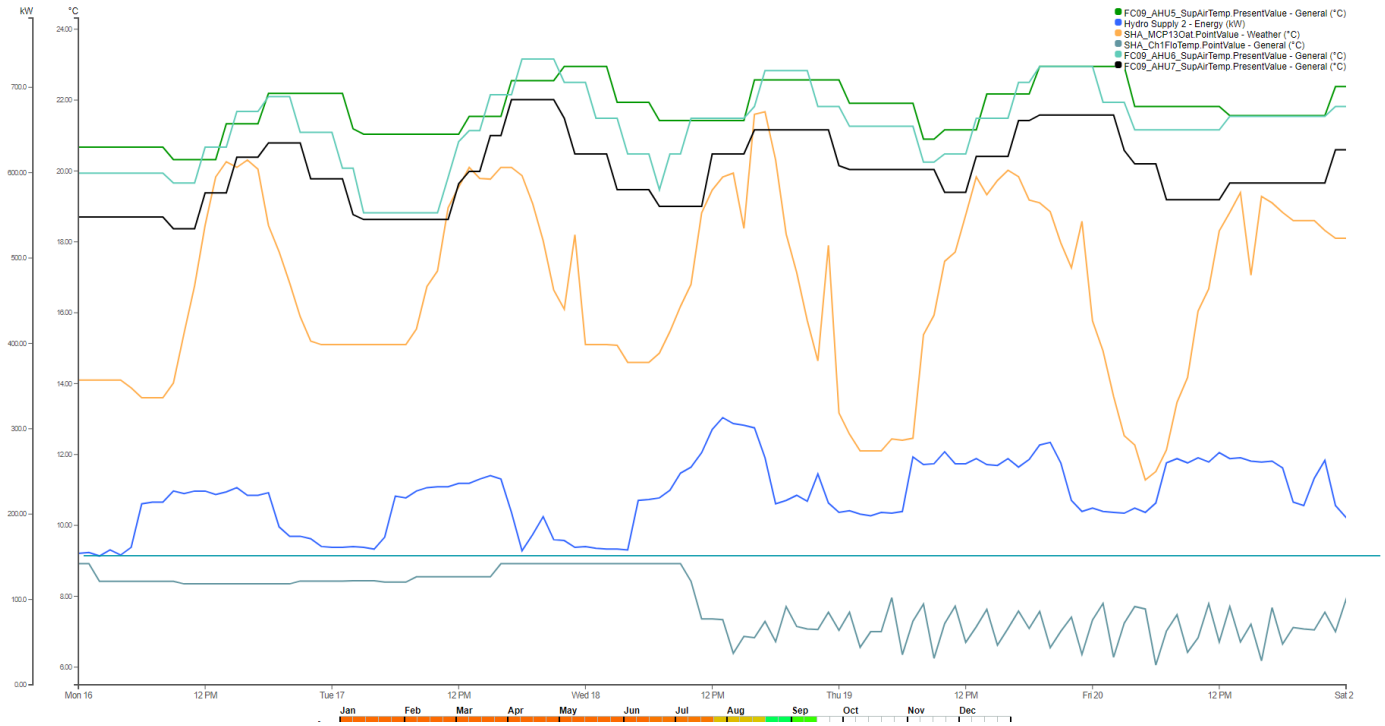
- Network modelling
- Energy balance across vectors
- Detailed modelling
- Pumps, compressors, lifts etc.
- Heating, power, cooling

iVN

- Network modelling
- Energy balance across vectors

BRING DATA TOGETHER

To understand system characteristics



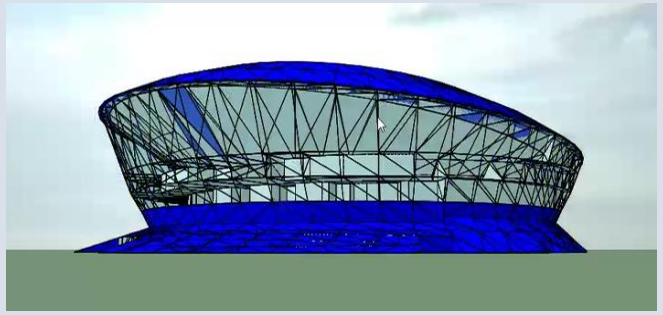
HYDRO COOLING

Data suggest chilled water flow rates need recommissioning

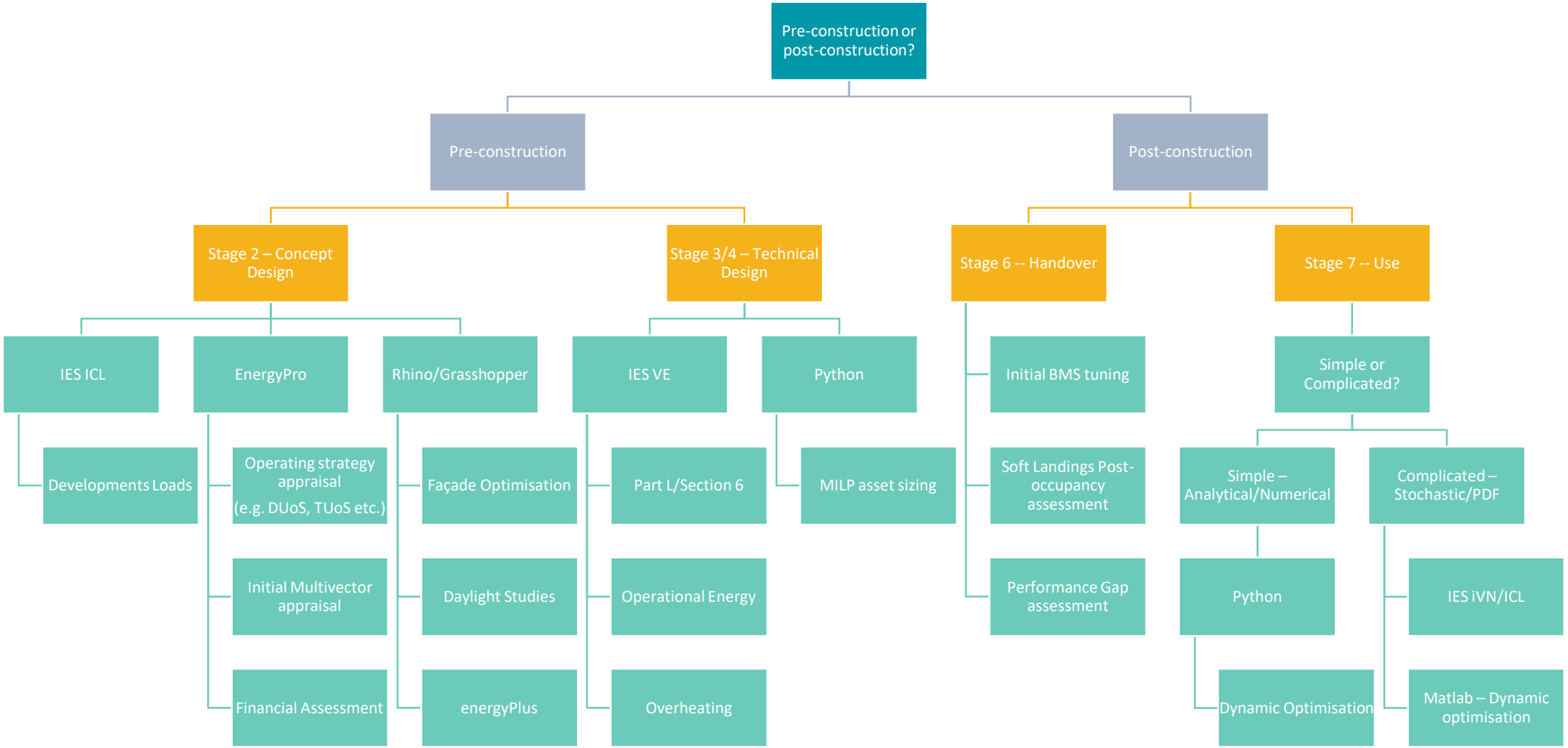
OAT not driving load

Baseload by increase by 50%

Chilled water send out temperature cycling



SOFTWARE OPTIONS



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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.

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