Data Centre Design Assessment - Part 1 - Design and Planning

Daniel Cortez

These assessment tasks provide an opportunity for you to demonstrate the competencies required to design a data centre to meet operational and efficiency goals.

- You are allowed to refer to your text books, notes and the Internet during the Assessment.
- The documentation and research work must be entirely your own.
- By commencing this assessment, you confirm that you have read and agree to abide by the ACIT Academic Honesty Policy

Successful completion of this assessment contributes towards attaining competency in the following:

ICTICT418	Contribute to copyright, ethics and privacy in an IT environment
ICTPMG610	Develop a project management plan
ICTSUS601	Integrate sustainability in ICT planning and design projects
ICTPMG611	Prepare a detailed design brief
ICTTEN611	Produce an ICT network architecture design
ICTNWK529	Install and manage complex ICT networks

<u>Overview</u>

You are required to prepare a Data Centre Design brief. The design must make provision for the first 10 years of the data center's life.

<u>Scenario</u>

Pacific Internet Solutions, a multinational ISP offers a range of cloud-based solutions and services to customers. A surge in demand for these services in Australia has led Pacific Internet Solutions to commission the construction of an additional data centre in the region.   You have been appointed to develop a design brief that will be used to define the high-level requirements and provide high level specifications to architects, engineers, and other specialists.

Requirements

Pacific Internet Solutions have their head office and top level management in the USA and are familiar with US data centre standards and operations.

- The management team has decided that the new data centre must meet Tier II standards for uptime and availability and provide N+1 for power and cooling.
- All operational, technical, and administrative staff for the data centre shall be located at the data centre and space and facilities should be allocated for this. The staff numbers are 2 administrative staff, 3 operational staff, and 5 technical staff.
- It is envisaged that the data centre will house 10 IT pods, each pod will accommodate 22 racks. Each rack will house 2 x HP BladeSystem c7000 enclosures. Each HP BladeSystem c7000 enclosure will house 16 HP ProLiant BL460c G7 servers. It is envisaged that the data centre will be operating at full capacity approximately 5 years after construction.
- The sites geographical location must be low risk for earthquake, flooding, tsunami, and volcanic activity. The location must provide access to water, power, and telecommunications services. The site must also provide the opportunity for free cooling.

Tasks

1. Plan for site selection. *References - Student materials - site planning folde*r

    1. List 2 possible sites in Australia.
    2. Assess the risks of proposed sites.
    3. Assess the availability of services and supporting facilities.
    4. Describe the geographical, topological and environmental attributes, including hazards and climate.
    5. Include a map of each site
    6. List the advantages and disadvantages of each site.
    7. Select the preferred site. Explain why you selected it.

1. _ 628 Gympie Rd, Chermside, Brisbane QLD 4032

   _ 157 Kingsgrove Rd, Kingsgrove Rd Sydney, NSW 2208

Site attributes

Site 1: 628 Gympie Rd, Chermside, Brisbane Qld 4032	
General Information	_628 Gympie Rd, Chermside, Brisbane Qld 4032 _Type of Site: Brownfield _Size: 5.752 square meters
Assess the risks of proposed sites.	The agreed address has no risk of flooding, the closest to a possible risk is in a nearby street (Henry St) that is 60 m away, but the risk of this is very minimal, likely to occur during a single lifetime (70 years). A flood of this size or larger has a 1% chance of occurring in any year.
Assess the availability of services and supporting facilities.	Mission critical facilities require a 4-hour response time for support services, as there is a concentration of mission critical facilities in Brisbane, providers providing this service are within a 4-hour radius. Stock of spare parts and equipment are readily available. It has multiple types of electrical companies that can pay for the necessary energy, such as Wire-not Electrical or MCS electrical, which do not exceed a distance of km..
Describe the geographical, topological and environmental attributes, including hazards and climate.	Seismic activity occurs from time to time In the Brisbane region but generally at such a low level that has little to no community impact. A maximum Richter magnitude of 6.5 is theoretically possible within region, which includes Brisbane but is an extremely unlike event for Brisbane. Also, according to a recent tsunami modelling study by Queensland Government's Department of Environment and Science, Brisbane is not included in the highest tsunami hazard risk. The chance of Queensland being flooded due to a tsunami is very low because is not near major sources like other countries.
fiber and telecommunication infrastructure	There are several long-distance fiber operators very close to the city center. These carriers could provide adequate bandwidth to meet the communications requirements of a data center or other mission critical installations. The company that will provide us with fiber and telecommunications infrastructure will be BFN (Building Fiber Network) which is located at 23 Duntroon St, Brendale, Brisbane. almost 9 km from our Data Center. They are specialist in building, operating and maintaining fiber-to-the-premises optical fiber networks to new and existing multiple dwelling residential and multi-use developments.
Water	Seqwater manages up to $11 Billion of bulk water supply infrastructure – including the SEQ Water Grid – and the natural catchments of the region´s water supply sources to

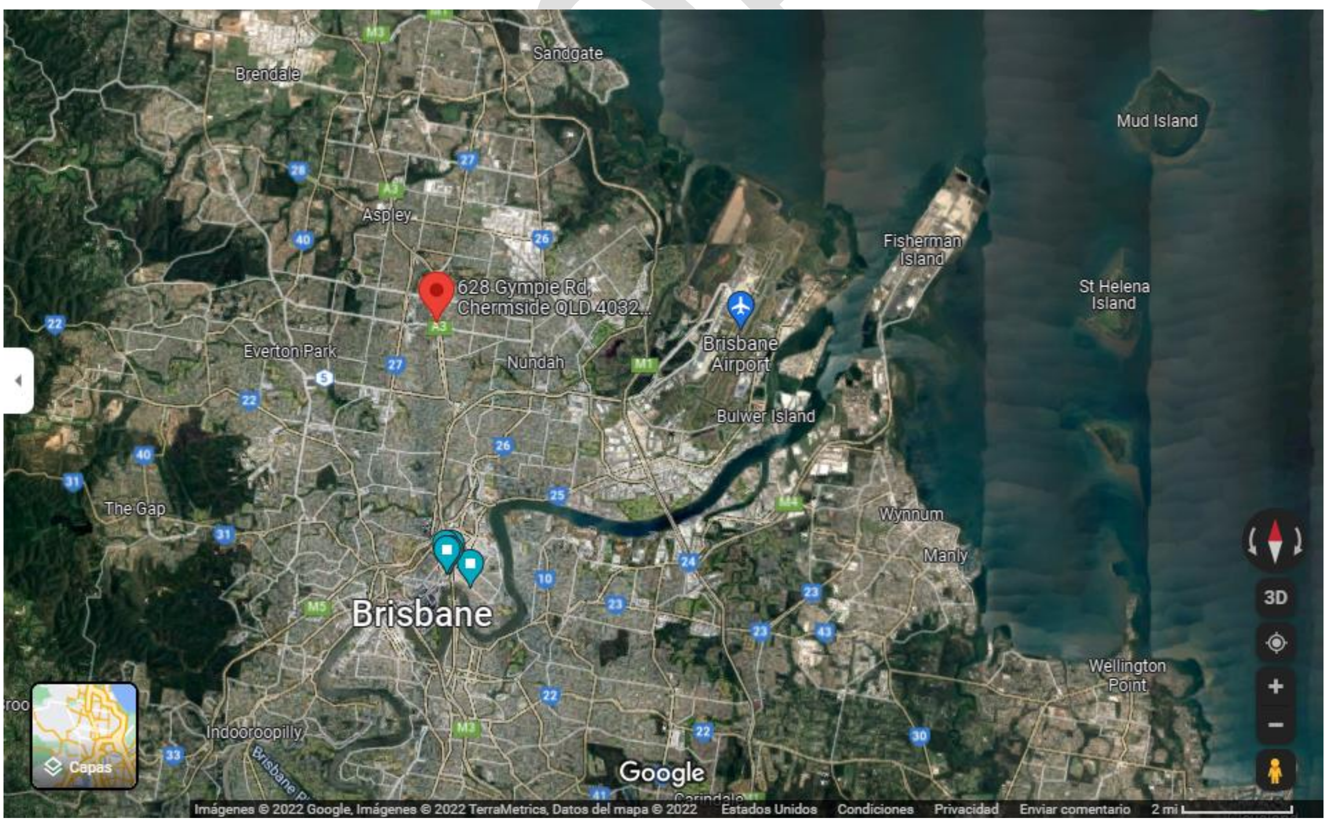
	ensure a reliable, quality drinking water supply for more than three million consumers across South East Queensland. These water supply assets include 73.000 + hectares of catchment land, dams and weirs, conventional water treatment plants and climate resilient sources of water through the Gold Coast Desalination Plant and the Western corridor Recycled Water Scheme, as well reservoirs, pump stations and more than 600 Kilometers of bi-directional pipeline networks. Seqwater also supply water to 53.000 people living in 16 off-grid communities. The water for these communities is sourced and treated locally, then distributed to households and businesses.
Air quality	The capital of Queensland state on Australia´s east coast, and the country´s 3rd most populated city, Brisbane generally experiences relatively healthy air quality year-round, in comparison with other global major cities. However, similarly to many locations in Australia, Brisbane air quality is also prone to experience short-term extreme pollution events which frequently exceed the national limits for daily air pollution exposure, such as dust storm. The low levels of background air pollution that are present in the air year-round present significant health hazards to Brisbane´s 2.5 million residents.

Location Evaluation

Very Favorable	Favorable	Mixed	Unfavorable

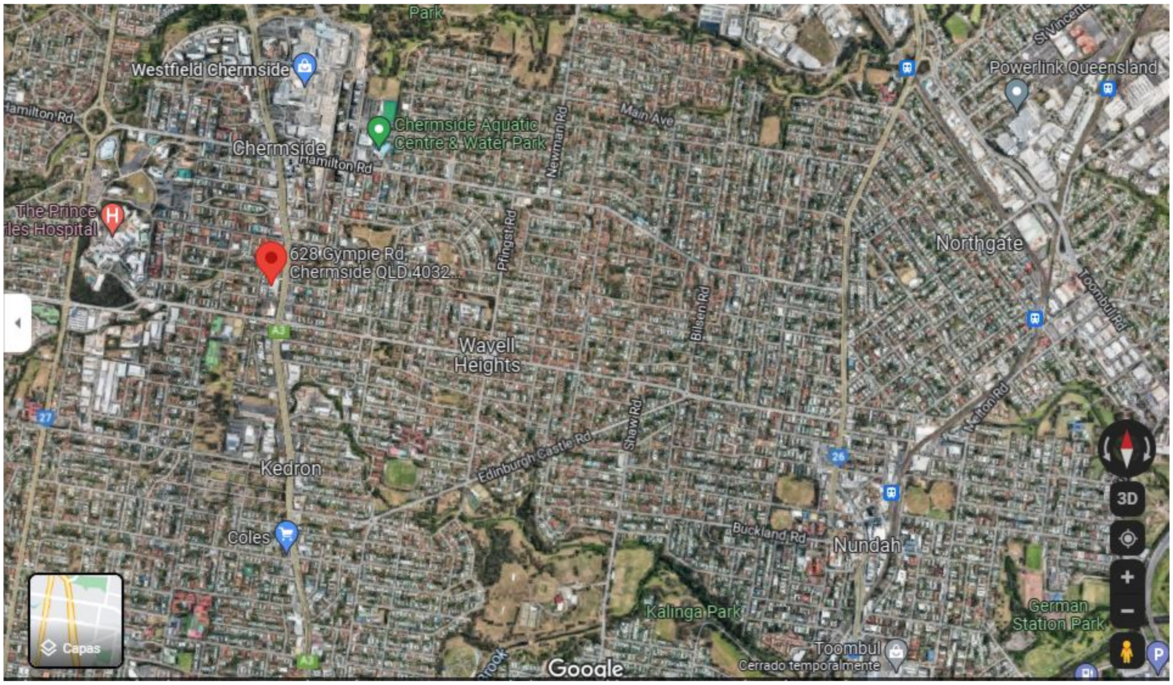
Site 1: 628 Gympie Rd, Chermside, Brisbane Qld 4032	
Location	
_Proximity to Major Highways	Very Favorable
_Proximity to Public Transportation	Very Favorable
_Distance to Metropolitan Cities (7,19 km)	Favorable
_Proximity to Major financial market hubs	Favorable
_Proximity to Brisbane´s Center (7,19 km)	Favorable
Available utility resources	
_High voltage electrical services	Very Favorable
_Water	Favorable
_Natural Gas	Favorable
_Fiber Connectivity	Favorable
Site Logistics/Security	
_Ability to Fence/Secure Property	Very Favorable
_Susceptibility to Natural Disasters	Mixed
_ Susceptibility to Man-made Disasters	Unfavorable
_Distance from Building Structure to Street	Favorable
_ Distance from Building Structure to Railroads	Favorable

_Access to Public Transportation	Very Favorable
_Access to Service Vendors	Favorable
_Access to Fuel	Very Favorable
_Weather	Very Favorable
_Air quality	Favorable
_Proximity to adjoining Buildings/Property	Favorable
Property	
Available Yard Space for Mission Critical Facility Equip	Very Favorable
Paved Surfaces/Parking	Very Favorable
Provisions for Future Expansion	Favorable
Area Demographics	
Population Density	Very Favorable
Workforce and Talent Pool	Very Favorable
Housing	Favorable
Employment and Income Statistics	Favorable
Local Government and Services	Very Favorable
School District and Higher Education	Very Favorable

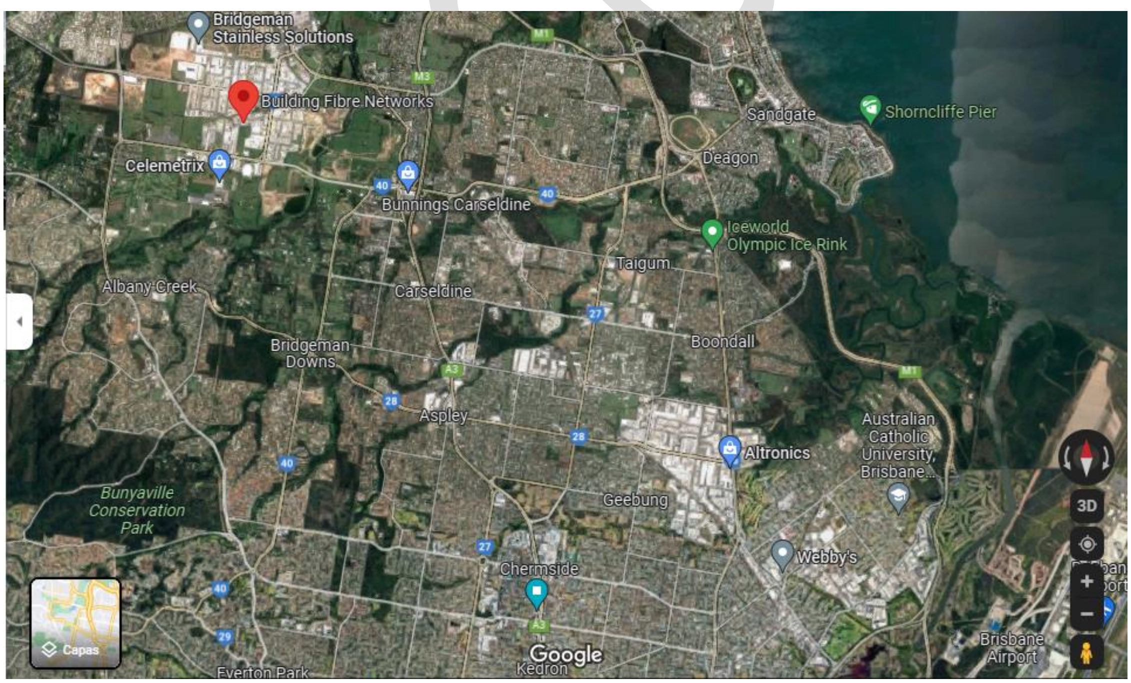


F1: Overview of Brisbane

Daniel Cortez id: 9849909

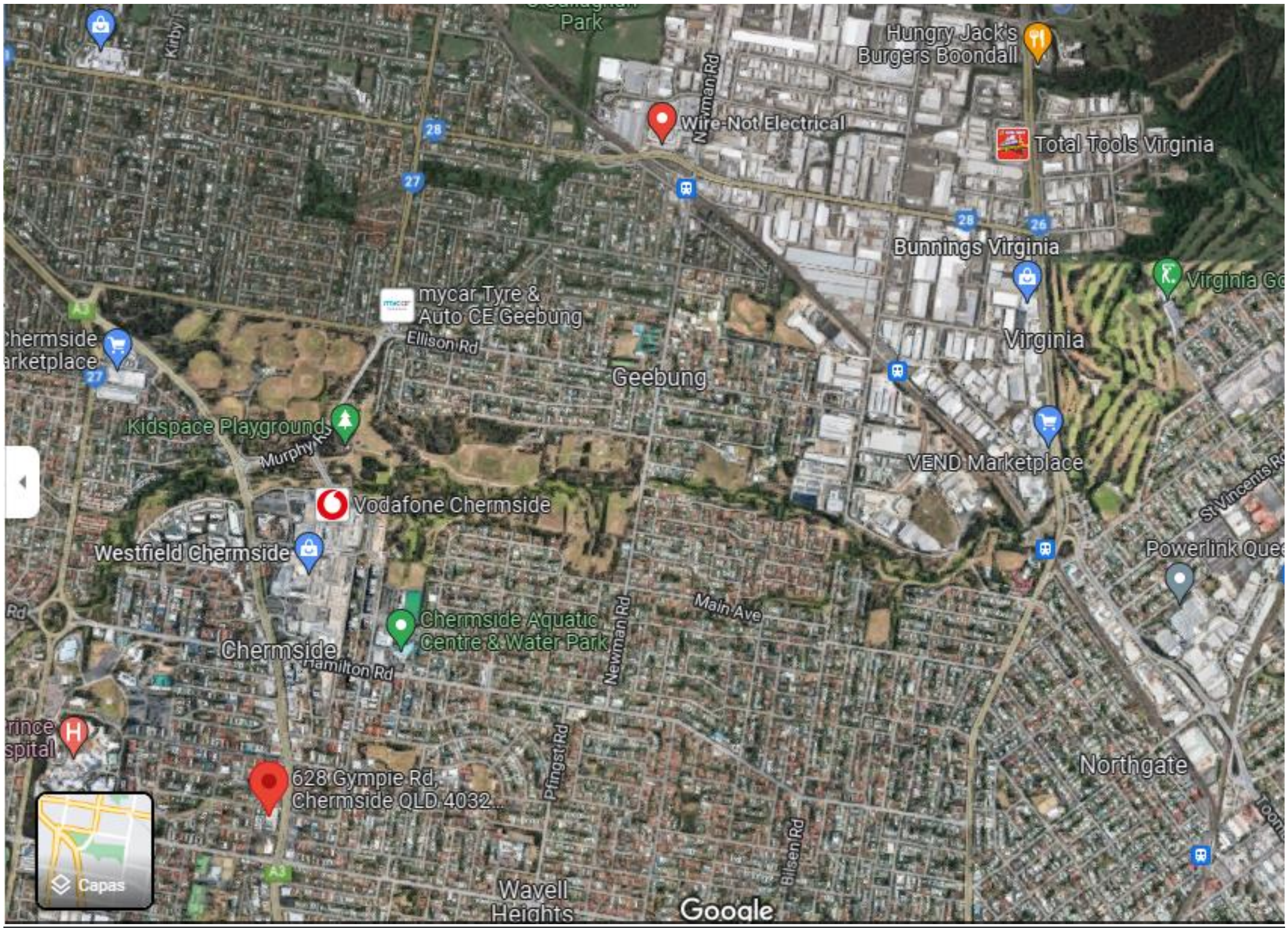


F2: Photo zoomed in on the data center.



F3: Photo showing the distance between the fiber service company and the data center.

Daniel Cortez id: 9849909



F4: Photo that shows the distance of the data center with one of the nearby electric companies.

Site Attributes

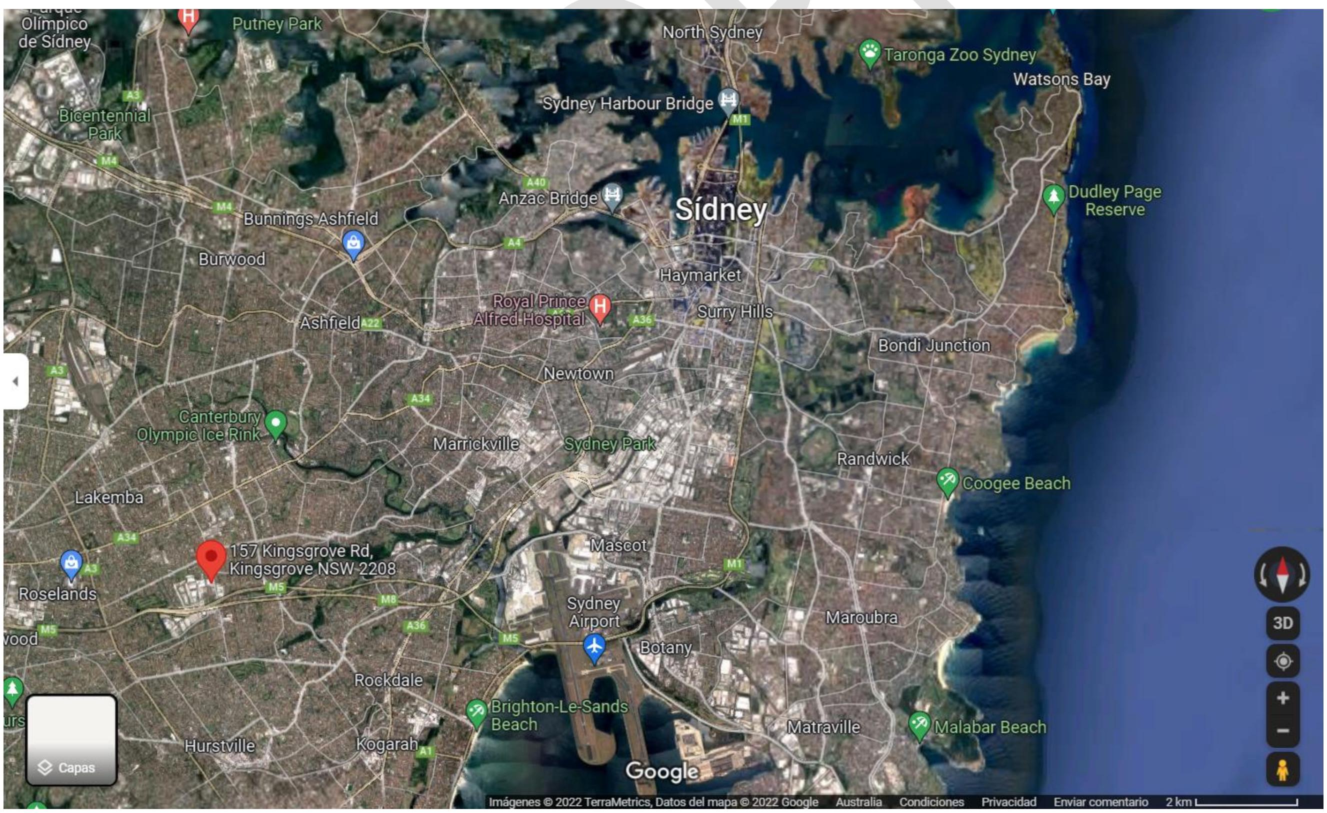
Site 1: 157 Kingsgrove Rd, Sydney, NSW 2208	
General Information	_157 Kingsgrove Rd, Sydney, NSW 2208 _Type of Site: Brownfield _Size: 9926 square meters
Assess the risks of proposed sites.	Like our previous proposal, this location has a low probability of flooding, which consists of Medium probability (1.0% Annual Chance), its closest distance to the sea is 6.8 km to the south east towards the coast.
Assess the availability of services and supporting facilities.	Sydney has SFS (Sydney Facility Service) that provides property maintenance team to ensure all areas internal and external repairs and maintenance needs are catered. The electrical company that will be available will be Sydney Electrical & Data Pty Ltd. which is located 5.45 km from the data center.
Describe the geographical, topological and environmental attributes, including hazards and climate.	Current estimates of earthquake risk in the Sydney basin indicate that on average, there is a 10 percent chance of ground accelerations exceeding 0.11 g in 100 years. So, while the earthquake risk is much lower than in cities such as Tokyo and Los Angeles, which are on active plate margins, the risk in the Sydney region must be addressed, particularly for special buildings. University of Newcastle coastal geoscientist, Dr Hannah Power, said a Sydneysider would probably experience a tsunami in their lifetime. Since 1805, about 55 tsunamis have been detected in Australia. Of those with a known source, most started in Chile, New Zealand, the Australian Bureau of Meteorology says. But given Australia´s distance from tectonic plates that causes many tsunamis, the impact on Sydney would most likely be small compared to other, more vulnerable places around the world.
fiber and telecommunication infrastructure	Sydney Electrical & Data provides optical fibre cabling installation services for commercial data and telecommunications applications. Typical applications include installing an optical fibre link between offices over several floors in a building, or installing an optical fibre link over a long distance on an industrial site.
Water	Sydney Water's role and responsibility is broad. They supply water, wastewater, recycled water and some stormwater services to more than 5 million people in Greater Sydney and the Illawarra. Every day, the supply around 1.5 billion litres of drinking water to homes and businesses. Although pipes

	sometimes break unexpectedly, the water supply is available at least 99.7% of the time across the entire water network.
Air quality	In general, air quality in Australia is relatively healthy by global standards – however, there is room for improvement, and particularly a number of areas in Australia are facing health risks from air pollution in relation to increasing occurrences of bush fires. Sydney air quality is no exception to this, as the city experiences year-round exposure to a range of air pollutants, in addition to more extreme, short-term air pollution events such as wildfires and dust storms. In 2019, Sydney's annual average PM2.5 concentration was 10.1 µg/m^3, exceeding both the Australian and WHO target limit. In broader Australian context, this ranked as the 15th most polluted city for annual PM2.5 levels in Australia out of 95 included cities in IQAir's 2019 World Air Quality Report.

Location Evaluation

Very Favorable	Favorable	Mixed	Unfavorable
Site 2: 157 Kingsgrove Rd, Kingsgrove Rd Sydney, NSW 2208			
Location			
_Proximity to Major Highways		Very Favorable	
_Proximity to Public Transportation		Very Favorable	
_Distance to Metropolitan		Very Favorable	
_Proximity to Major financial market hubs		Favorable	
_Proximity to Brisbane´s Center Cities (center of Sydney, 13,71 km)		mixed	
Available utility resources			
_High voltage electrical services		Very Favorable	
_Water		Favorable	
_Natural Gas		Favorable	
_Fiber Connectivity		Very Favorable	
Site Logistics/Security			
_Ability to Fence/Secure Property		Very Favorable	
_Susceptibility to Natural Disasters		Favorable	
_ Susceptibility to Man-made Disasters		Unfavorable	
_Distance from Building Structure to Street		Favorable	
_ Distance from Building Structure to Railroads		Favorable	
_Access to Public Transportation		Very Favorable	

_Access to Service Vendors	Favorable
_Access to Fuel	Very Favorable
_Weather	Very Favorable
_Air quality	Very Favorable
_Proximity to adjoining Buildings/Property	Favorable
Property	
Available Yard Space for Mission Critical Facility Equip	Favorable
Paved Surfaces/Parking	Very Favorable
Provisions for Future Expansion	Favorable
Area Demographics	
Population Density	Very Favorable
Workforce and Talent Pool	Very Favorable
Housing	Very Favorable
Employment and Income Statistics	Favorable
Local Government and Services	Very Favorable
School District and Higher Education	Very Favorable



F1: Overview of Sydney

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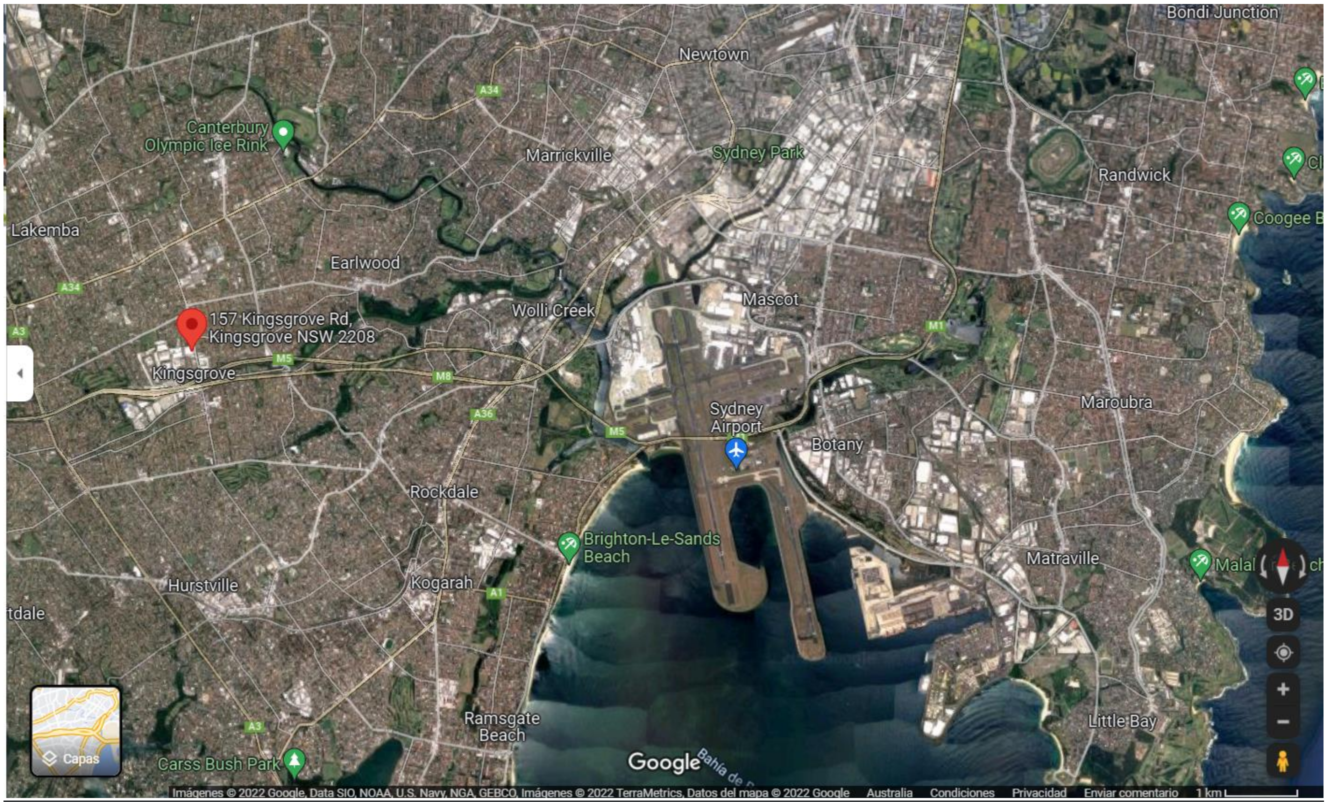
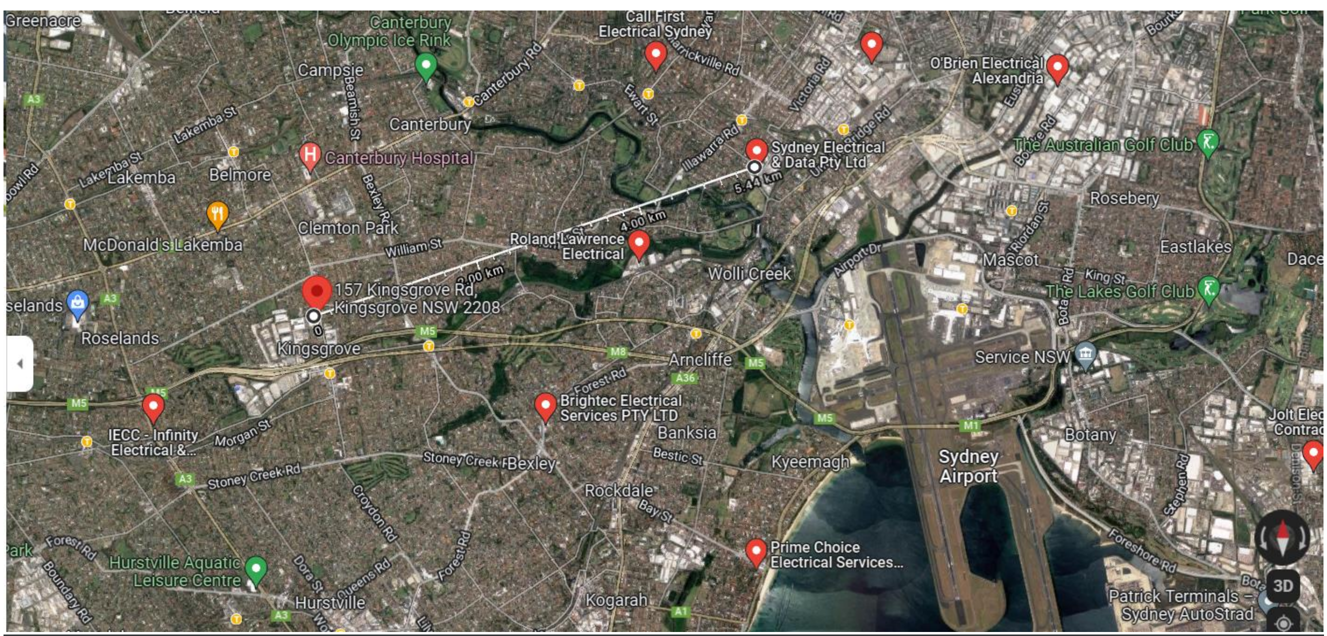


F2: Photo zoomed in on the data center.



F3: Photo showing the distance between the fiber and electrical service company and the data center.

7. As a designer and programmer of the data center, I have to watch over its development, its correct implementation and avoid as many risks as possible in order to more safely guarantee its growth in future years and that it correctly complies with the parameters and laws of each city. For this reason, I have chosen the data center located at 628 Gympie Rd, Chermside, Brisbane Qld 4032.

While it is true that the other option is also favorable, it seems to me that Brisbane has fewer natural risks and its location almost in the middle of the country gives us an advantage in terms of distance communication with other cities in Australia. It has very good services and the proximity to potential workers make this an unbeatable location.

2. Calculate the power requirements for the IT and network room equipment. *References - APC White Paper 3 - Calculating Total Power Requirements*

Item	Data Required	Calculation	Subtotal KW
	Power Requirement – Electrical		
Critical load-sizing calculator value from APC website	Rating of each IT device	(Calculator total in VA x 0.67) /1000	1182,78 KW
For equipment not listed in the sizing Calculator, critical Load- nameplate	Subtotal VA (include fire, security and monitoring systems)	(Subtotal VA x 0.67) / 1000	0.79 KW
Future loads	VA of nameplate of each anticipated IT device	[(Add VA rating of future devices) x 0.67] / 1000	**DOES NOT APPLY IN THIS CASE**
Peak power draw due to variation in critical loads	Total steady state critical load power draw	(# 1 + # 2 + # 3) x 1.05	1242,74 KW
UPS inefficiency and battery charging	Actual Load + Future Loads (In KW)	(# 1 + # 2 + # 3) x 0.32	378,74 KW
Lighting	Total floor area associated with the data center	0.002 x floor area (sq ft), or 0.0215 x floor area (sq m)	0,5 KW
Total power to support electrical demands	Total from #4, #5, #6 above	# 4 + # 5 + # 6	1621,98 KW

Power Requirement – Cooling			
Total power to support cooling demands	Total from # 7 above	For Chiller systems # 7 x 0.7 For DX systems # 7 x 1.0	1135,386 KW
Total Power Requirement			
Total power to support electrical and cooling demands	Total from # 7 and #8 above	**# 7 + # 8**	2757,366 KW*
Size of Electrical Service Estimate			
Requirements to meet NEC and other regulators	Total from # 9 above	**# 9 x 1.25**	3446,70 KW
Three phase AC voltage provided at service entrance	AC voltage	**400**	400 VAC
Electrical service required from utility company in AMPS	Total from # 10 and AC voltage in # 11	**(# 10 x 1000) / (#11 x 1.73)**	4980.80 AMPS
Size of standby Generator Estimate			
Critical loads requiring generator back up	Total from # 7 above	**# 7 x 1.3**	2108,574 KW
Cooling loads requiring generator back up	Total from # 8 above	**# 8 x 1.5**	3162.861 KW
Size of generator needed	Total from # 12 and # 13 above	**#12 + #13**	5271,435 KW

3. Calculate the cooling requirements and describe the specifications for the required cooling systems and equipment. *References - APC White Paper 25 Calculating Total Cooling Requirements, Schneider Electric - Reference Design 33*

Ítem	Data required	Heat output calculation	Heat output subtotal
IT Equipment	Total IT load power in Watts	Same as total IT load power in watts	1621980 W
UPS with Battery **N+1**	Power system rated power in Watts	(0.04 x Power system rating)(0.9)+ (0.05 x Total IT load power)(1621980)	81099,36 W
Power Distribution	Power system rated power in Watts	(0.01 x Power system rating)(2.5) + (0.02 x Total IT load power)(1621980)	32439,98 W
Lighting	F162loor area in square feet, or Floor area in square meters	2.0 x floor area (sq ft), or 21.53 x floor area (sq m) (250 M2)	5382,5 W
People	Max #of personnel in data center	100 x Max # of personnel (10)	1000 W
Total	Subtotals from above	Sum of heat output subtotals	1741901.84 W 1741,90 KW

The facility cooling design is comprised of a chilled water-cooling system in the IT space, integrated with two hydronics modules arranged in parallel and six packaged chillers. Each hydronics module includes pumps, valves, controls, and instrumentation necessary to provide cooling in a Tier II redundant architecture.

Each of the hydronics modules is accompanied by a set of three Uniflair BREF chillers in an N+1 configuration. Economization is achieved with dry coolers integrated within each chiller, to save energy during favorable outdoor conditions. A thermal storage system is offered as an option to provide 5 minutes of continuous cooling after a power outage or chiller restart.

The piping architecture of the mechanical system feeds row-based InRow RC Chilled Water-Cooling units in the IT space.

Facility Cooling Attributes

Name	Value	Unit
Total cooling capacity	3140	Kw
Input voltage	480	V
Heat rejection medium	Chilled water	
Mechanical redundancy	N+1	
Outdoor heat exchange	Packaged chiller with free-cooling	
Coolant supply temperature	59	F
Storage tank size	10036	gallons
Ride-through time	5	minutes
Economizer type	Water-side	

Equipment List – Facility Cooling

Equipment Designation	Type	Architecture Location	Product Description	Quantity
CH-3	Chiller	Outside	Uniflair BREF2802A packaged chiller with free-cooling option; Capacity: 785 KW	6
CHWP-3	Pump	Hydronics module	Single head vertical in line pumps; Duty: 93.5 ft; Motor: 20 hp	6
ET-2	Expansion tank	Hydronics module	79.3 gal bladder type	2
ET-3	Expansion tank	Hydronics module	132.1 gal bladder type; included with Thermal Storage Tank option	2
CDP-1	Chemical dosing pot	Hydronics module	Volume: 5.28 gal	2
DAS-2	Dirt and air separator	Hydronics module	Horizontal type	2
ST-1	Thermal storage tank	Outside	Tank with internal diffusers and baffles; Capacity:2509 gal(optional)	4
	Suction guide	Hydronics module	90° Elbow type	6
	Flow meter	Hydronics module	Insertion turbine type	2
	Temperature sensor	Hydronics module	Operation temp range 41-69.8 F	6

	Temperature sensor	Hydronics module	Operation temp range 41-69.8 F; included with Thermal Storage Tank option	4
	Pressure gauge	Hydronics module	Pressure range: 0-6 bar	6
	Differential pressure sensor	Hydronics module	Measuring range: 0-4bar	2
	Safety relief valve	Hydronics module	For expansion tank. Safety relief pressure: 6 bar	2
	DX AC for electric room	Hydronics module	DX cooling unit 4 KW	4

4. Calculate the power requirements for the cooling system and other data centre equipment/services. *References - APC White Paper 3 - Calculating Total Power Requirements, Schneider Electric - Data Center Design-Tools, Schneider Electric - Reference Design 33*

We will use **1.2 KW** generators as power modules.

So, we will apply the following formula:

Amp= (1.2 x 1000) / (400 x 1.73) =1.73

1.734 x 1135,386 = 1986, 759 is the power requirement for the cooling system and other data centre equipment.

5. Describe the specifications for the required power systems and equipment. *References - APC White Paper 3 - Calculating Total Power Requirements, Schneider Electric - Data Center Design-Tools, Schneider Electric – Refe rence Design 33*

First of all, we calculate how many servers (7040) and enclosures (440) we will need. That gave us 1182.78 kw as a result.

Later we calculated some ratings of the equipment not listed as critical load for example fire security or monitoring systems, we applied the formula and the result was 0.79 kw.

We take into account the value of the inefficiency of the ups and the battery charge that we know is approximately 30% and we add them to the previous amount, which gives us a result of 378.74 kw that we must add.

Later we did the calculations of the lights inside our network room. We apply the formula with 250 M2 and get the result of 0.5 KW.

The total of all the previous values that gives us the power to support the electrical demands was 1621.98 kW.

We estimated the power required for cooling and it gave us 1135,386 kW which, added to the total power to support electrical demands, gives us 2757,366 KW of required energy.

With the vision of increasing the capacity to increase power, we continue to increase by 25% the energy required to meet NEC regulators. Later we agreed that the three pass AC voltage provided at service entrance is 400 volt since in Australia this is the norm. As for single phase the value is 230, the three phase is 400.

So, to finish we obtained the value of the electrical service requires form utility company in AMPS of 4980.80 amps.

Facility Power

The facility power system supplies energy to the critical and non-critical components within the data center. In this Tier II design, power is supplied through two 1200kw power modules. The two modules provide N+1 UPS power to the IT modules, all together backed up by an N+1 generator configuration. Inside each power module a 3000 amp bus feeds QED-2 electrical switchboards and three 600 kw symmetra MW UPS with 5 minutes of runtime. In both power modules, the main bus also feeds an I-Line panelboard to provide energy to the cooling system. Within each hydronics module, pumps are supplied with protected power through an N+1 configuration of Smart-UPS VTs.

Facility Power Attributes

Name	Value	Unit
Total amps (main bus)	3000	A
Input voltage (main bus)	480	V
Switchboard Kaic	65	KA
Power path	Single	
Generator redundancy	N+1	
IT space UPS capacity	2400	KW
IT space UPS redundancy	N+1	
IT space UPS runtime @ rated load	5	minutes
IT space UPS output voltage	480	V

Facility cooling UPS capacity	96	KW
Facility cooling UPS capacity	N+1	
Facility cooling UPS runtime @ rated load	5	minutes

IT SPACE

In this Tier II design, the power distribution within the IT pod provides N power to individual racks.

The design is highly scalable and adaptable; it can be configured to support IT loads from 400 kw to 5940 kw. Smaller starting loads can be supported by making adjustments such as reducing the number of IT pods and prefabricated power modules. Likewise, this design can be used as a baseline for larger loads by using a step and repeat approach to the design.

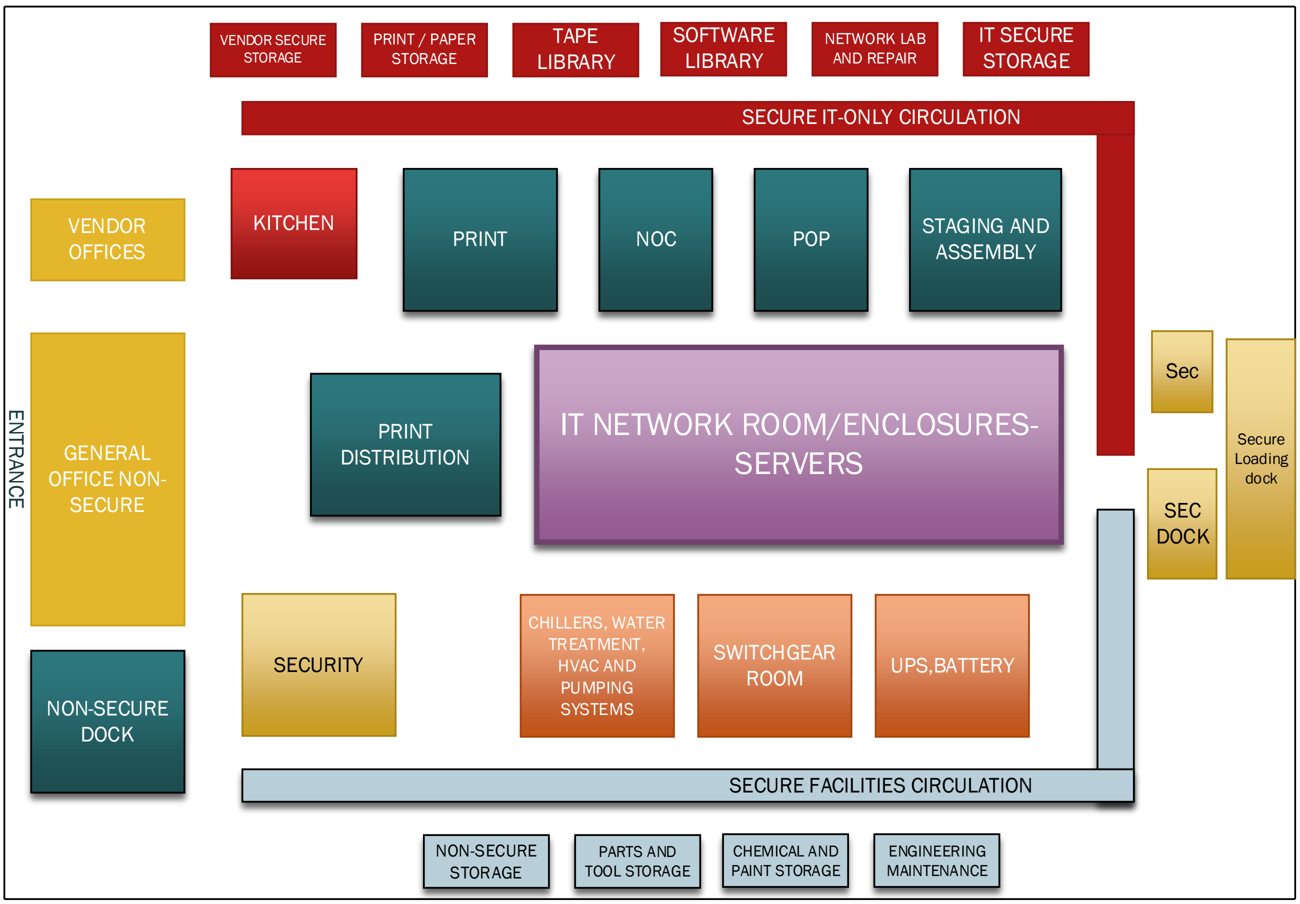
Each pod is powered by floor mount factory-configured power distribution units (PDUs) with isolation transformers. Every rack is configured with a metered rack-mount PDU to enable remote monitoring of the units for efficiency and capacity management.

Each IT pod includes hot-aisle containment and is cooled by N+1 redundant chilled water-based InRow RC CRAHs that control the supply of cool air by monitoring temperature variation at the rack level. In order to ensure tier II reliability, this design includes redundant valves and piping.

IT ROOM ATTRIBUTES

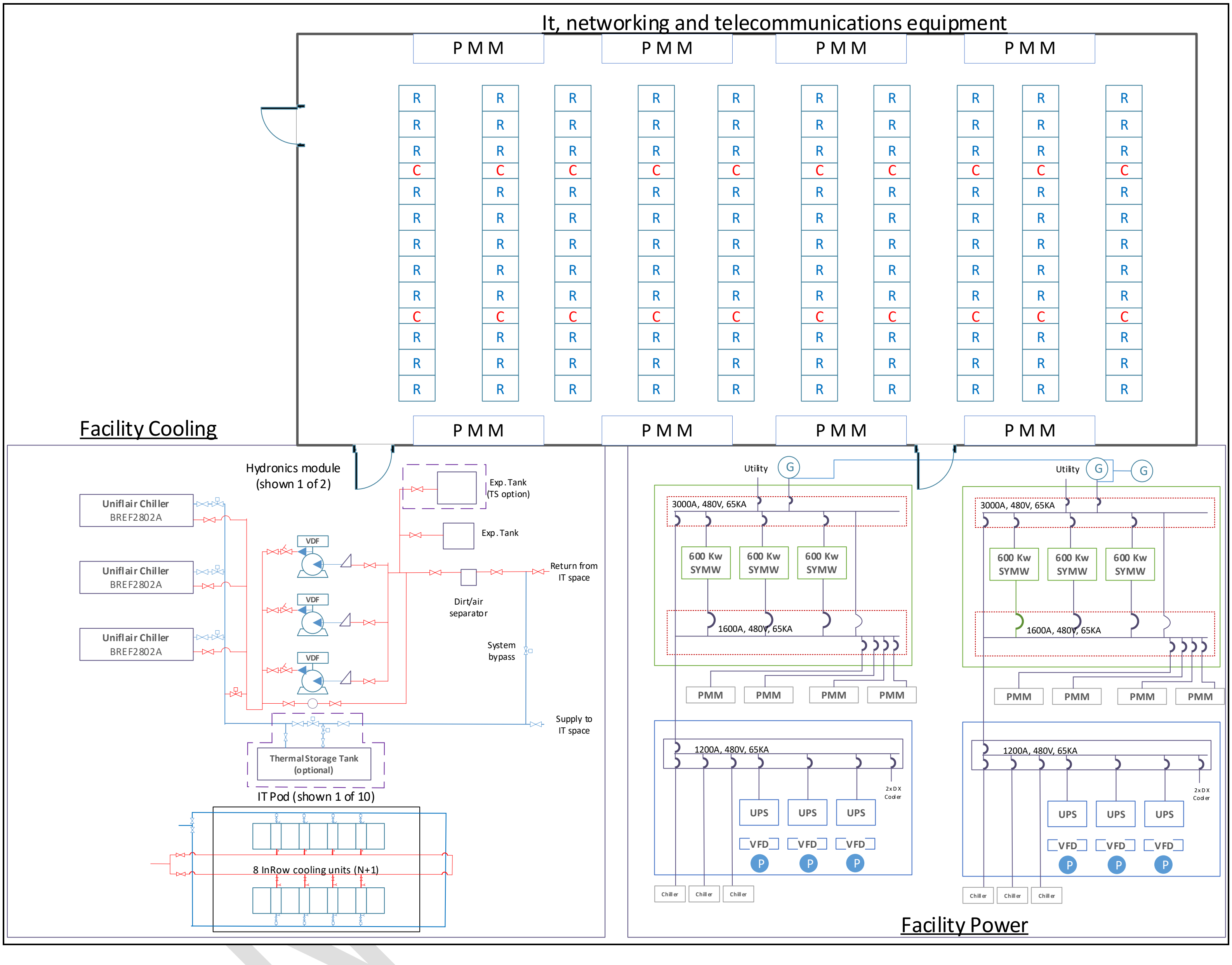
Name	Value	Unit
IT load	1980	Kw
Input voltage	480	V
Supply voltage to IT	208	V
Average density	9	Kw/rack
Number of racks	220	Racks
IT floor space	7325	Ft2
Single or dual cord	Single	
Heat rejection medium	Chilled water	
CRAC/CRAH type	Row-based CRAH	
CRAC/CRAH redundancy	N+1	
Containment type	Hot aisle	

6. Plan and design the space requirements and layout including critical and supporting spaces

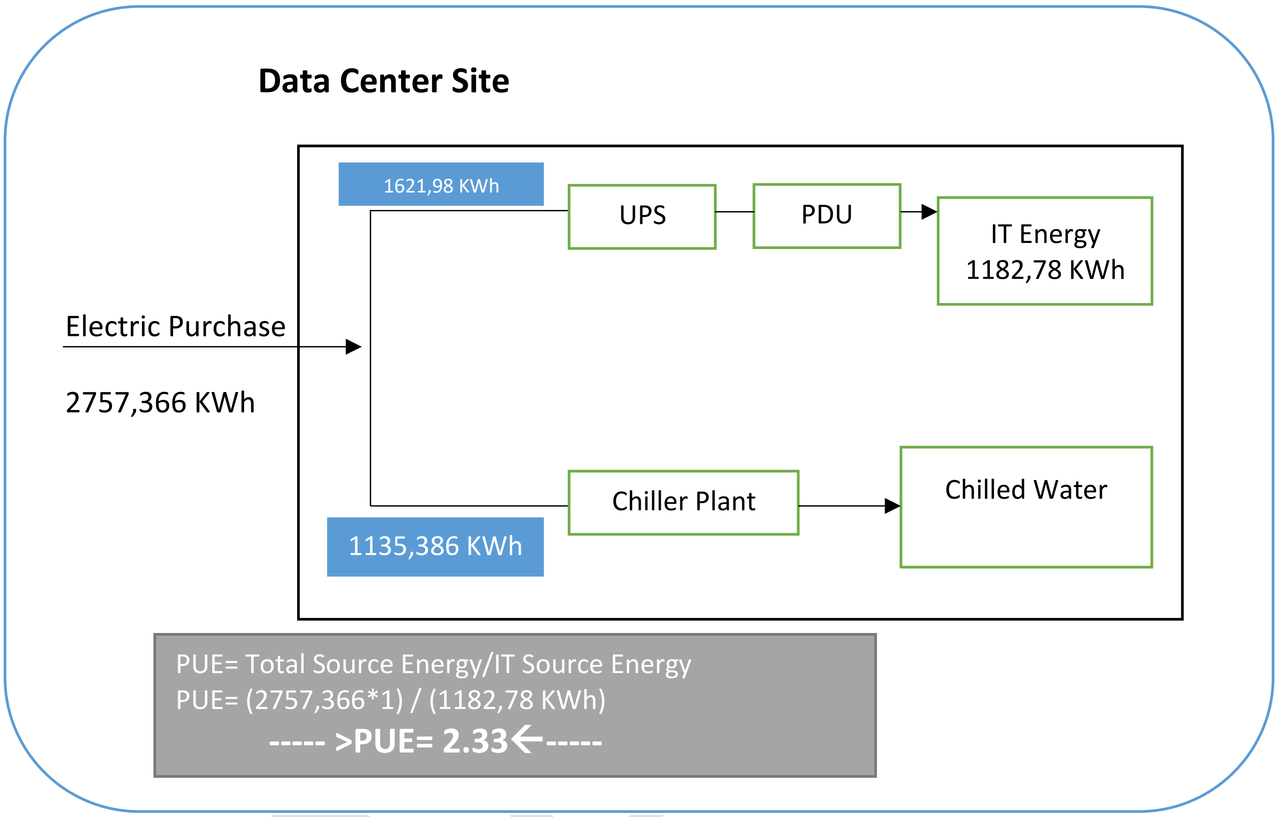


7. Prepare a simple CAD drawing of the Data Centre that shows: DATA CENTRE DISTRIBUTION

1. The Data Centre spaces`
2. The location and layout of the IT, networking and telecommunications equipment
3. The location and layout of the power equipment
4. The location and layout of the cooling equipment


It, networking and telecommunications equipment
P M M
R
C
Facility Cooling
Hydronics module
(shown 1 of 2)
Uniflair Chiller
BREF2802A
VDF
Exp. Tank
(TS option)
Exp. Tank
Return from
IT space
Dirt/air
separator
System
bypass
Supply to
IT space
Thermal Storage Tank
(optional)
IT Pod (shown 1 of 10)
8 InRow cooling units (N+1)
Utility
G
3000A, 480V, 65KA
600 Kw
SYMW
1600A, 480V, 65KA
PMM
1200A, 480V, 65KA
2xDX
Cooler
UPS
VFD
P
Chiller
Facility Power

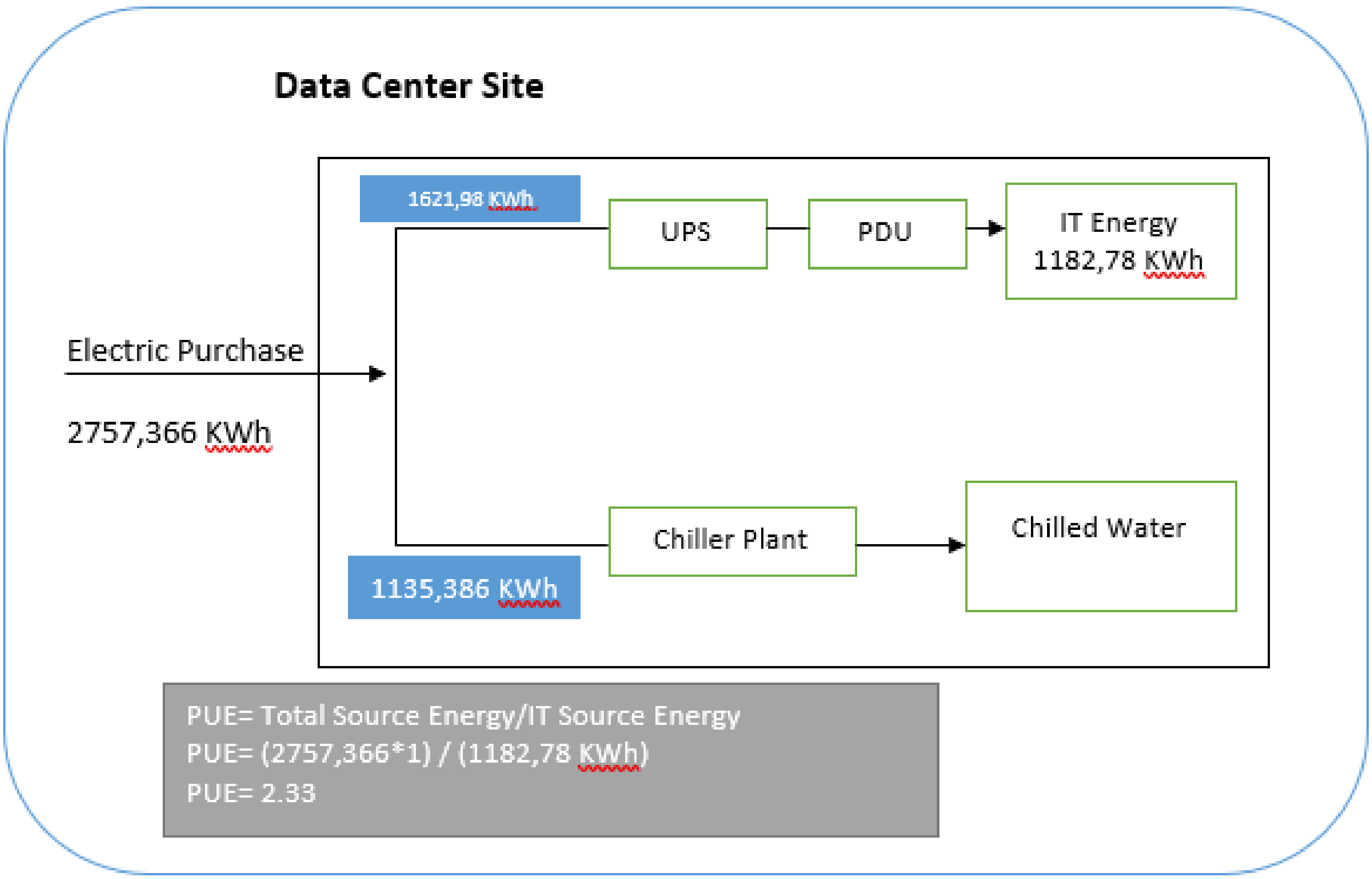
8. Calculate the PUE of the data centre when it is operating at maximum capacity based on the design specifications. *References - The Green Grid - PUE, Schneider Electric - Data Center Design-Tools, Schneider Electric - Reference Design 33*



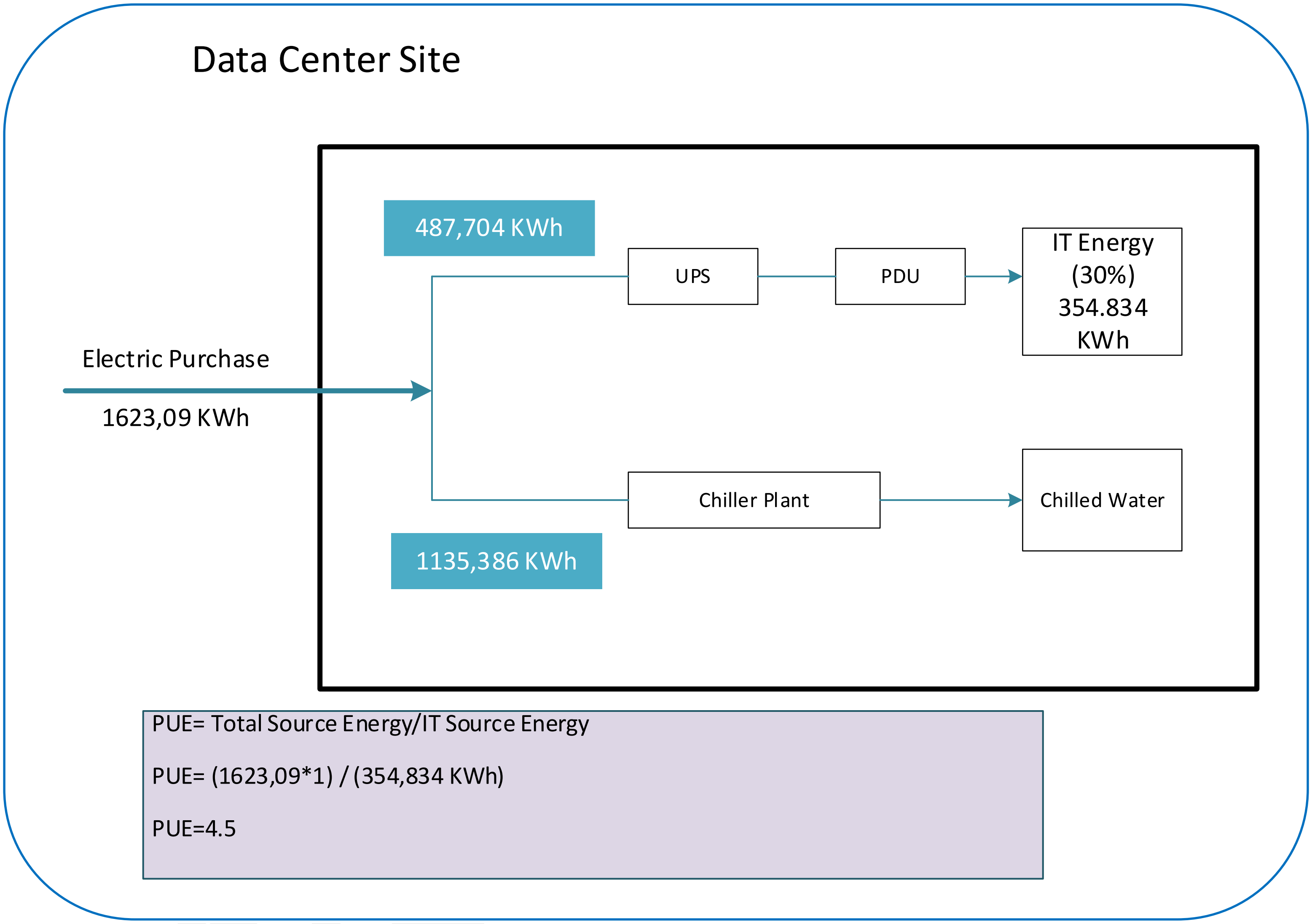
----> PUE= 2.33 <-----

9. Calculate the PUE of the data Centre for each of the years leading up to maximum capacity based on the following assumptions: *References - The Green Grid - PUE, Schneider Electric - Data Center Design-Tools, Schneider Electric - Reference Design 33*

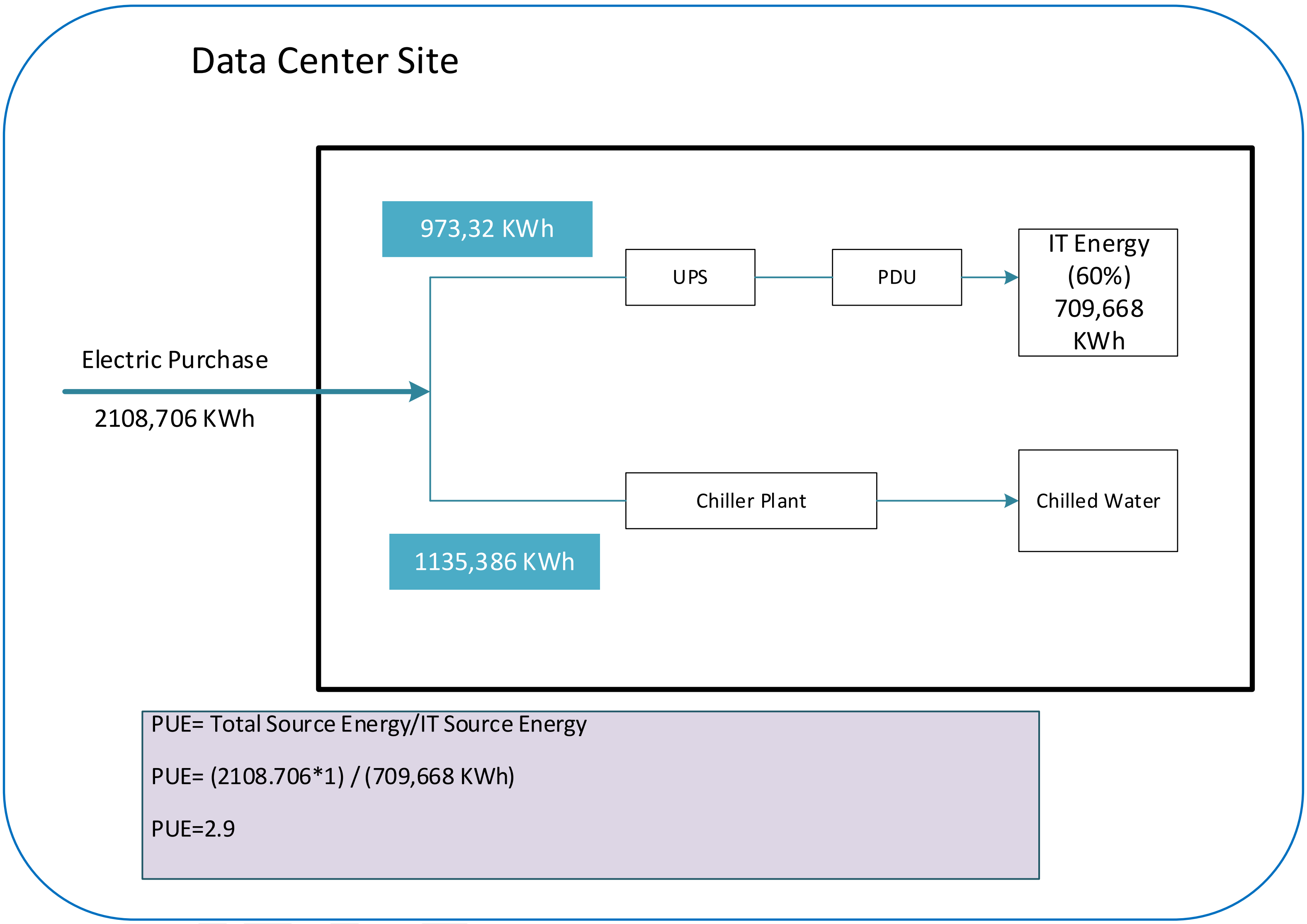
1. Power and cooling are designed for maximum capacity



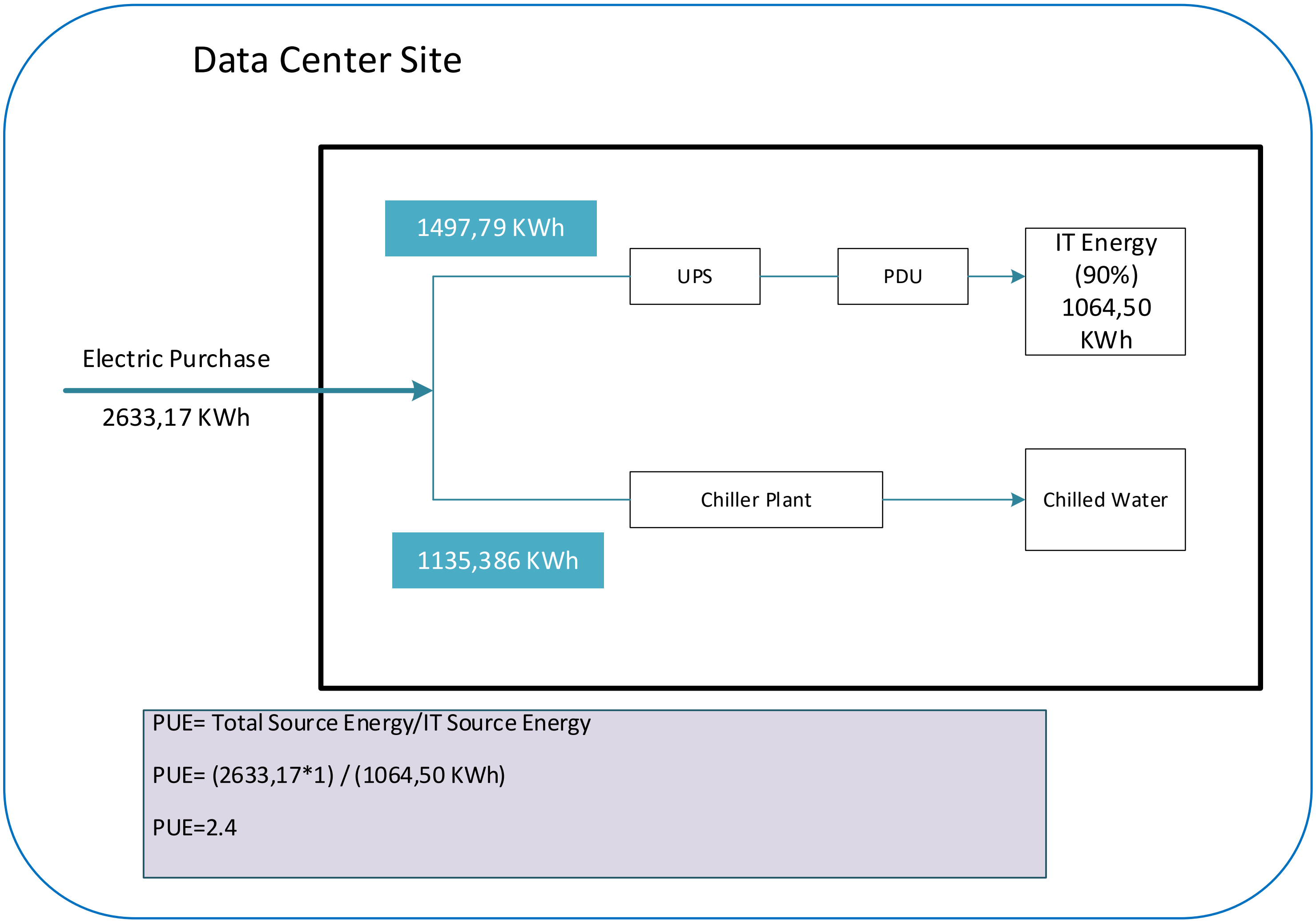
2. In years 1 and 2 the data centre operates at 30% capacity



3. In year 3 the data centre operates at 60% capacity



4. In year 4 the data centre operates at 90% capacity



10. Calculate the projected carbon footprint of the datacentre over the first 5 years. Your calculation may be based on the average Australian emission per KWh. *References -*

CO2EmissionsFromFuelCombustionHighlights2013 page 110, Schneider Electric - Data Center Design-Tools, Schneider Electric - Reference Design 33

The average Australian emission per KWh is 823 grammes.

Carbon footprint First and Second year: 823*1623,09 =1.335.803,07grammes=1335,80 Kg **=1,3358 tons of CO2**

Carbon footprint Third year: 823*2108,706=1.735.465,04 grammes=1735,46 Kg**=1,73546 tons of CO2**

Carbon footprint fourth year: 823*2633,17=2.167.098,91 grammes =2167,09 Kg=**2,16709 tons of CO2**

Carbon footprint Fifth year (maximum capacity): 823 * 2757,366 = 2.269.312,22 grammes = 2.269,31 Kg= **2,26931 tons of CO2**

11. What strategy could you employ to improve the PUE in the years leading up to maximum capacity? *References - APC White Paper 37 Avoiding Costs Oversizing, Schneider Electric - Data Center Design-Tools, Schneider Electric - Reference Design 33*

The fundamental uncertainty of future requirements during the planning process for data center and network room infrastructure is an insurmountable challenge that cannot be solved without predicting the future. Given this situation, the clear solution is to provide data center and network room infrastructure responsive to the unpredictable demand.

The ideal situation is to provide a method and architecture that can continuously adapt to changing requirements. Such a method and architecture would have the following attributes:

_ The one-time engineering associated with the data center and network room design would be reduced.

_The data center or network room infrastructure would be provided in pre-engineered modular building blocks.

_Components could be wheeled in though common doorways and passenger elevators and plugged in without the need for performing wiring operations on live circuits.

_Special site preparation such as raised floors would be reduced.

_The system would be capable of operating in N, N+1, or 2N configurations without modification.

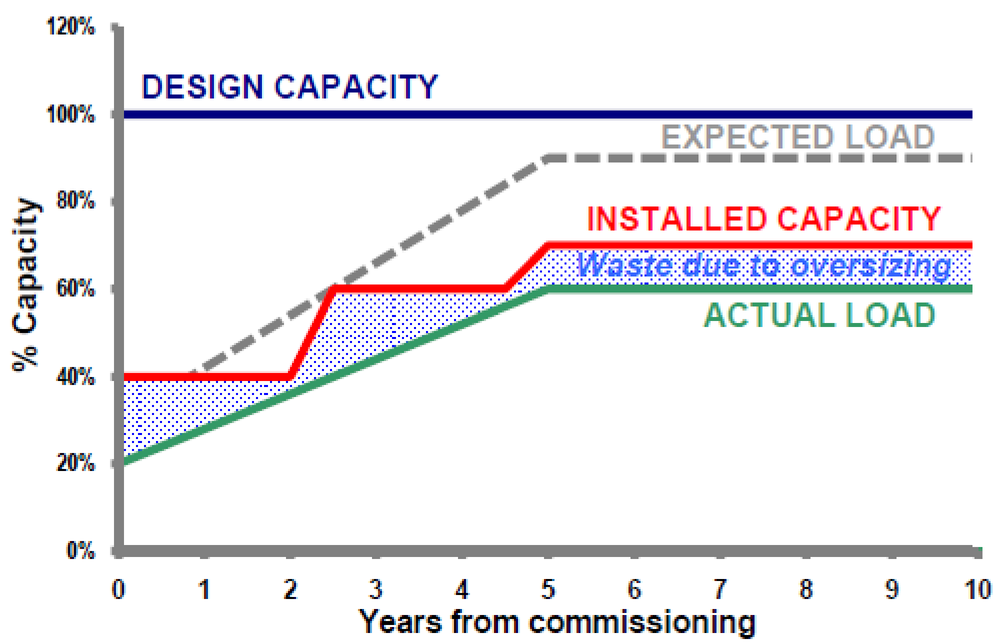
_Installation work such as wiring, drilling, and cutting would be greatly reduced.

_Special permitting or regulatory procedures would not be required in order to increase capacity.

_The equipment cost of the modular system would be the same or less than the cost of the traditional centralized system.

_The maintenance cost of the modular system would be the same or less than cost of the traditional centralized system.

When an adaptable physical infrastructure system is deployed, the waste due to oversizing shown as the shaded area can be reduced substantially.



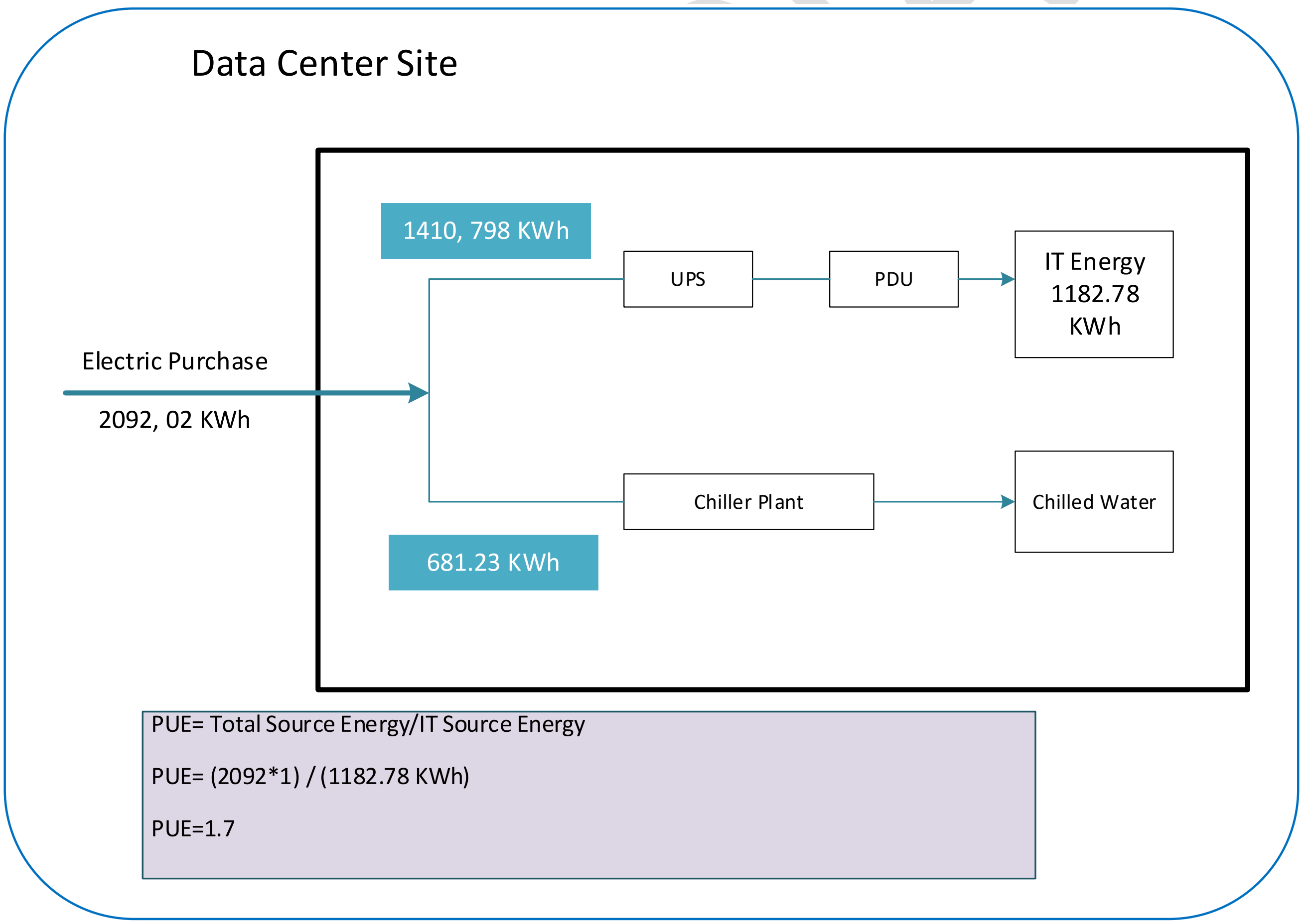
12. Assuming your recommended strategy has been implemented, recalculate the PUE of the data centre for each of the years leading up to maximum capacity based on the following

assumptions: *References - APC White Paper 37 Avoiding Costs Oversizing, Schneider Electric - Data Center Design-Tools, Schneider Electric - Reference Design 33*

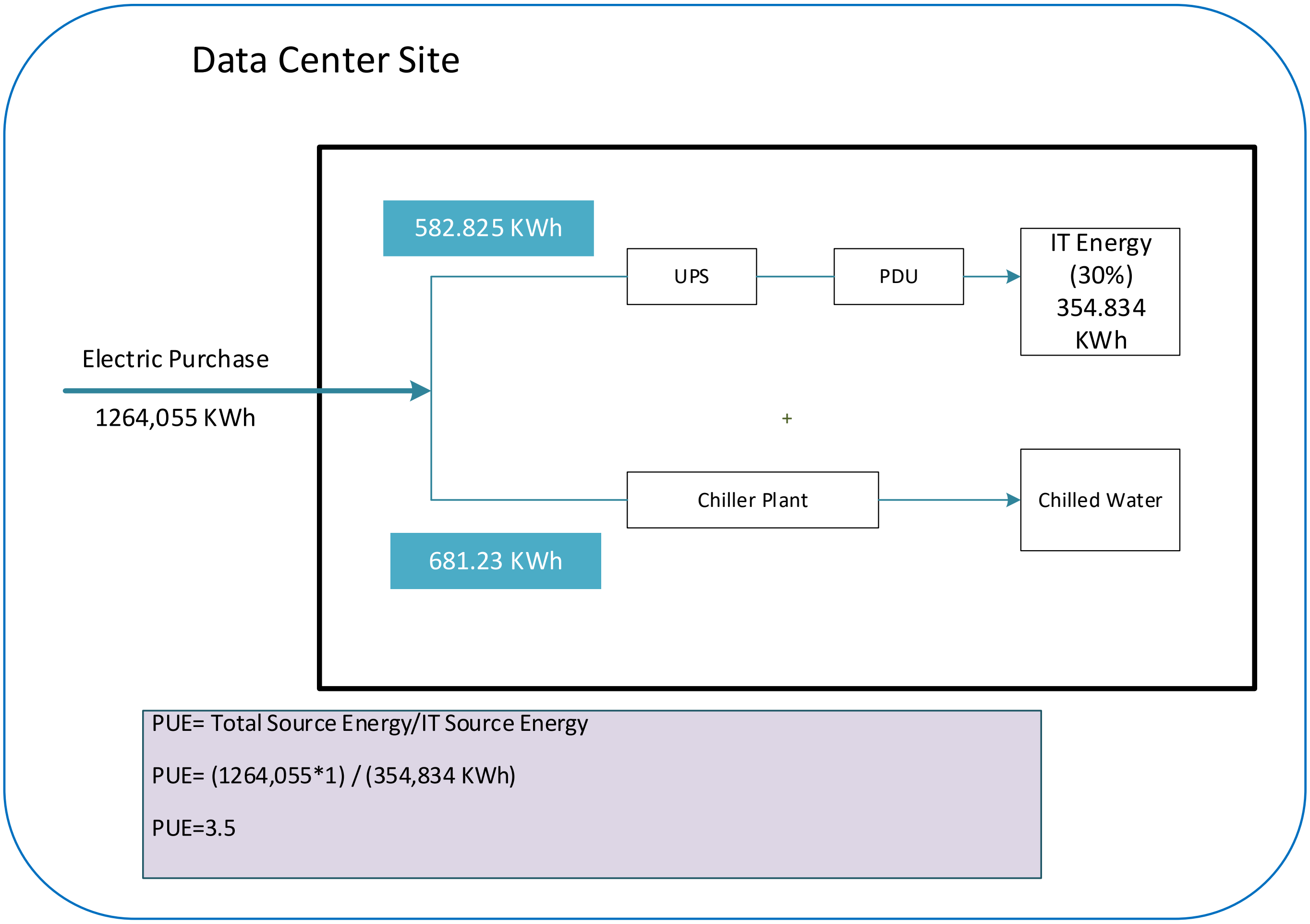
1. Power and cooling are designed according to the strategy above
2. In years 1 and 2 the data centre operates at 30% capacity
3. In year 3 the data centre operates at 60% capacity
4. In year 4 the data centre operates at 90% capacity

With the strategy previously explained in the previous task, we reached the conclusion that the maximum capacity would reach 60% of the total capacity prior to the strategy. Therefore, the new PUE results would be the following:

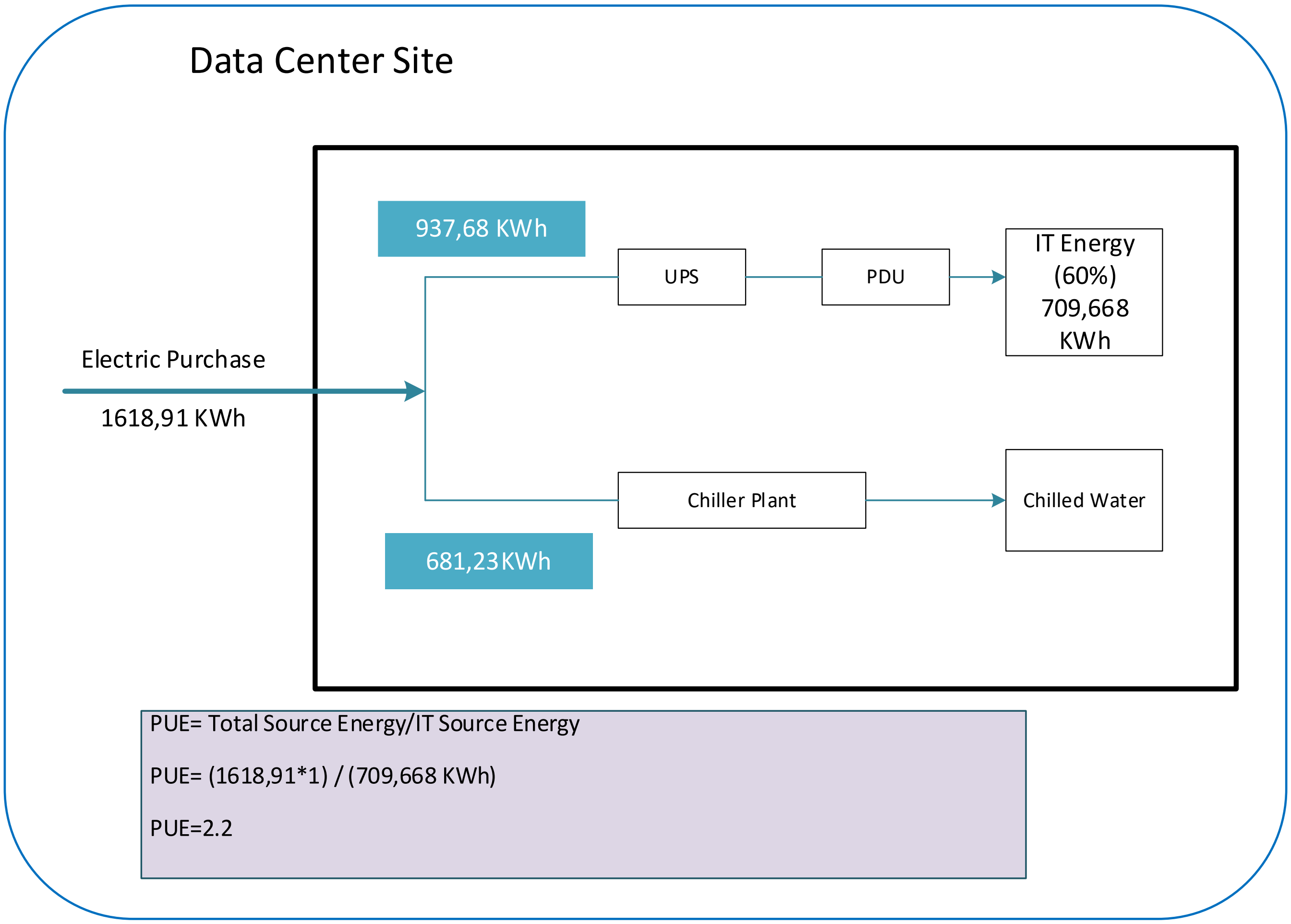
1. Power and cooling are designed according to the strategy above



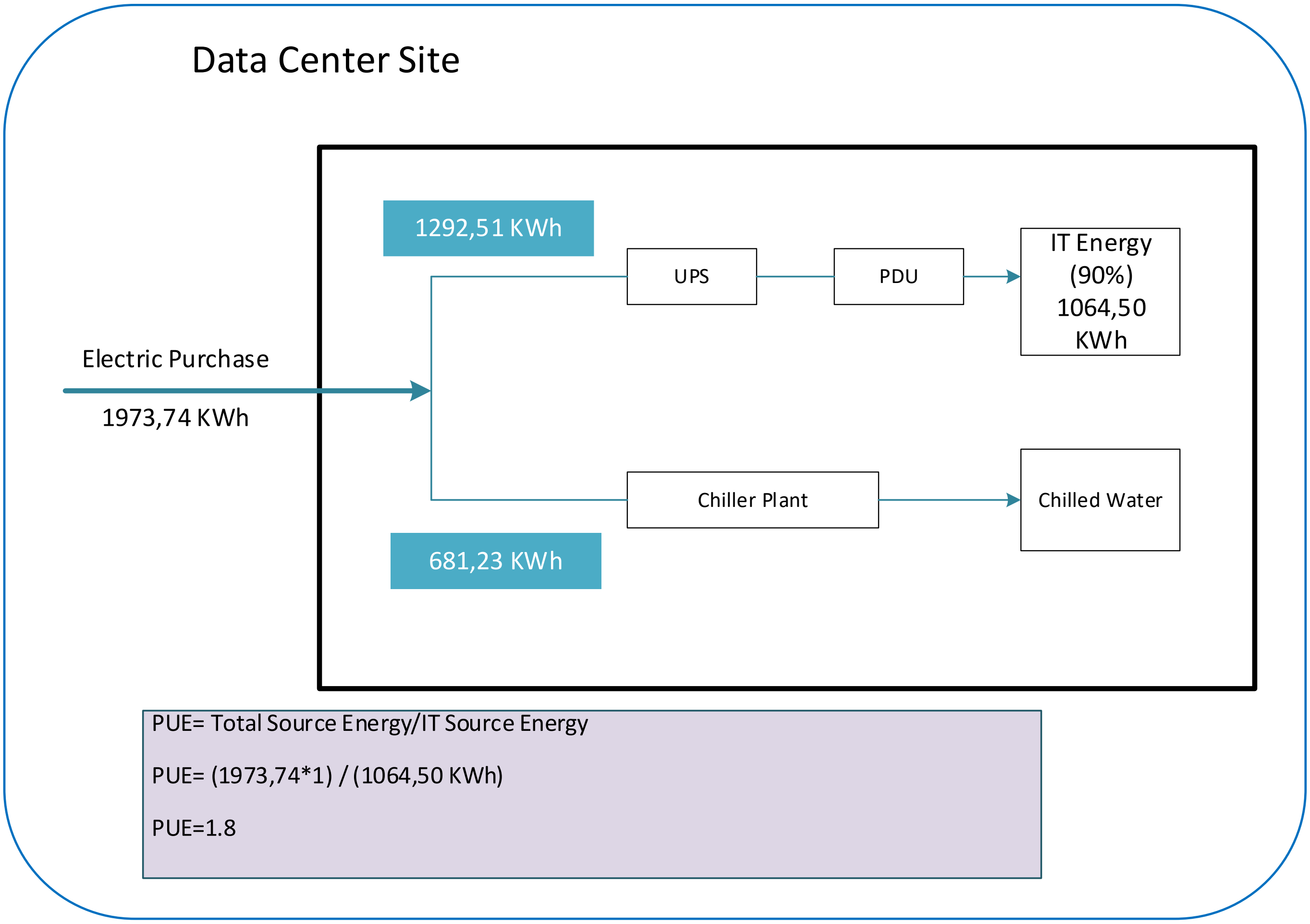
2. In years 1 and 2 the data centre operates at 30% capacity


Data Center Site
582.825 KWh
UPS
PDU
IT Energy (30%) 354.834 KWh
Electric Purchase
1264,055 KWh
Chiller Plant
Chilled Water
681.23 KWh
PUE= Total Source Energy/IT Source Energy
PUE= (1264,055*1) / (354,834 KWh)
PUE=3.5

3. In year 3 the data centre operates at 60% capacity



4. In year 4 the data centre operates at 90% capacity



13. Recalculate the projected carbon footprint of the datacentre over the first 5 years. Your calculation may be based on the average Australian emission per KWh

Carbon footprint First and Second year: 823 *1264,055 =1.040.317,265 grammes =1 040,31Kg= **1,04031 tons of CO_2**

Carbon footprint Third year: 823 * 1618,91 = 1.332.362,93 grammes = 1332,36 Kg=**1,33236 tons of CO_2**

Carbon footprint fourth year: 823 * 1973,74=1.624.388,02 grammes =1624,38Kg=**1,62438 tons of CO_2**

Carbon footprint Fifth year (strategy): 823 * 2092,02 = 1.721.732,46 grammes = 1721,73Kg=**1,72173 tons of CO2**

14. If you have a situation where some stakeholders want the data centre to build to full capacity and others want a staged implementation, what advice would you give? Describe the pros and cons of each option and present an argument to support your advice.

My advice as a data center designer is that the data center has to be built in stages. As we could see in the previous tasks, it is much more effective both in money and in communication to build the data center thinking about the future and agreeing on the steps to build as the it loads increases. A huge increase in Pue not only affects the owners of the data center but also the customers.

Power costs can wreak havoc on customer IT budget. Therefore, it´s important to understand how a data center charge based on actual usage. Charges are measured in KW/hr and include customer equipment and overhead costs for the entire data center. Overhead can include items like running multiple utility feeds, multiple generators, and multiple UPS systems for each and every customer.

A lower PUE rating means a more efficient data center, which in turn means lower operating costs for both the owner/operator and customer. A data center that makes the best use of its power without wasting available resources costs less to maintain and manage, and these savings can be passed on to the customers.

The opposite is true for inefficient facilities – data centers that require more power likely have considerably higher operating costs. In order to support these processes, these providers must charge their customers more for their services.

Pros: staged implementation allows both customers and the data center save capital cost and operational cost. A lower PUE rating means a more efficient data center, which in turn means lower operating costs for both the owner/operator and customer, where it does not have to dedicate power and cooling for unutilized spaces in the data center and it can save cooling and power cost as a result. It is also worth mentioning that this method is less polluting, since it emits less Co2 than the full capacity method.

Cons: While there are many benefits to a phased approach, this decision should be made with an eye open to the downsides. A big consideration is the amount of time the organization will be disrupted by the change. In addition, a staged approach often means operating in a hybrid service and technical environment, which creates complexity. During a transition like this, organizations typically need to use multiple service paths and technologies until the entire service is unified, extending the transition period to new technologies.

Full capacity method

Pros: The data center integration process will be activated at the same time. which can generate a better control and monitoring of the tasks that may be associated with each other.

The implementation of a full capacity system should be faster and more agile so that some goals that may arise at first can be promptly achieved and studied in order to foresee in a shorter term the following objectives that may be proposed.

Cons: This form of implementation is not environmentally friendly in terms of CO_2 pollution. If we implement the data center at full capacity, the resources such as energy and cooling will be working at their maximum capacity, giving us a very high PUE, so the waste of work and energy will be very high, so this will also bring much higher costs. since the data center will require more resources for which it will charge much more to its clients, making the entire investment cycle much more expensive for all parties.

Submission requirements

1. The written tasks must be completed on a word processor and uploaded to the learning portal. You must clearly indicate which question each answer relates to.
2. All files must have your name in the file name.
3. You must click the 'Submit' button.