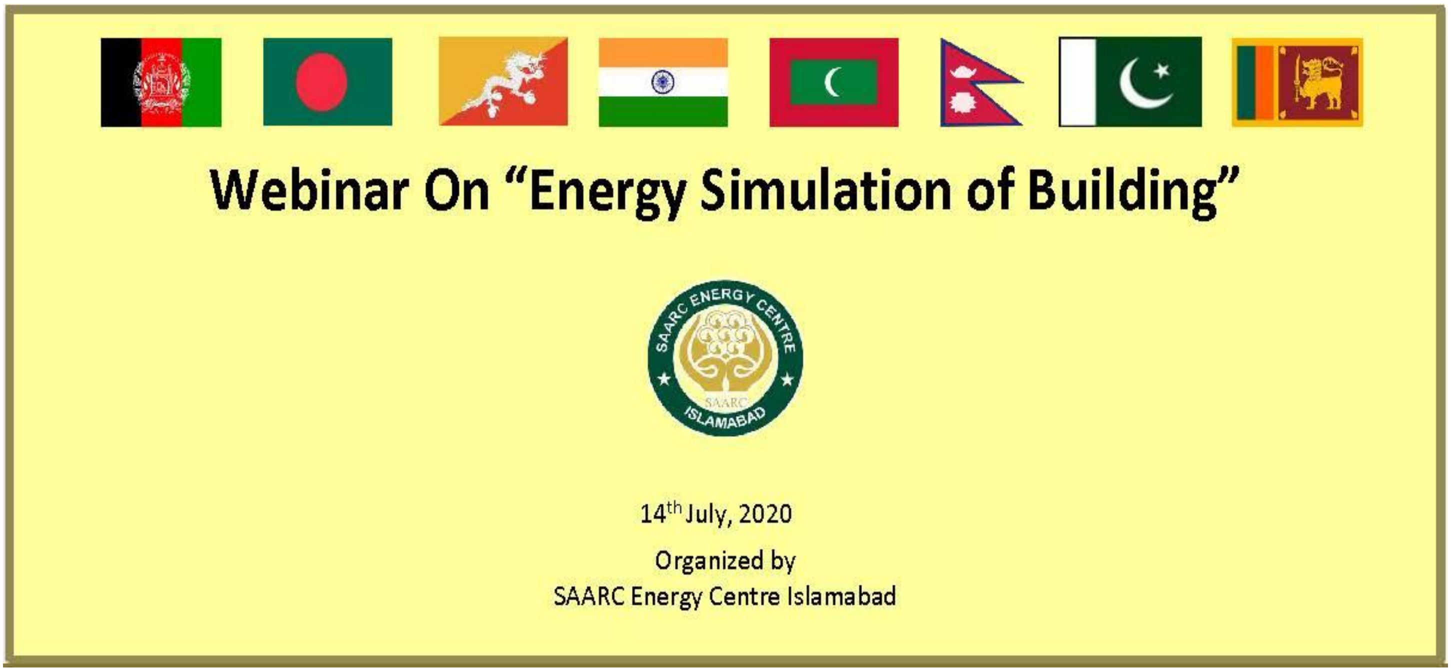
SAARC Energy Centre, Islamabad

Pakistan

THE REPORT



July 14, 2020

SAARC Energy Centre
697, Street 43, Sector E-11/4 (NPF),
Islamabad, Pakistan
www.saarcenergy.org

Introduction

1. SAARC Energy Centre, Islamabad successfully conducted a Webinar entitled "Energy Simulation of Building" on Tuesday, 14th July 2020. Webinar Agenda is available at Annexure-I.

2. Focus of the webinar was to increase awareness about the building simulation tools and their applications so that more efficient buildings can be designed and retrofitted in the SAARC region. Areas discussed were: Simulation tools and application, modelling of building operation, control and retrofit; green buildings and associated aspects and building performance simulation challenge.

Participation

3. The webinar was attended by 63 participants representing public sector organizations, academia, private sector, industrial professionals and other stakeholders within and outside SAARC region. The experts from Australia, China and Pakistan shared their knowledge on simulation of a building and its application. Experts also highlighted the challenges in carrying out the energy simulation in the SAARC region. The queries raised by participants during question answer session were addressed by respective speakers. The participants list is available at Annexure-II.

Description

4. The webinar was started with introduction by Program Coordinator, Mr. Tula Ram Poudel, Research Fellow (Energy Trade). The technical session comprised of presentations by the expert speakers. Each presentation was followed by a brief Q & A session. The Program Coordinator read out conclusions, which were gathered during the webinar. Before closing the webinar, the Program Coordinator from SAARC Energy Centre offered remarks of appreciation to all the participants and presenters.

Technical Proceedings

5. Three resource persons from Australia, China and Pakistan shared their knowledge in the webinar. All the presentations delivered during the webinar are available at SEC's website (https://www.saarcenergy.org/webinar-on-energy-simulation-of-building/). Details of Resource Persons are available at Annexure-III and their Presentations at Annexure-IV. A brief information on the content of the delivered presentations is as follows:

Presentation 1 – Introduction to Energy Simulation of Buildings

Mr. PC Thomas, Director, Team Catalyst, Driving sustainability through teamwork, Australia

6. PC Thomas is a founding Director of Team Catalyst Proprietary Limited, with the motto, "Driving Sustainability Through Teamwork" Mr. PC Thomas is also Adjunct Associate Professor at the University of Sydney. He has a Master's degree in Mechanical Engineering, 30 years of consulting, research and teaching experience in Sustainable Buildings, Building Energy Simulation, Energy Auditing, Energy Efficiency in Buildings, and Solar Energy.

7. Mr. Thomas specializes in Integrated Building Design; using simulation tools to assist in the design and delivery of sustainable buildings, in particular, to predicting the performance of the mechanical services. He is involved at some level with teaching, developing or reviewing each of them. During his presentation, Mr. Thomas talked about building performance analysis, Thermal comfort in conditioned rooms, building envelop, window performance parameters. He also talked about building loads such as lighting, equipment, people and fresh air. He presented the simulation model components and process that has been run in design builder simulation software.

Presentation 2 – China's Building Energy Conservation Development and Software Application

Ms. Menglin Wang, Product Manager, Beijing Glory PKPM, Technology Co. Ltd, China.

8. Ms Menglin Wang has been working as a software product manager for over 7 years in Beijing Glory PKPM, which is one of the biggest building design software development company in China. Her main work and research scope are the design and development of building energy-saving simulation software and green building simulation software, and she has participated in the preparation of several relevant Chinese standards. Over the past few years, she has accumulated a lot of practical experience of software application in engineering practice, the PKPM software developed by her team now is the most widely used building simulation analysis software in China. Her team and their products have helped many architects and project owners solve problems like building energy efficiency, environmental comfort and air quality

9. Ms Mengling started her presentation with China's building energy consumption scenario. She talked about the EER Simulation Software. She took the participants through the developmental trends in energy efficiency buildings such as simply green building, healthy buildings, ultra-low energy buildings and monitoring system to submetering technique incorporated in efficient buildings. She also presented the case of Shenzhen Art, Museum and Library with the simulated data and figures.

Presentation 2- Addressing Building Performance Simulation Challenges
Mr. Asad Mahmood, Manager Technical, National Energy Efficiency and Conservation Authority/Energy Conservation Fund, Pakistan.

10. Mr. Asad Mahmood is a Mechanical Engineer by Profession and is associated with the field of Renewable Energy and Energy Efficiency since last 15 years. He has played a vital role in the development and approval process of the National Energy Efficiency Act. Currently, he is currently working as a Manager Technical for National Energy Efficiency & Conservation Authority and Company Secretary of the Energy Conservation Fund. He is also a member of the Think Tank of Pakistan Engineering Council on Energy.

11. Mr. Asad started his discussion from general simulation process and basic concept of sequential simulation. He presented about the various simulation tools. He described in detail the challenges and gaps in carrying out energy simulation of buildings especially in the SAARC member states.

Conclusion and recommendation

Mr. Tula Ram Poudel, Research Fellow (Energy Trade), SAARC Energy Centre).

12. Mr. Poudel thanked everyone for attending the event. He informed the participants that energy simulation tools can be used to save the energy in the building of SAARC regions. The following are the main conclusions:

a. Every building construction and design should be viewed from energy saving perspective
b. With the use of simulation software, about 17 percent of energy can be saved in building alone.
c. Construction and retrofitting of energy efficient building should be regularized and enforced by government authority through appropriate policy formulation.
d. In the SAARC region, skill development and awareness on simulation and modelling of energy efficient building should be prioritised in the quest for energy efficient techniques and measures.

Closing of Webinar

13. Mr. Poudel, informed all the participants that the presentations and recording of the webinar proceedings will be available on SAARC Energy Centre's website (www.saarcenergy.org). He requested the participants to submit suggestions/comments for any further improvement of these webinars and suggest topics to SEC. He closed the webinar with a thank you note to everyone attending the Webinar.

Annexures

Annexure-I

Webinar Agenda

Webinar on

"Energy Simulation of Building"

Tuesday, 14th July, 2020

1100-1110	Introduction
1110-1200	"Introduction to Energy Simulation of Buildings" (By: PC Thomas, Director, Team Catalyst, Driving sustainability through teamwork, Australia)
1200-1210	Q&A
1210-1240	"China's Building Energy Conservation Development and Software Application "(By: Ms. Menglin Wang, Product Manager, Beijing Glory PKPM Technology Co. Ltd.
1240-1250	Q&A
1250-1310	"Addressing Building Performance Simulation Challenges" (By: Mr. Asad Mahmood, National energy efficiency conservation Authority, Pakistan)
1310-13020	Closing of Webinar
Moderator: **Tula Ram Poudel**, Research Fellow (Energy Trade), SAARC Energy Centre	

Information for the participants:

1. All times mentioned in agenda are according to Pakistan Standard Time (PKT). The participants from other Member States may attend Webinar by following their own national time. The time conversion for all Member States is given below for reference:

Country	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Sri Lanka
Local time	(PKT-00:30)	(PKT+01:00)	(PKT+01:00)	(PKT+00:30)	PKT	(PKT+00:45)	(PKT+00:30)

2. The participants can ask questions to presenters by typing questions or clicking to the raised hand option into the Attendees pane of the main window of GotoWebinar software. You may send in your questions at any time during the presentations; we will collect these and address them during the Q&A session at the end of each presentation.

3. All participants can also submit comments/views and/or observations on the draft study report to Mr. Tula Ram Poudel, Research Fellow (Energy Trade) (rfet@saarcenergy.org) before 14th July, 2020.

List of Participants

Sr. No.	Last Name	First Name	Email address
1.	Pardhiv	SHIVAM	shivam02@infosys.com
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4.	Ali	Engr Majid	engr.majidali.baig@gmail.com
5.	Ali	Asif	asif.ali6794@gmail.com
6.	Arora	Harish	HARISH.ARORA111@GMAIL.COM
7.	Azhar	Muhammad	azhar.shafi2000@gmail.com
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37.	Oli	Tej	tejb.oli@gmail.com
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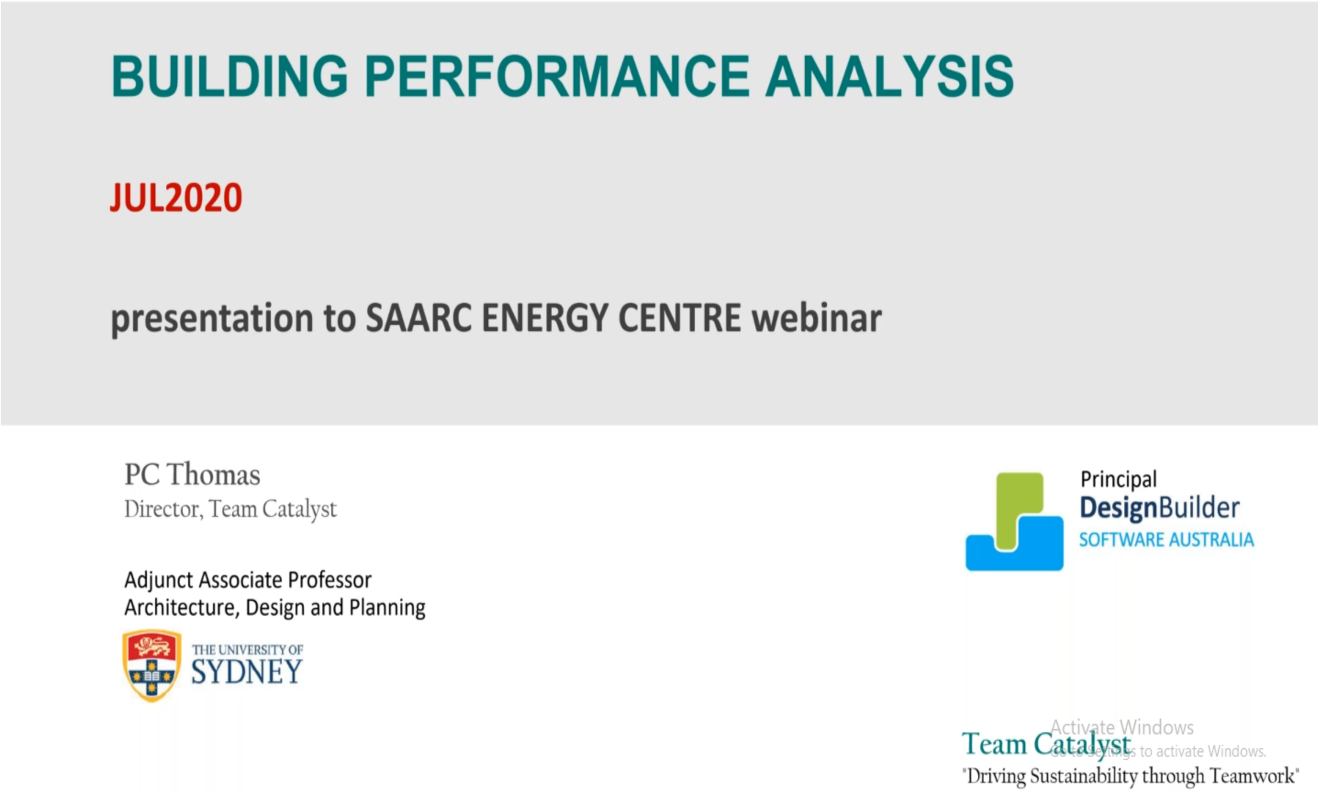
59.	grover	sugeet	sugeet.grover@cseindia.org
60.	hamid	mohsin	mohsinhamid66@gmail.com
61.	khan	Kamran	kamran.suit123@gmail.com
62.	manandhar	Krishna	krishnamanandhar.ee@gmail.com
63.	saif	bilal	bsaif44@gmail.com

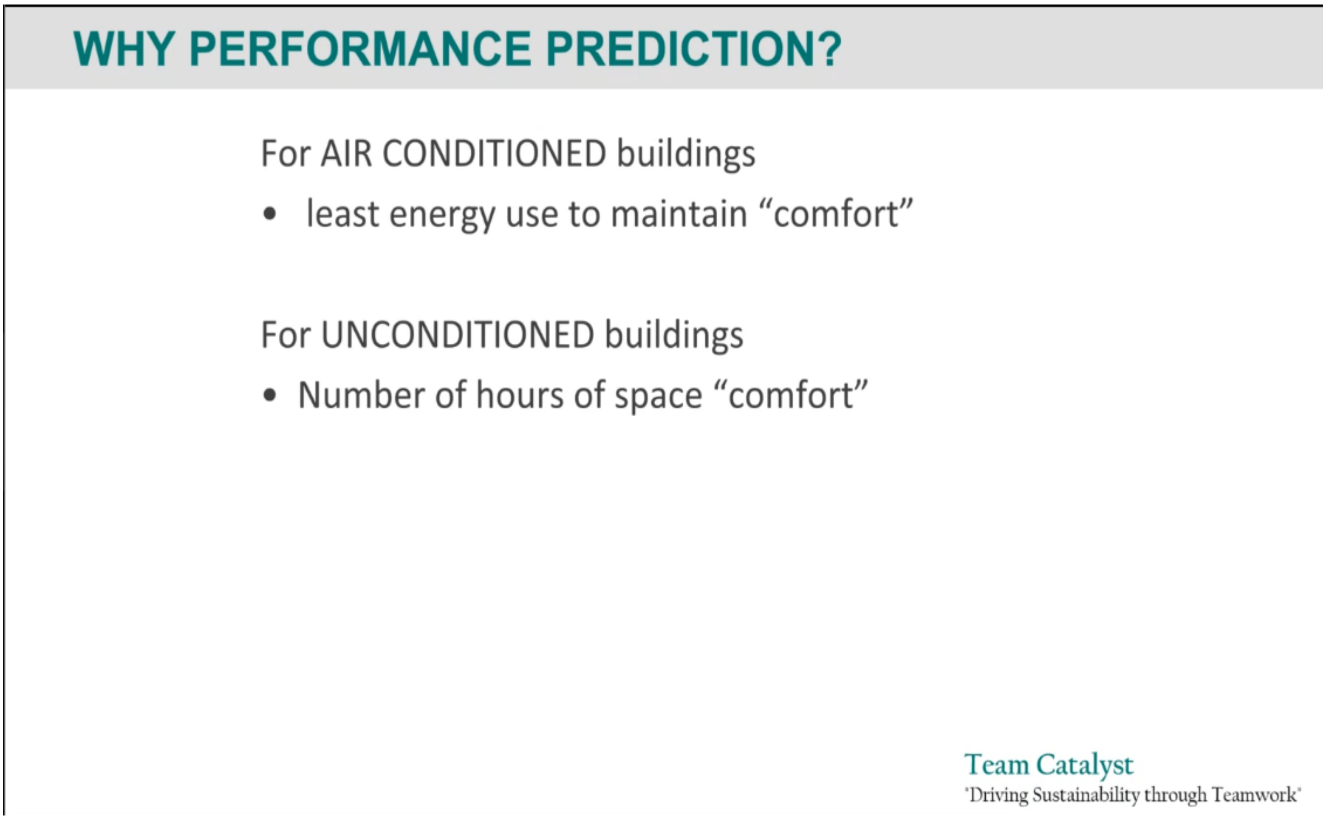
List of Presenters/Resource Persons

Sr. No.	Name	Designation	Organization	Email address
1.	PC Thomas	Director	Team Catalyst, Australia	pcthomas@teamcatalyst.com.au
2.	Mengling Wang	Project Manager	Beijing Glory PKPM Technology Co. Ltd.	wangmenglin@pkpm.com.cn
3.	Asad Mahmood	Manager Technical	National energy efficiency conservation Authority, Pakistan	asadm_46@yahoo.com

Presentations Delivered During the Webinar

1. "Introduction to Energy Simulation of Building." by PC Thomas, Director, Team Catalyst, Driving sustainability through teamwork, Australia



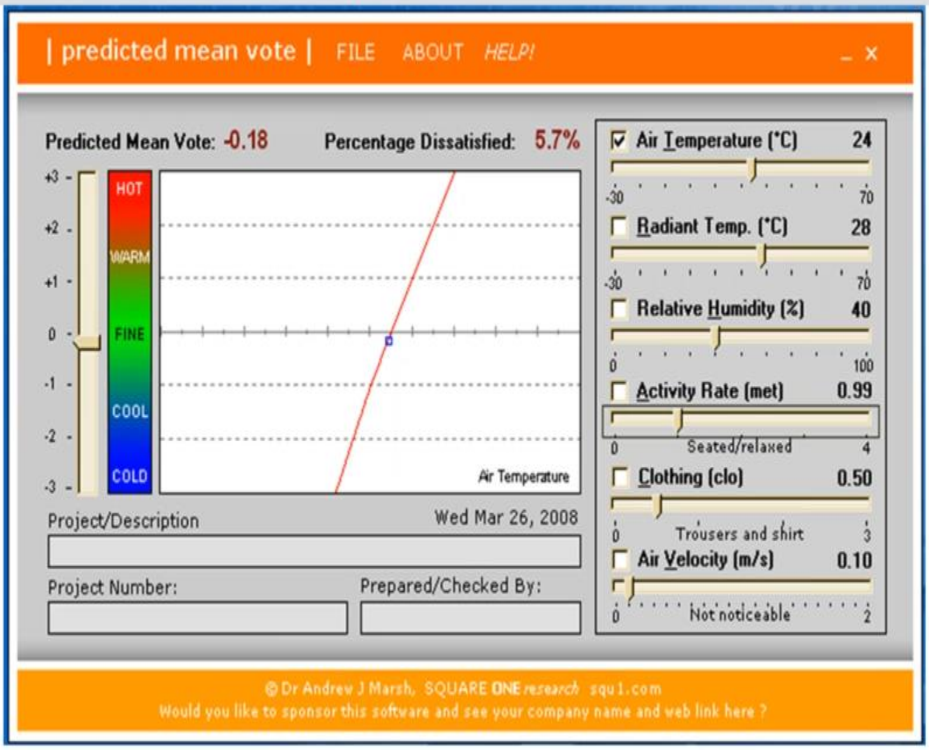


COMFORT

- Temperature
- Humidity
- Air movement
- Fresh air
- Clean air
- Noise levels
- Lighting
- Furniture and work surfaces

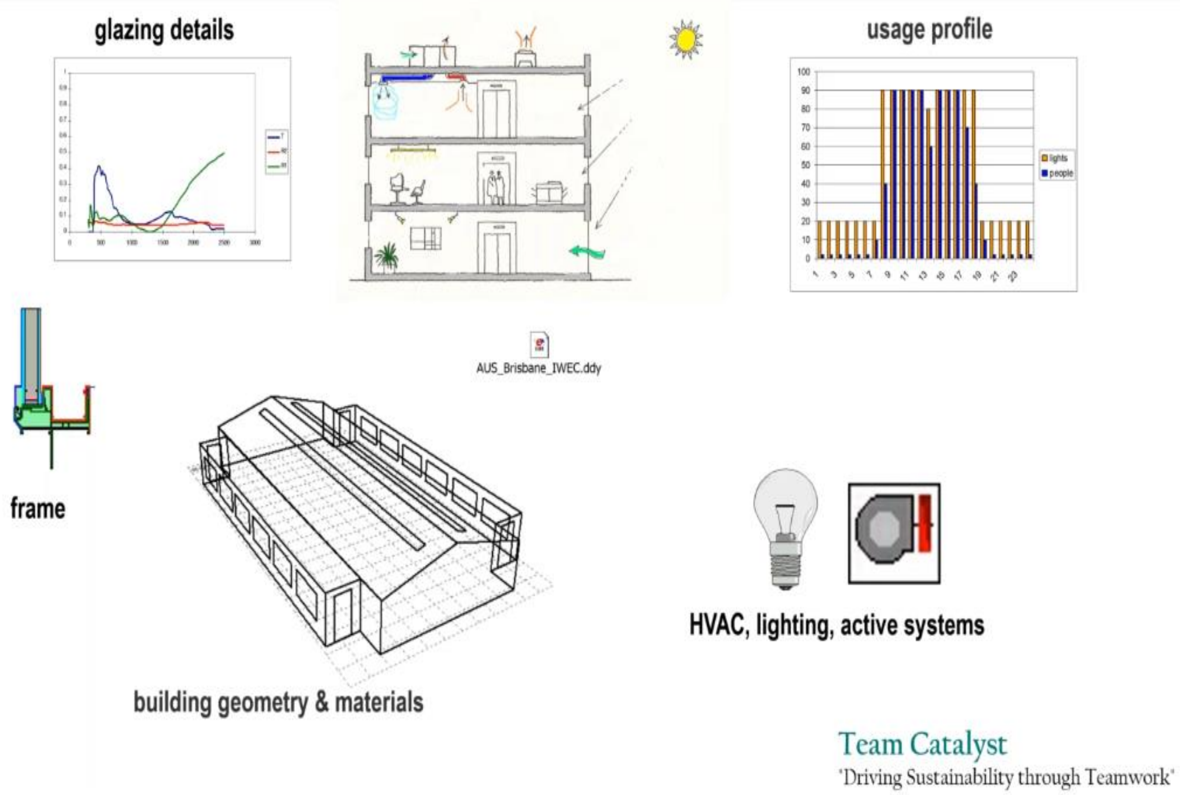
Team Catalyst
'Driving Sustainability through Teamwork'

THERMAL COMFORT (IN CONDITIONED SPACES)



Team Catalyst
'Driving Sustainability through Teamwork'

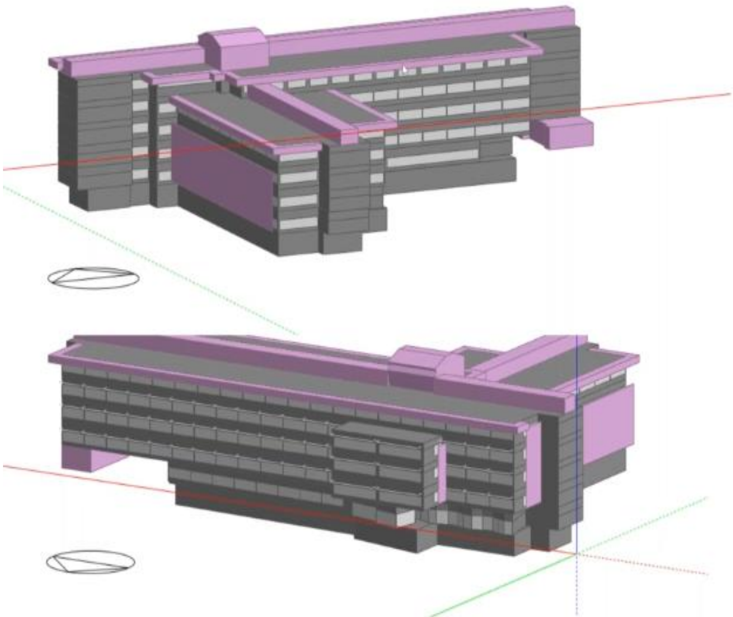
SIMULATION MODEL COMPONENTS

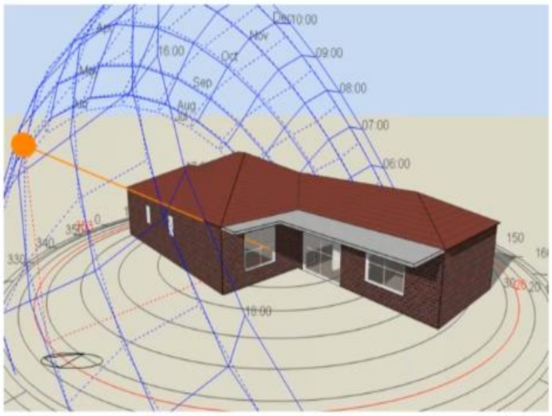


BUILDING ENVELOPE

BUILDING ENVELOPE

DesignBuilder SOFTWARE





Team Catalyst
'Driving Sustainability through Teamwork'

WINDOW PERFORMANCE PARAMETERS

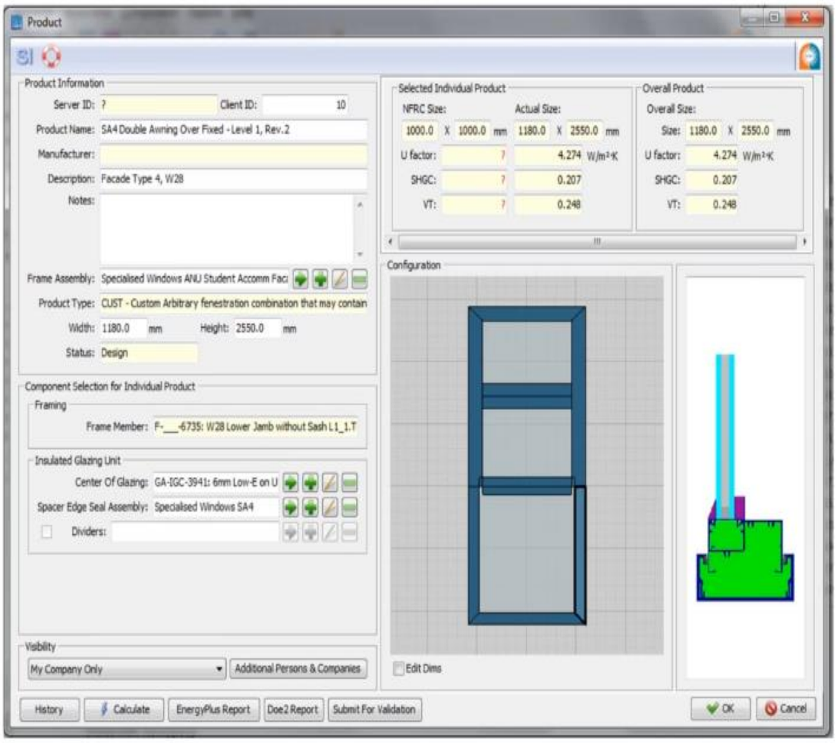
- SOLAR – SHGC
- DAYLIGHT – VLT (Tvis)
- THERMAL – U-value

SHGC = 0.54, VLT = 0.14 SHGC = 0.55, VLT = 0.63

Dr Peter Lyons, Fenestralia

Team Catalyst
'Driving Sustainability through Teamwork'

WHOLE WINDOW PERFORMANCE



Dr Peter Lyons, Fenestralia

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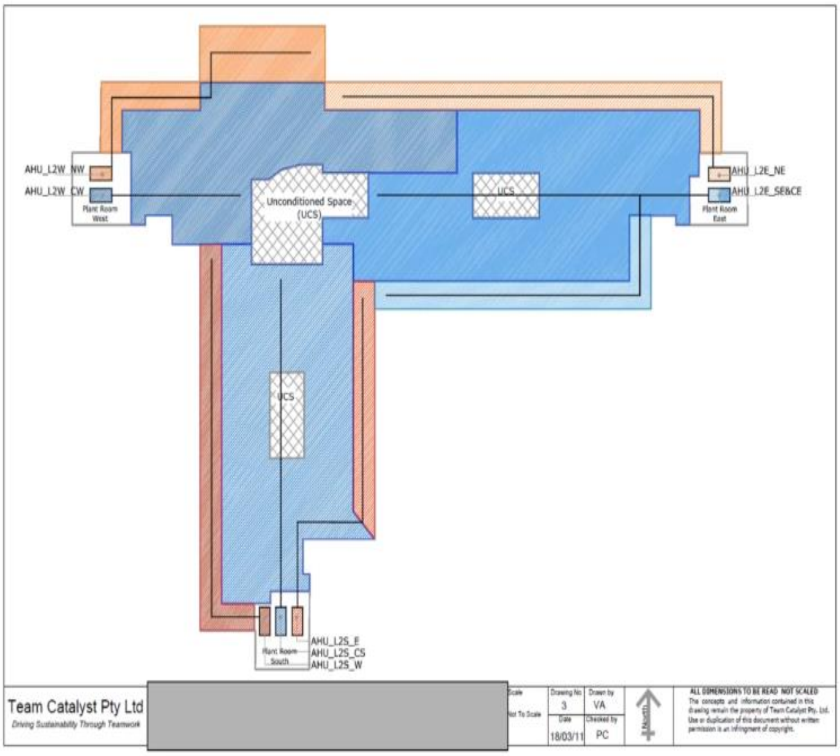
(THERMAL) ZONES – COMMERCIAL



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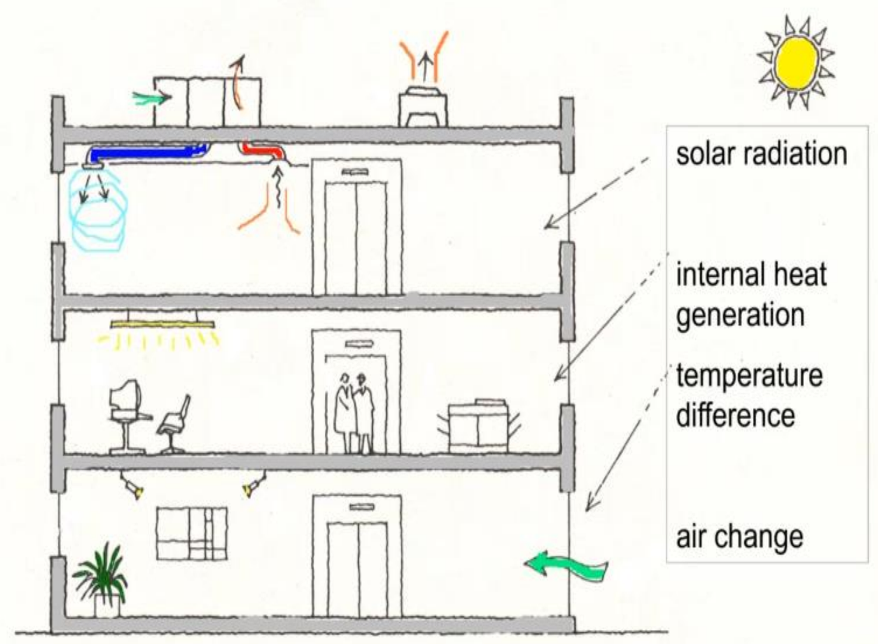
BUILDING LOADS



From Max Fordham & Associates

Team Catalyst
'Driving Sustainability through Teamwork'

INTERNAL DESIGN LOADS - OFFICE

1. LIGHTING – 4.5 W/m2

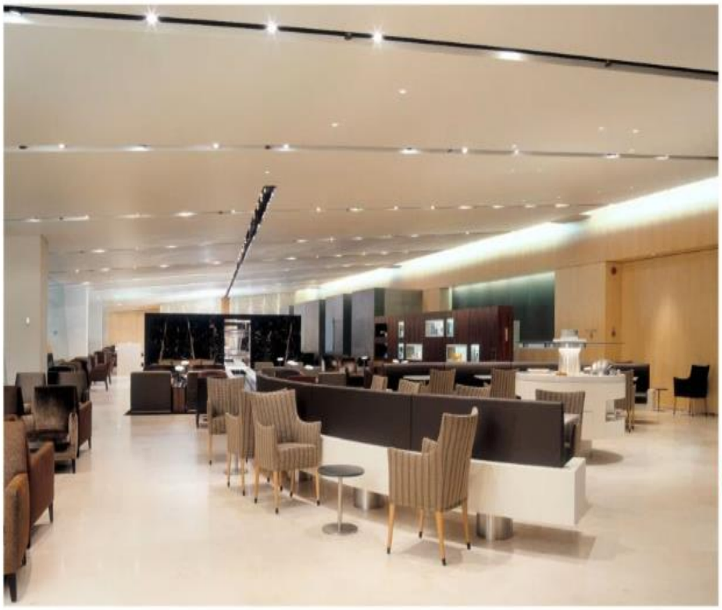
2. EQUIPMENT – 11 W/m2

3. PEOPLE – 10 m2/person
   - Sensible 75 W/person
   - Latent 60 W/person

4. "FRESH" OUTSIDE AIR – 10 l/s/person

Team Catalyst
'Driving Sustainability through Teamwork'

INTERNAL LOADS – LIGHTING



Appropriate light sources

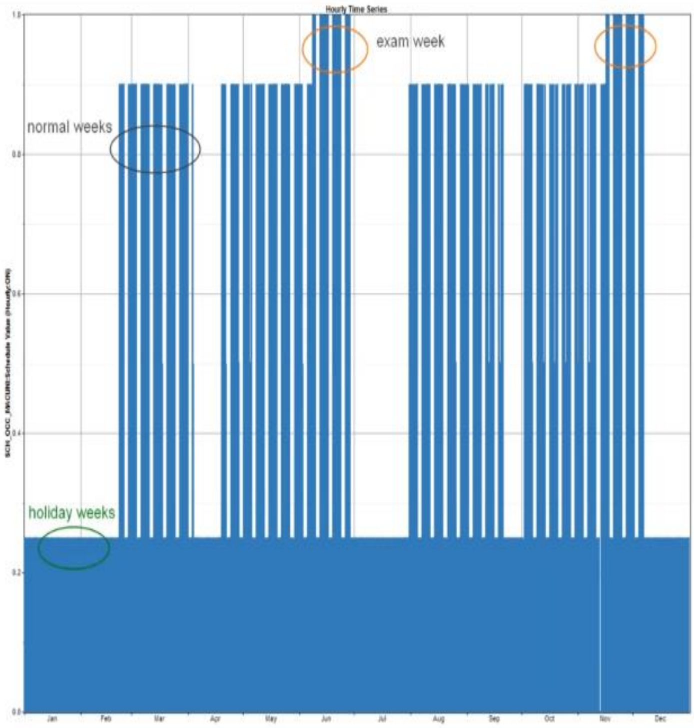
Efficient components

Switching control

Picture courtesy Peter McLean, Lighting, Art + Science Pty Ltd

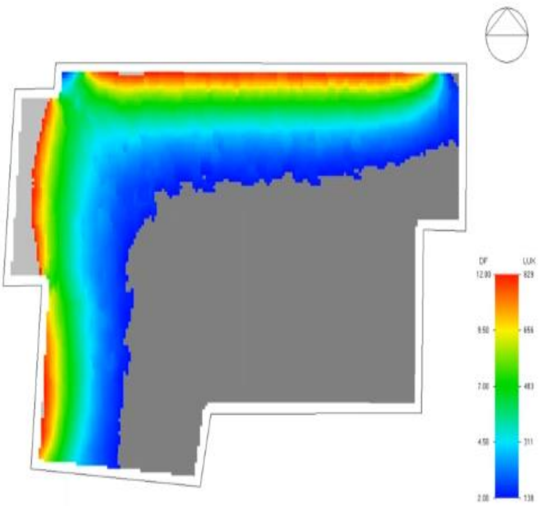
Team Catalyst
'Driving Sustainability through Teamwork'

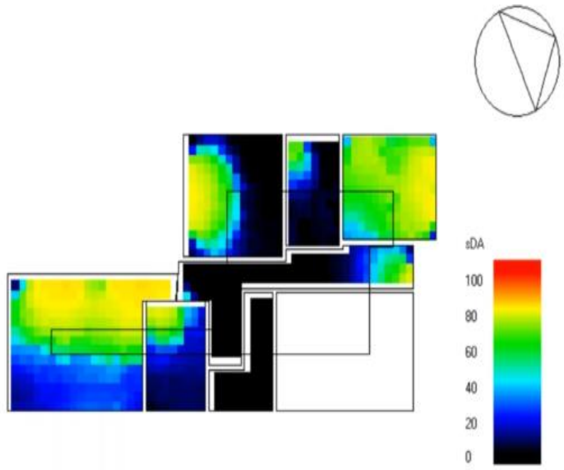
LIGHTING SCHEDULE



Team Catalyst
'Driving Sustainability through Teamwork'

DAYLIGHT





Team Catalyst
'Driving Sustainability through Teamwork'

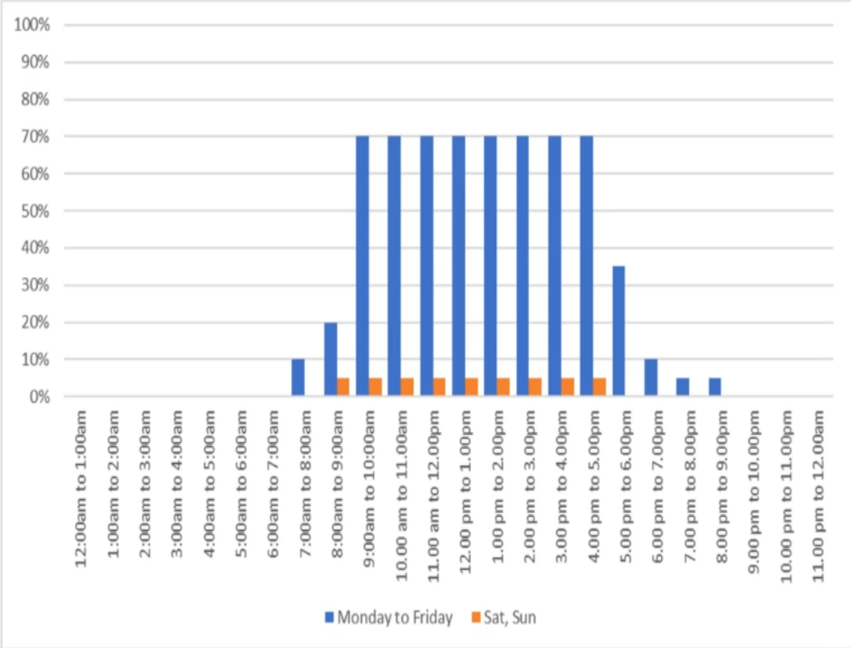
INTERNAL DESIGN LOADS - OFFICE

1. LIGHTING – 4.5 W/m2
2. EQUIPMENT – 11 W/m2
3. PEOPLE – 10 m2/person
   – Sensible 75 W/person
   – Latent 60 W/person
4. "FRESH" OUTSIDE AIR – 10 l/s/person

Team Catalyst
'Driving Sustainability through Teamwork'

OFFICE (CLASS 5) SCHEDULES

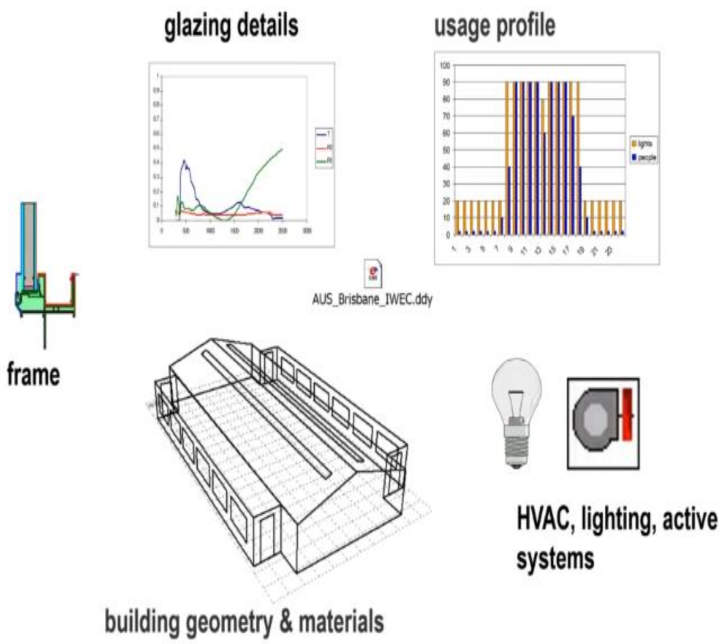
CLASS 5	Occupancy	
Time period	Monday to Friday	Sat, Sun
12:00am to 1:00am	0%	0%
1:00am to 2:00am	0%	0%
2:00am to 3:00am	0%	0%
3:00am to 4:00am	0%	0%
4:00am to 5:00am	0%	0%
5:00am to 6:00am	0%	0%
6:00am to 7:00am	0%	0%
7:00am to 8:00am	10%	0%
8:00am to 9:00am	20%	5%
9:00am to 10:00am	70%	5%
10.00 am to 11.00am	70%	5%
11.00 am to 12.00pm	70%	5%
12.00 pm to 1.00pm	70%	5%
1.00 pm to 2.00pm	70%	5%
2.00 pm to 3.00pm	70%	5%
3.00 pm to 4.00pm	70%	5%
4.00 pm to 5.00pm	70%	5%
5.00 pm to 6.00pm	35%	0%
6.00 pm to 7.00pm	10%	0%
7.00 pm to 8.00pm	5%	0%
8.00 pm to 9.00pm	5%	0%
9.00 pm to 10.00pm	0%	0%
10.00 pm to 11.00pm	0%	0%
11.00 pm to 12.00am	0%	0%



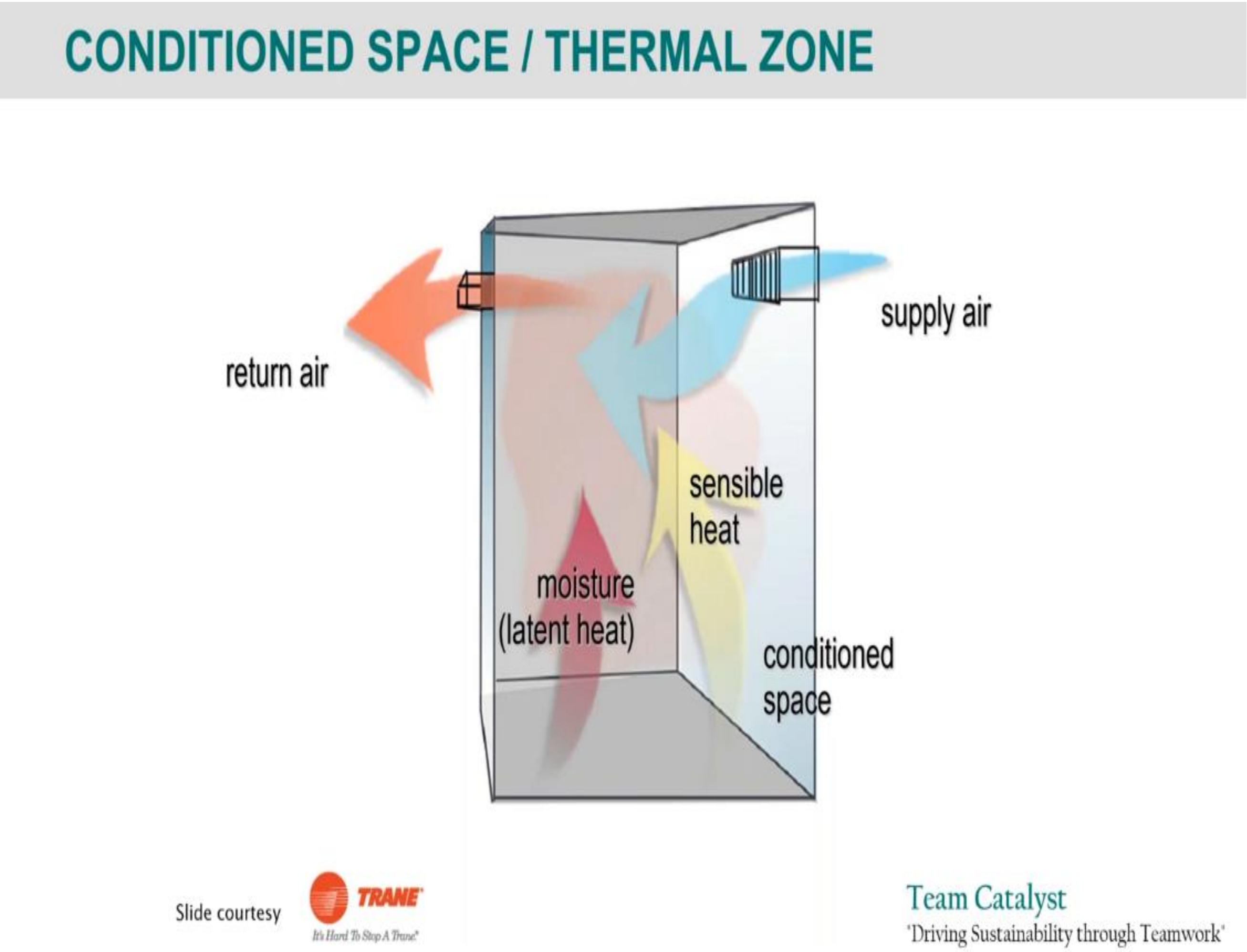
Team Catalyst
'Driving Sustainability through Teamwork'

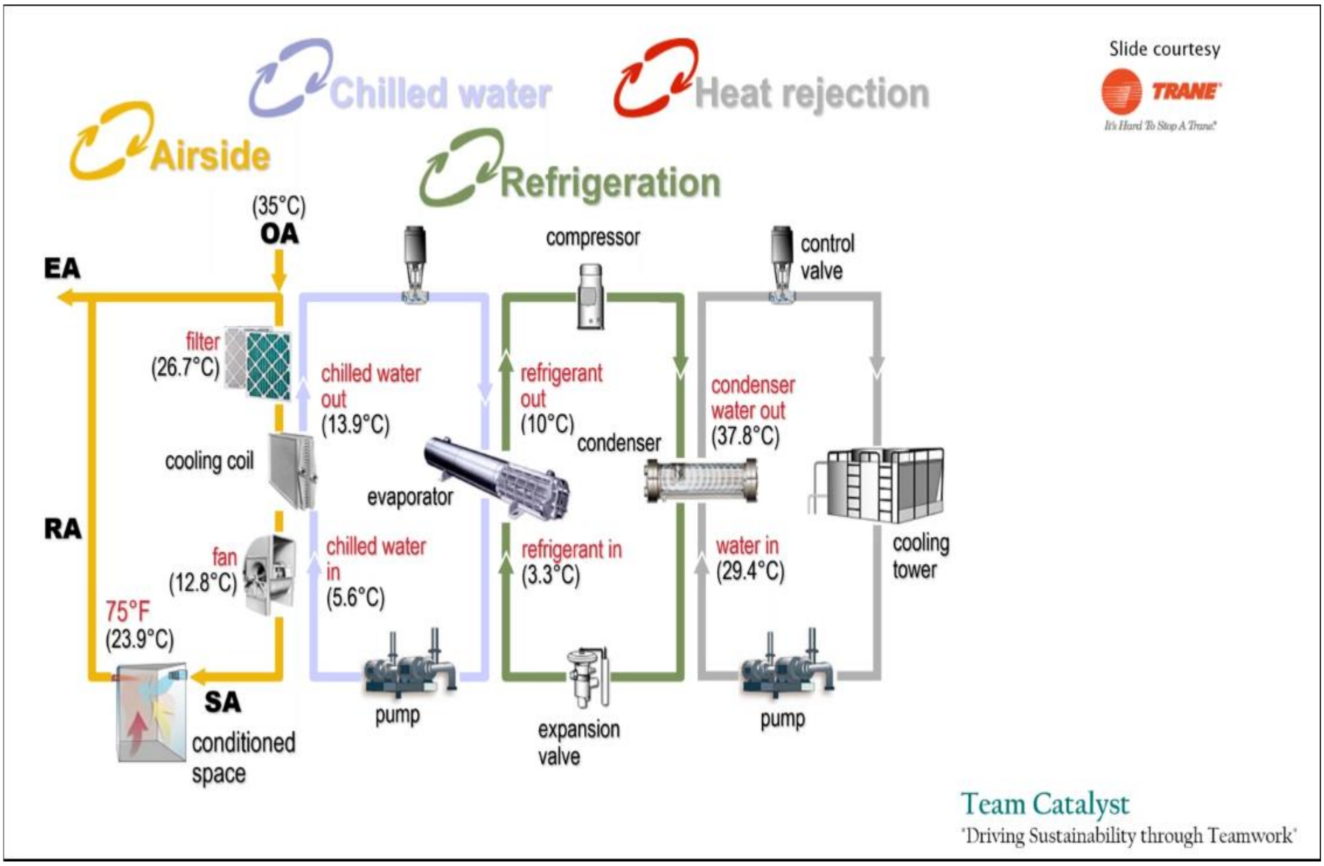
SIMULATION MODEL COMPONENTS

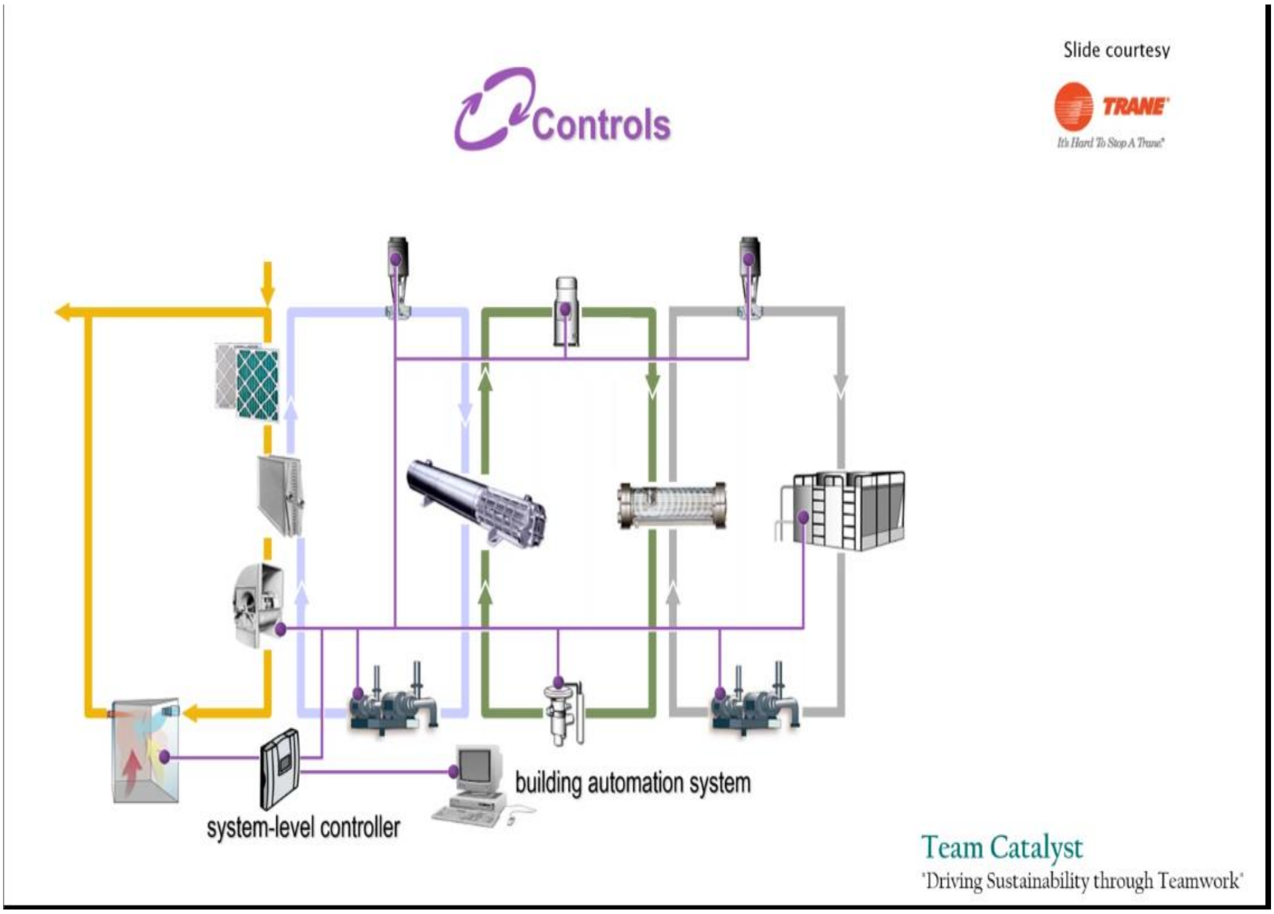
Slide courtesy Assoc Prof Leena Thomas, Faculty of Design Architecture & Building, University of Technology, Sydney (UTS)

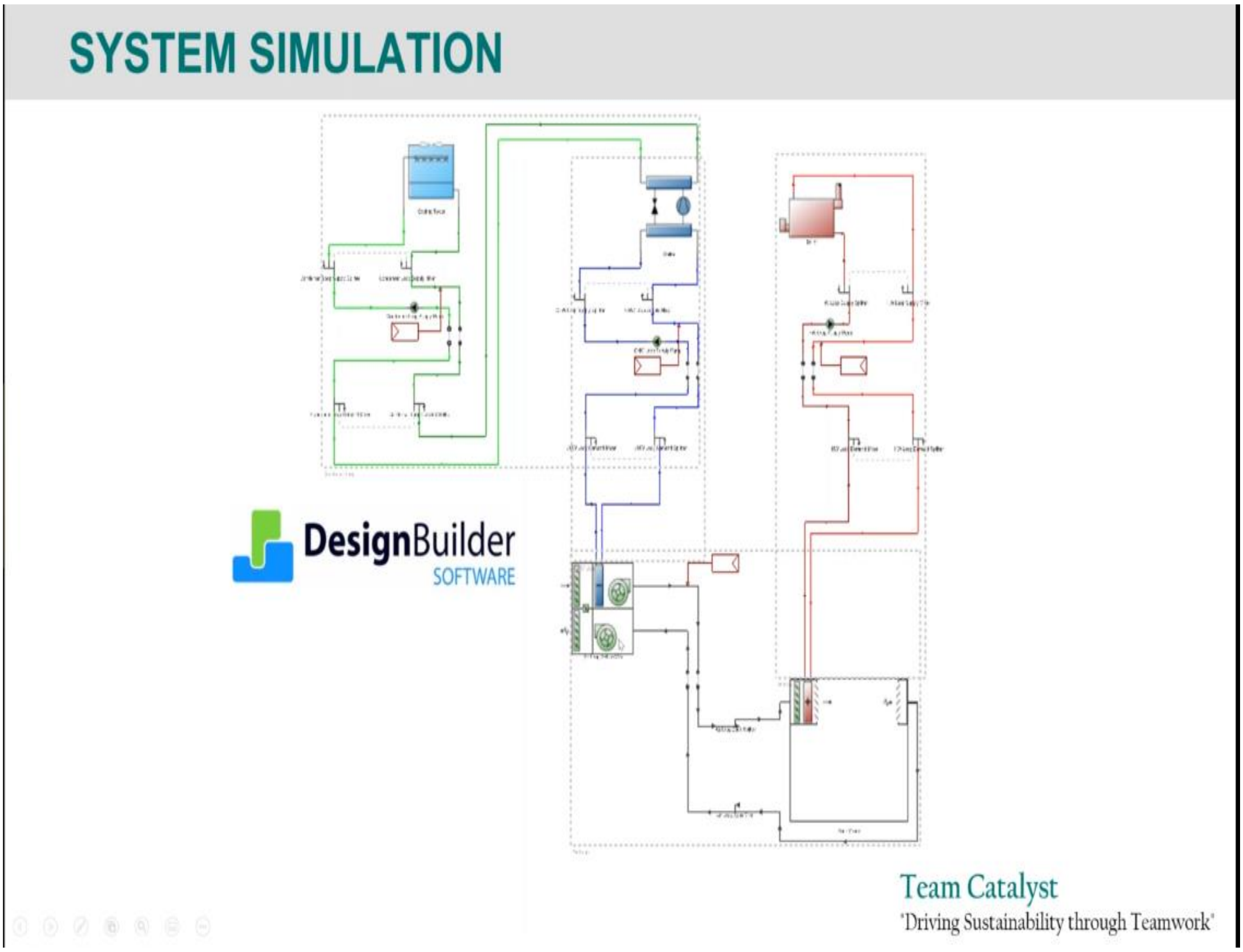


Team Catalyst
'Driving Sustainability through Teamwork'

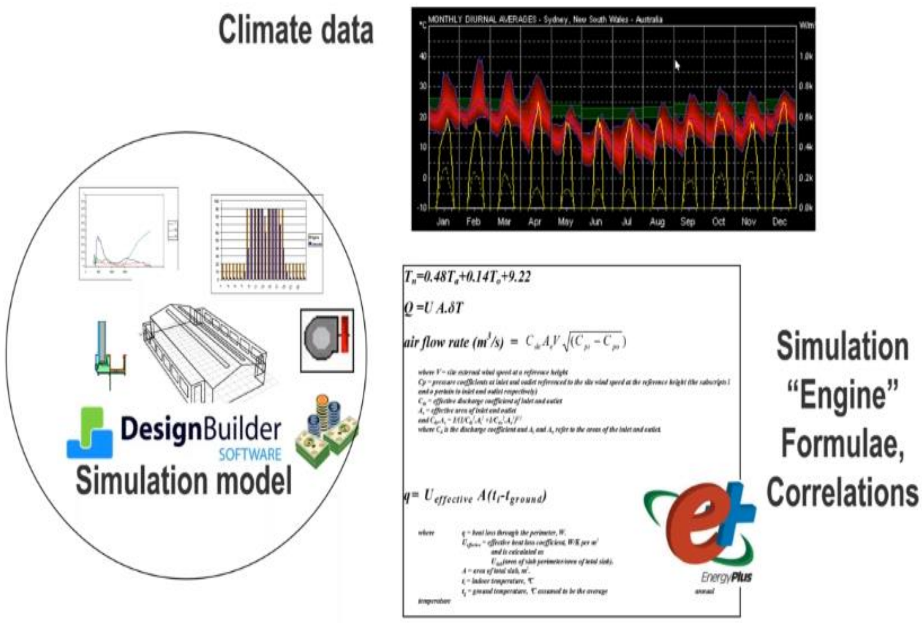

CONDITIONED SPACE / THERMAL ZONE
return air
supply air
sensible
heat
moisture
(latent heat)
conditioned
space
Slide courtesy
TRANE
It's Hard To Stop A Trane
Team Catalyst
'Driving Sustainability through Teamwork'


Chilled water
Heat rejection
Airside
Refrigeration
Slide courtesy
TRANE
It's Hard To Stop A Trane
(35°C)
OA
EA
compressor
control
valve
filter
(26.7°C)
chilled water
out
(13.9°C)
refrigerant
out
(10°C)
condenser
condenser
water out
(37.8°C)
cooling coil
evaporator
RA
fan
(12.8°C)
chilled water
in
(5.6°C)
refrigerant in
(3.3°C)
water in
(29.4°C)
cooling
tower
75°F
(23.9°C)
SA
conditioned
space
pump
expansion
valve
pump
Team Catalyst
'Driving Sustainability through Teamwork'


Slide courtesy
TRANE
It's Hard To Stop A Trane
Controls
building automation system
system-level controller
Team Catalyst
'Driving Sustainability through Teamwork'

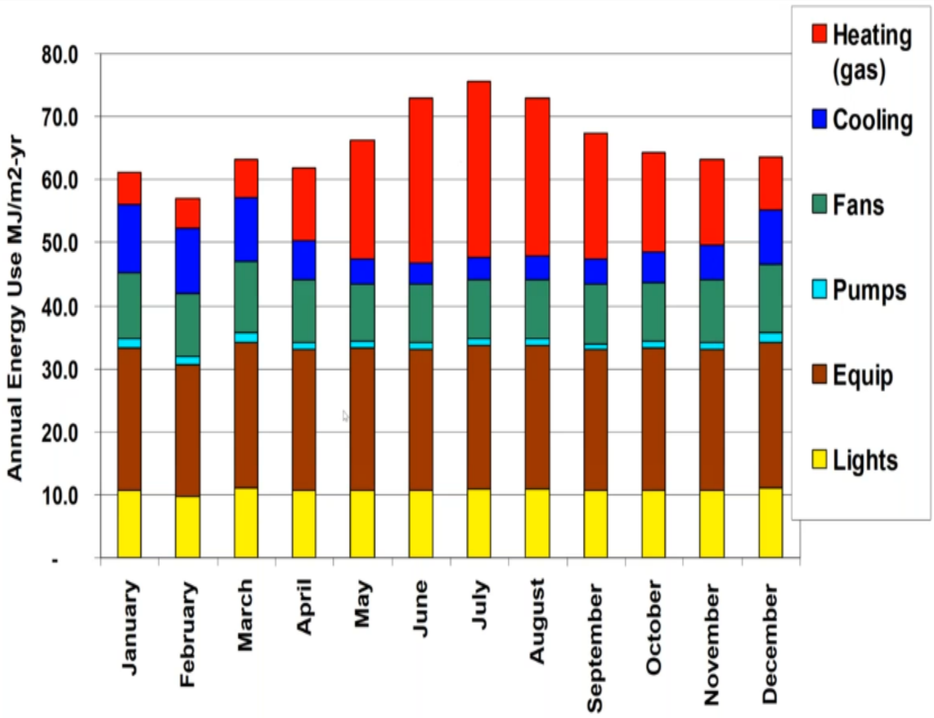

SYSTEM SIMULATION
DesignBuilder
SOFTWARE
Team Catalyst
'Driving Sustainability through Teamwork'

ENERGY MODELLING PROCESS



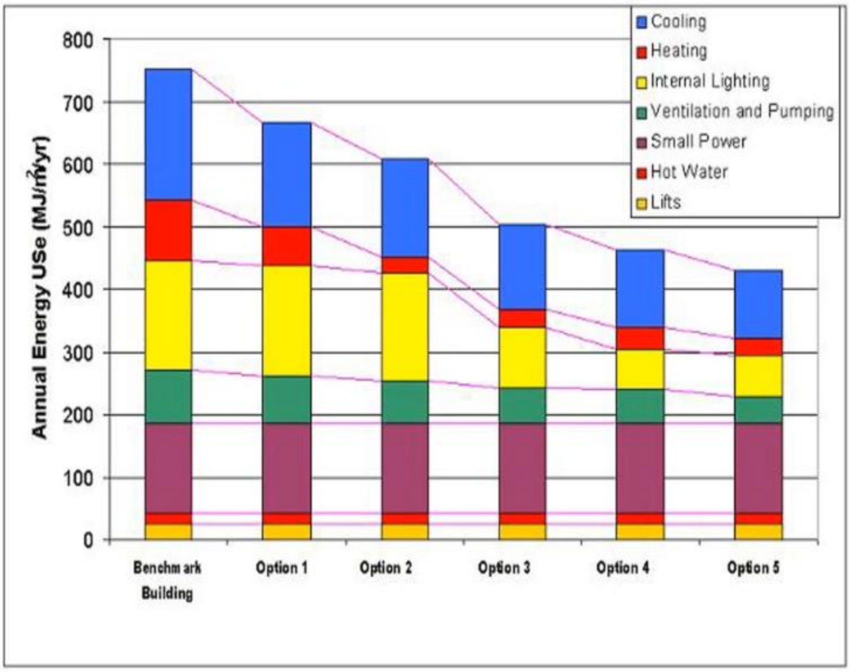
Team Catalyst
'Driving Sustainability through Teamwork'

ENERGY CONSUMPTION BY END USE



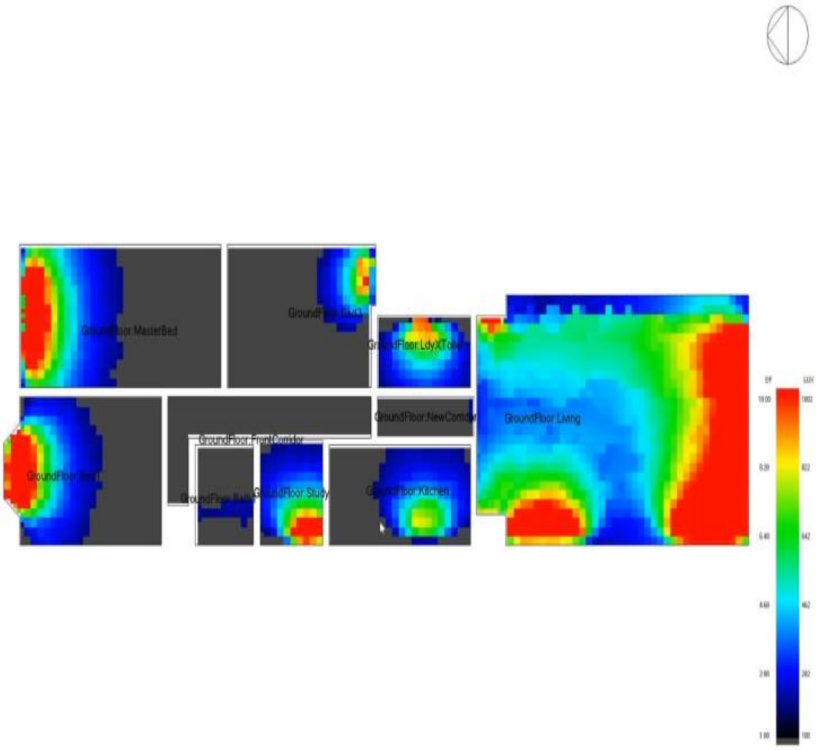
Team Catalyst
'Driving Sustainability through Teamwork'

OPTIMISE ENERGY USE

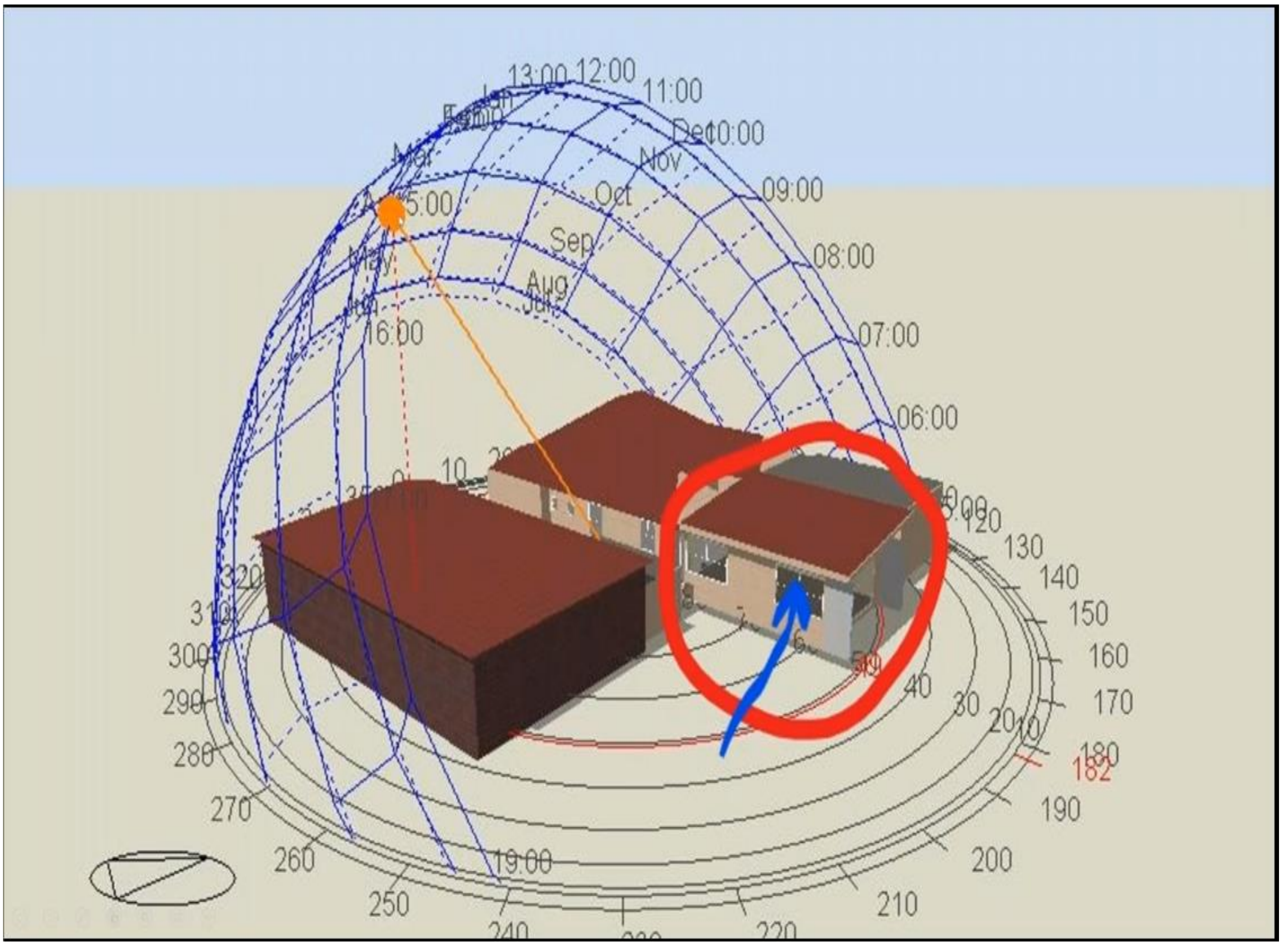


Team Catalyst
'Driving Sustainability through Teamwork'

DAYLIGHT ANALYSIS



Team Catalyst
'Driving Sustainability through Teamwork'


12:00
11:00
10:00
09:00
08:00
07:00
06:00
16:00
19:00
Nov
Oct
Sep
Aug
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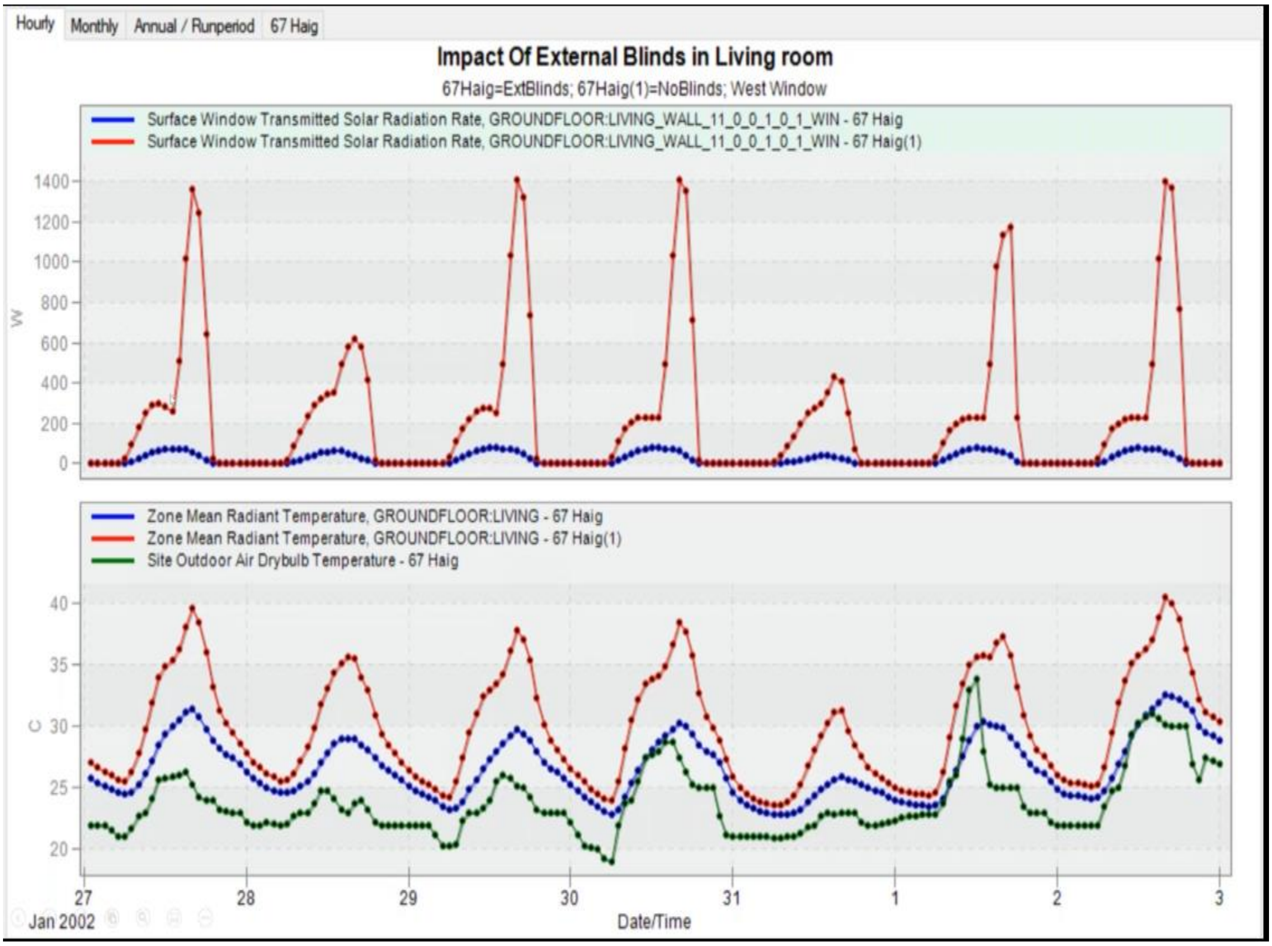
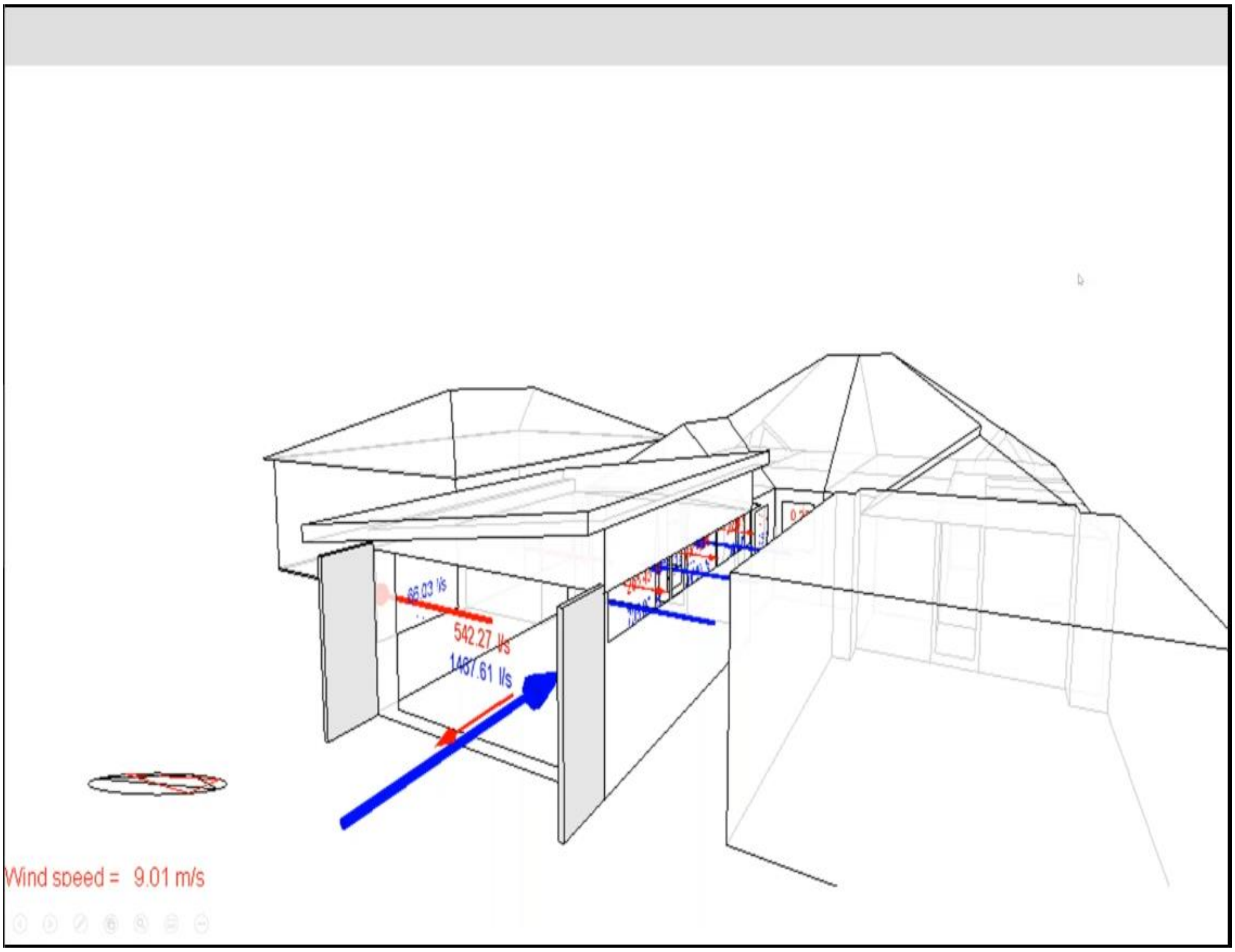
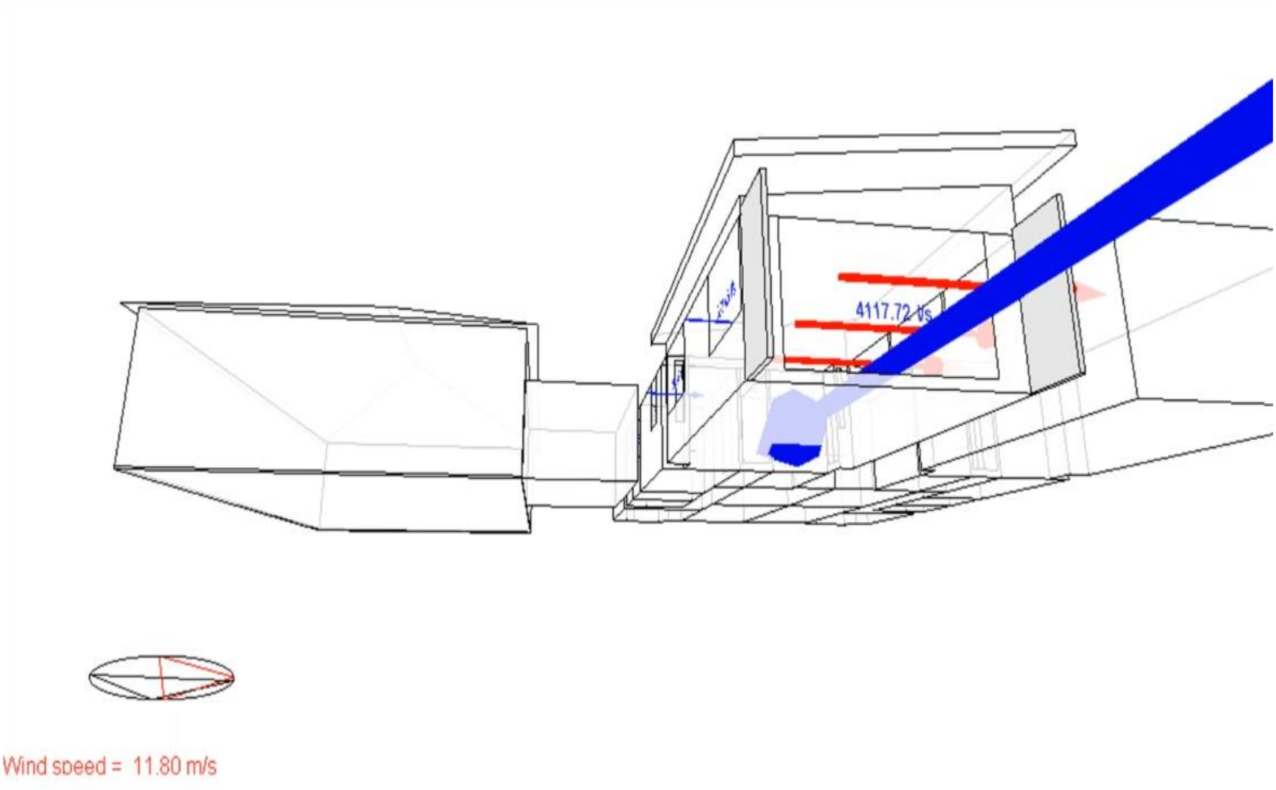
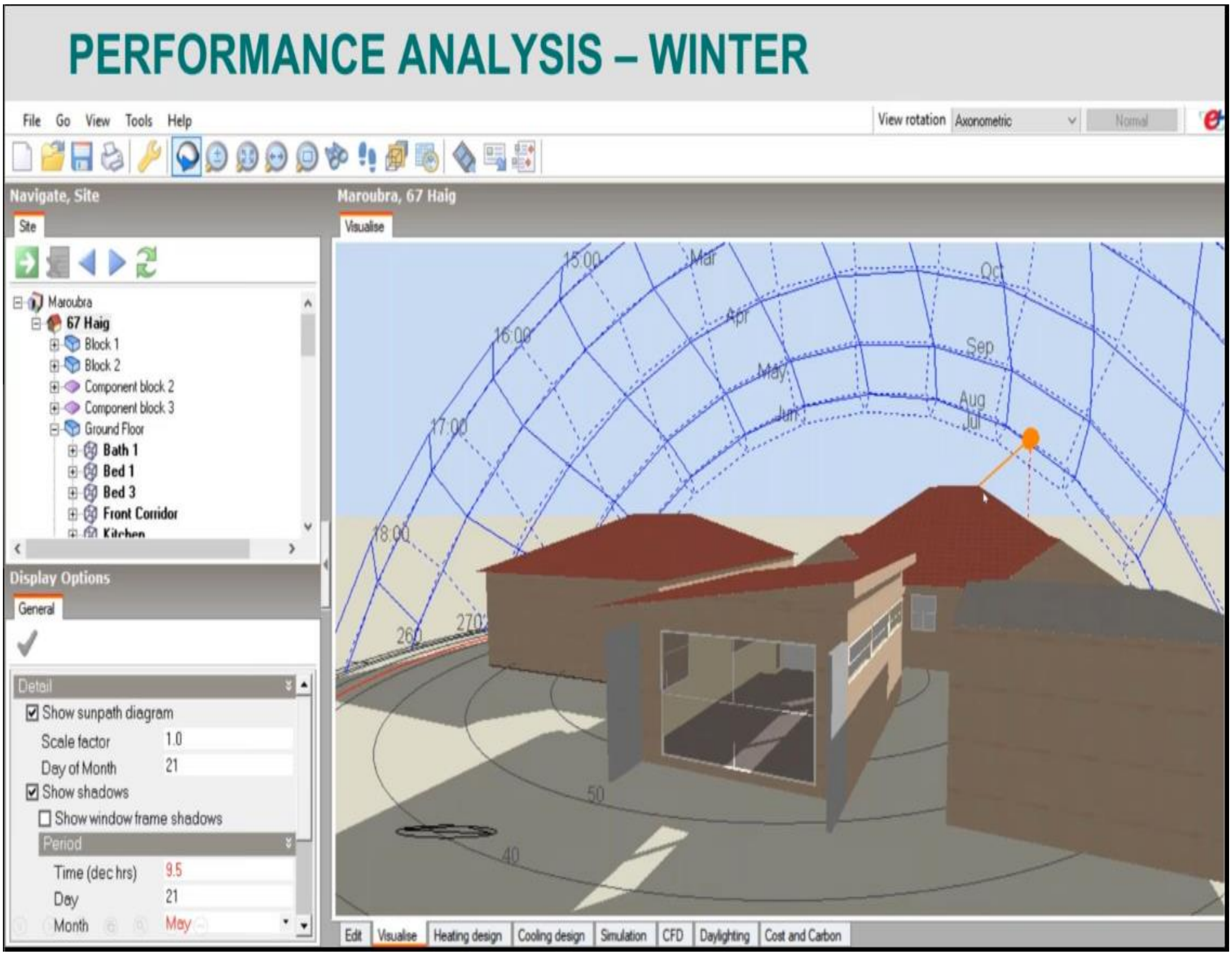
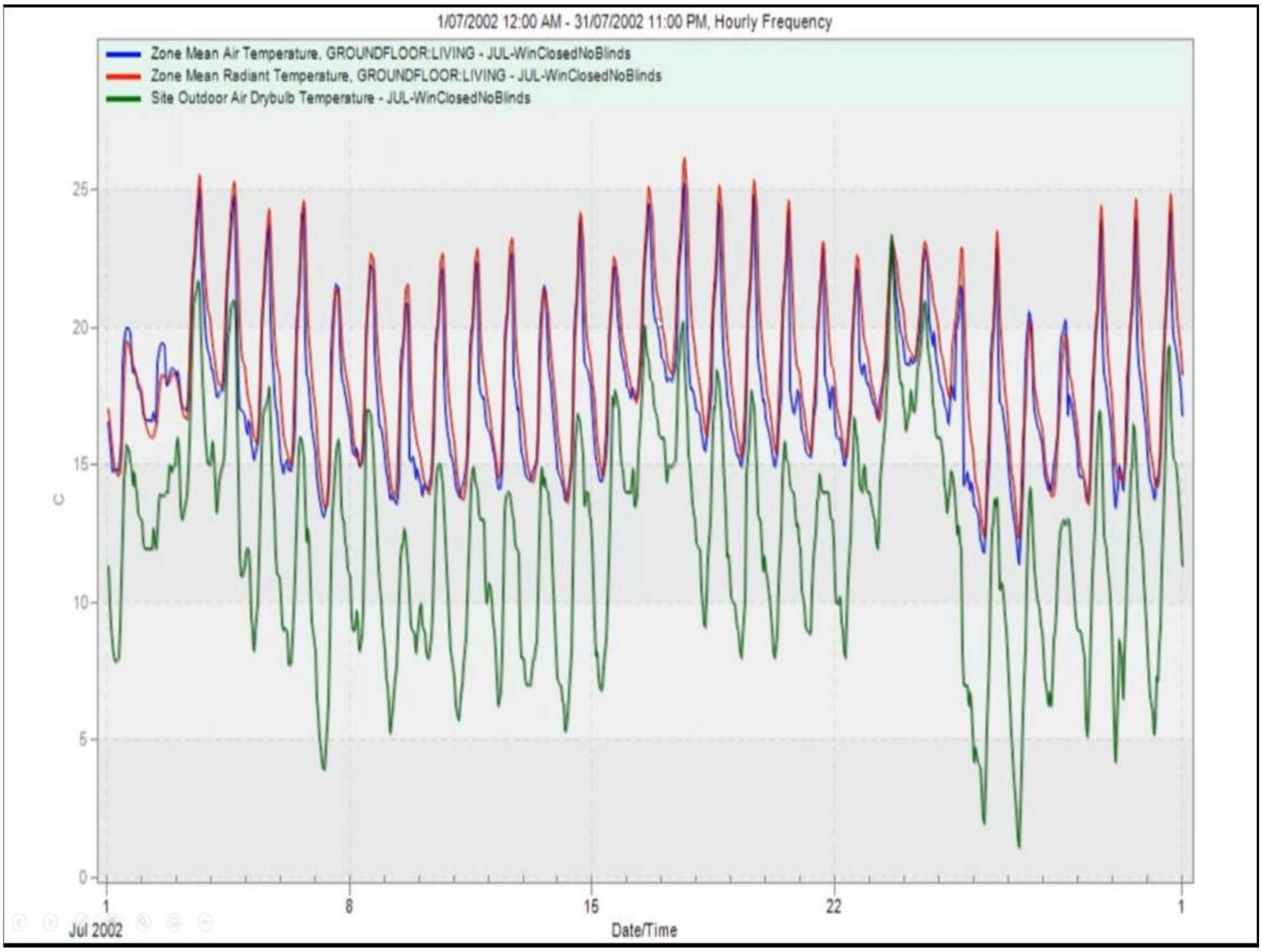
260
270
280
290
300


Hourly
Monthly
Annual / Runperiod
67 Haig
Impact Of External Blinds in Living room
67Haig=ExtBlinds; 67Haig(1)=NoBlinds; West Window
Surface Window Transmitted Solar Radiation Rate, GROUNDFLOOR:LIVING_WALL_11_0_0_1_0_1_WIN - 67 Haig
Surface Window Transmitted Solar Radiation Rate, GROUNDFLOOR:LIVING_WALL_11_0_0_1_0_1_WIN - 67 Haig(1)
W
1400
1200
1000
800
600
400
200
0
Zone Mean Radiant Temperature, GROUNDFLOOR:LIVING - 67 Haig
Zone Mean Radiant Temperature, GROUNDFLOOR:LIVING - 67 Haig(1)
Site Outdoor Air Drybulb Temperature - 67 Haig
C
40
35
30
25
20
27
28
29
30
31
1
2
3
Jan 2002
Date/Time


66.03 l/s
542.27 l/s
1467.61 l/s
Wind speed = 9.01 m/s


4117.72 l/s
Wind speed = 11.80 m/s


PERFORMANCE ANALYSIS – WINTER
File Go View Tools Help
View rotation Axonometric
Navigate, Site
Site
Maroubra
67 Haig
Block 1
Block 2
Component block 2
Component block 3
Ground Floor
Bath 1
Bed 1
Bed 3
Front Corridor
Kitchen
Maroubra, 67 Haig
Visualise
Mar
Apr
May
Jun
Oct
Sep
Aug
Jul
15:00
16:00
17:00
18:00
260
270
50
40
Display Options
General
Detail
Show sunpath diagram
Scale factor 1.0
Day of Month 21
Show shadows
Show window frame shadows
Period
Time (dec hrs) 9.5
Day 21
Month May
Edit Visualise Heating design Cooling design Simulation CFD Daylighting Cost and Carbon



1/07/2002 12:00 AM - 31/07/2002 11:00 PM, Hourly Frequency
Zone Mean Air Temperature, GROUNDFLOOR:LIVING - JUL-WinClosedNoBlinds
Zone Mean Radiant Temperature, GROUNDFLOOR:LIVING - JUL-WinClosedNoBlinds
Site Outdoor Air Drybulb Temperature - JUL-WinClosedNoBlinds
C
Jul 2002
Date/Time

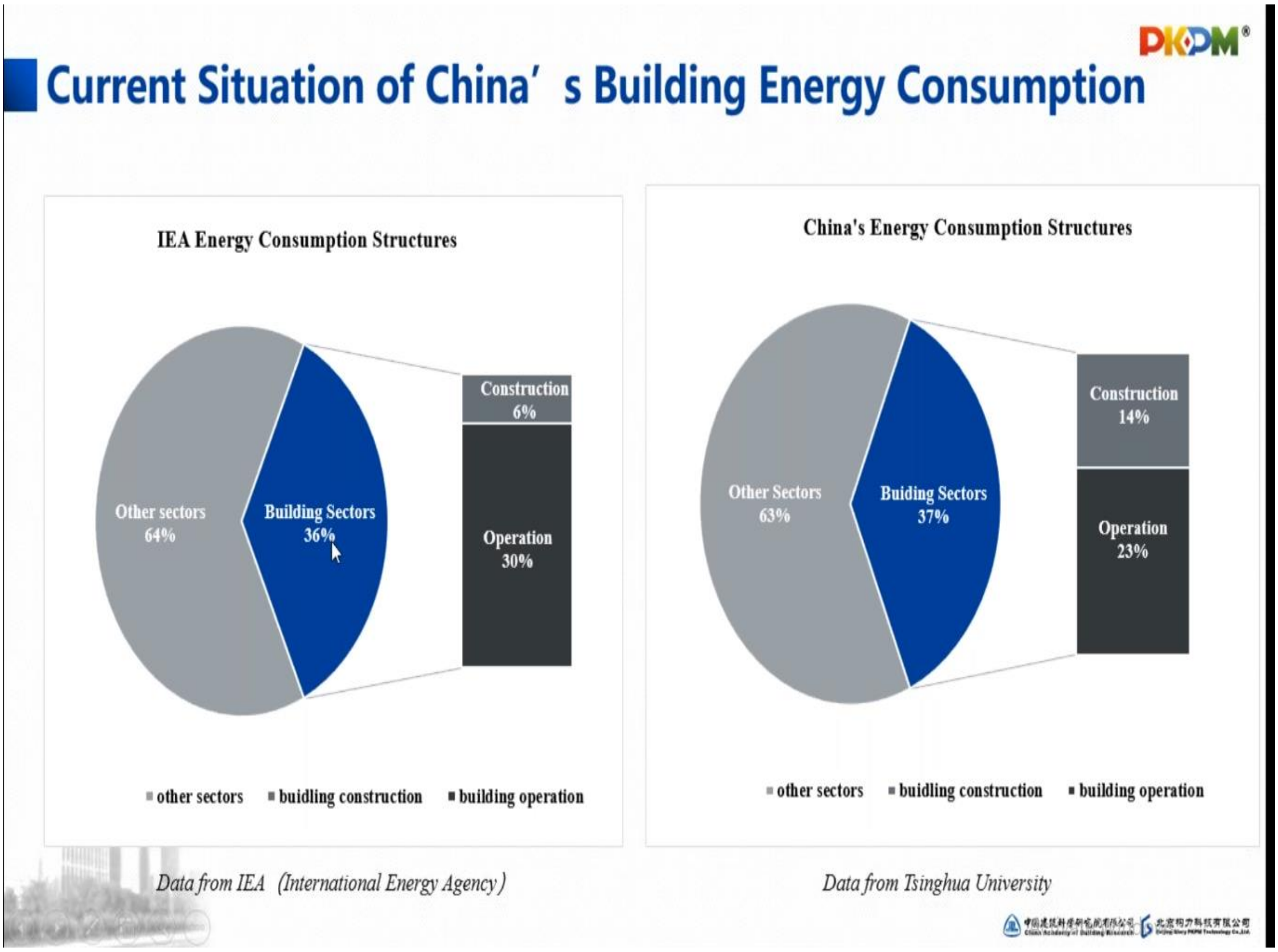
THERMAL COMFORT

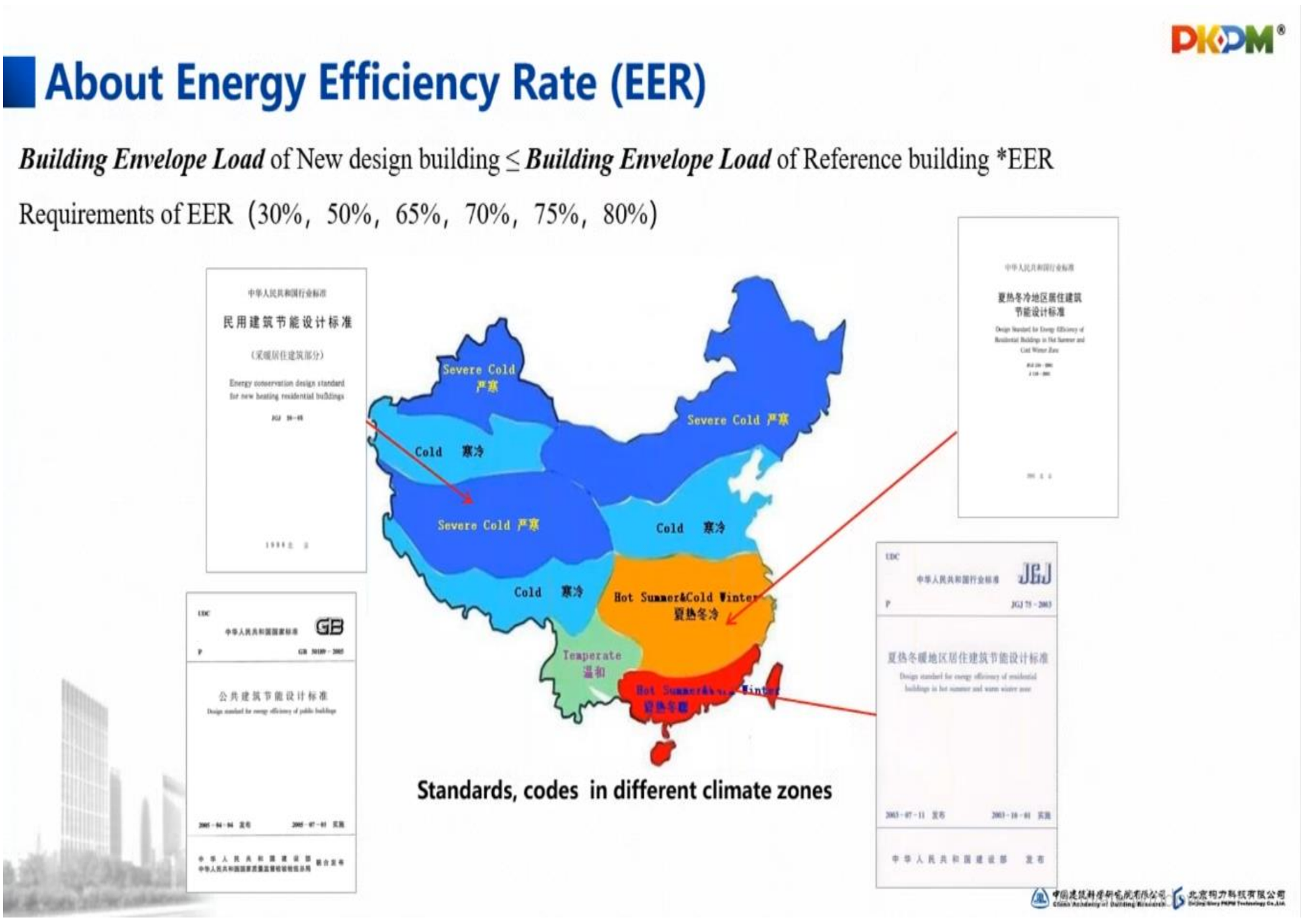
Interval Start / Interval End	19.00<= 20.00>	20.00<= 21.00>	21.00<= 22.00>	22.00<= 23.00>	23.00<= 24.00>	24.00<= 25.00>	25.00<= 26.00>
8:01 to 9:00 am	1.5	0	0	0	0	0	0
9:01 to 10:00 am	4.5	0	0	0	0	0	0
10:01 to 11:00 am	14.5	6.5	3.5	1	0	0	0
11:01 to 12:00 pm	8	14.5	4	4	0	0	0
12:01 to 1:00 pm	4.5	12.5	9	4	1	0	0
1:01 to 2:00 pm	2.5	6	9	9	4	0.5	0
2:01 to 3:00 pm	1.5	3.5	4.5	9	6.5	5.5	0.5
3:01 to 4:00 pm	2.5	2.5	4	8	3.5	9	1.5
4:01 to 5:00 pm	7	5	2	3	0	0	0
5:01 to 6:00 pm	5.5	2.5	1	0.5	0	0	0
6:01 to 7:00 pm	3	2.5	0.5	0	0	0	0
7:01 to 8:00 pm	2	2.5	0	0	0	0	0
8:01 to 9:00 pm	2.5	1	0	0	0	0	0
9:01 to 10:00 pm	3	0	0	0	0	0	0

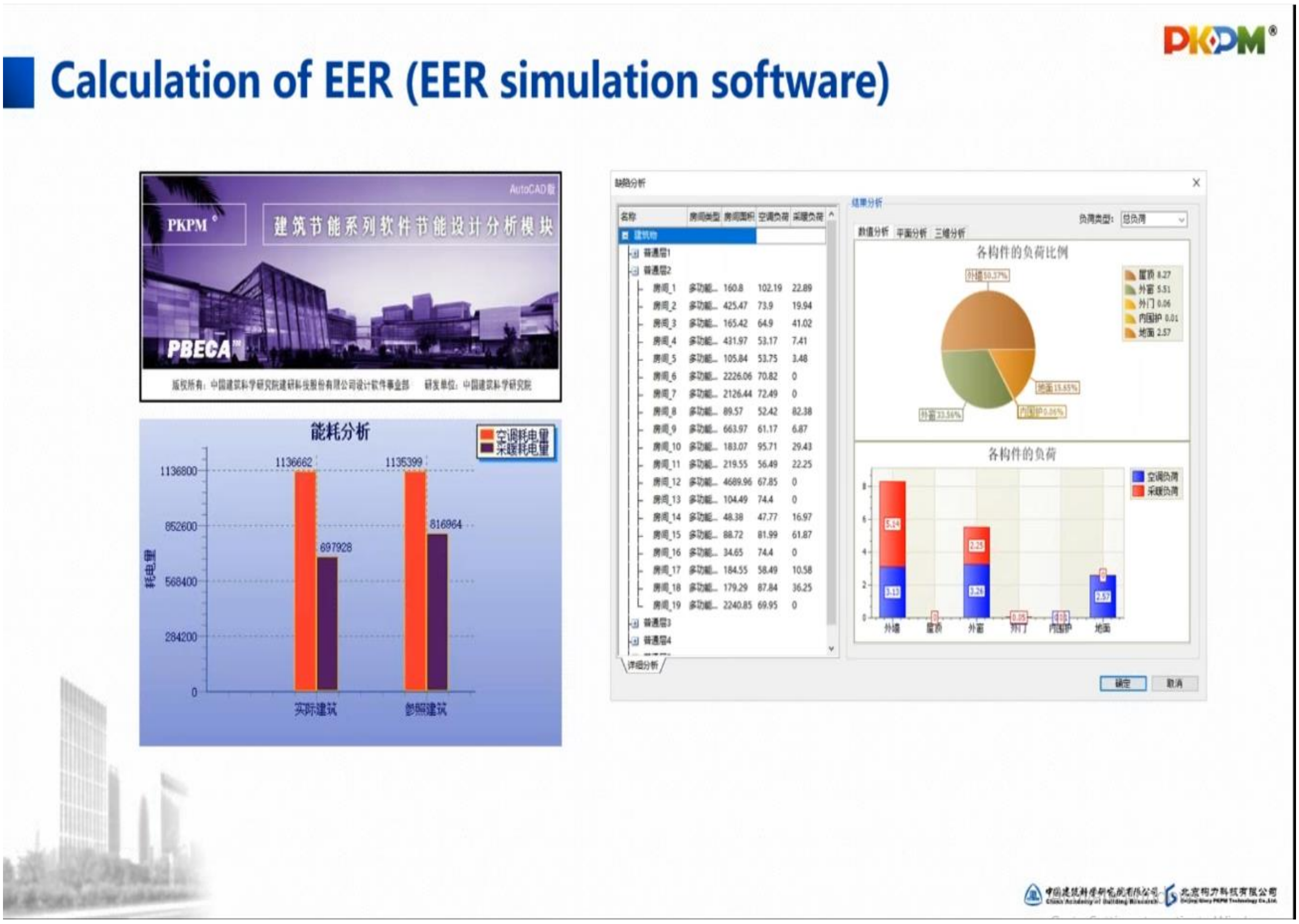
Total number of hours between 8am to 10pm in JUL	434.0
"Comfortable" hours during this time	229.5
Percent of "comfortable" hours	53%

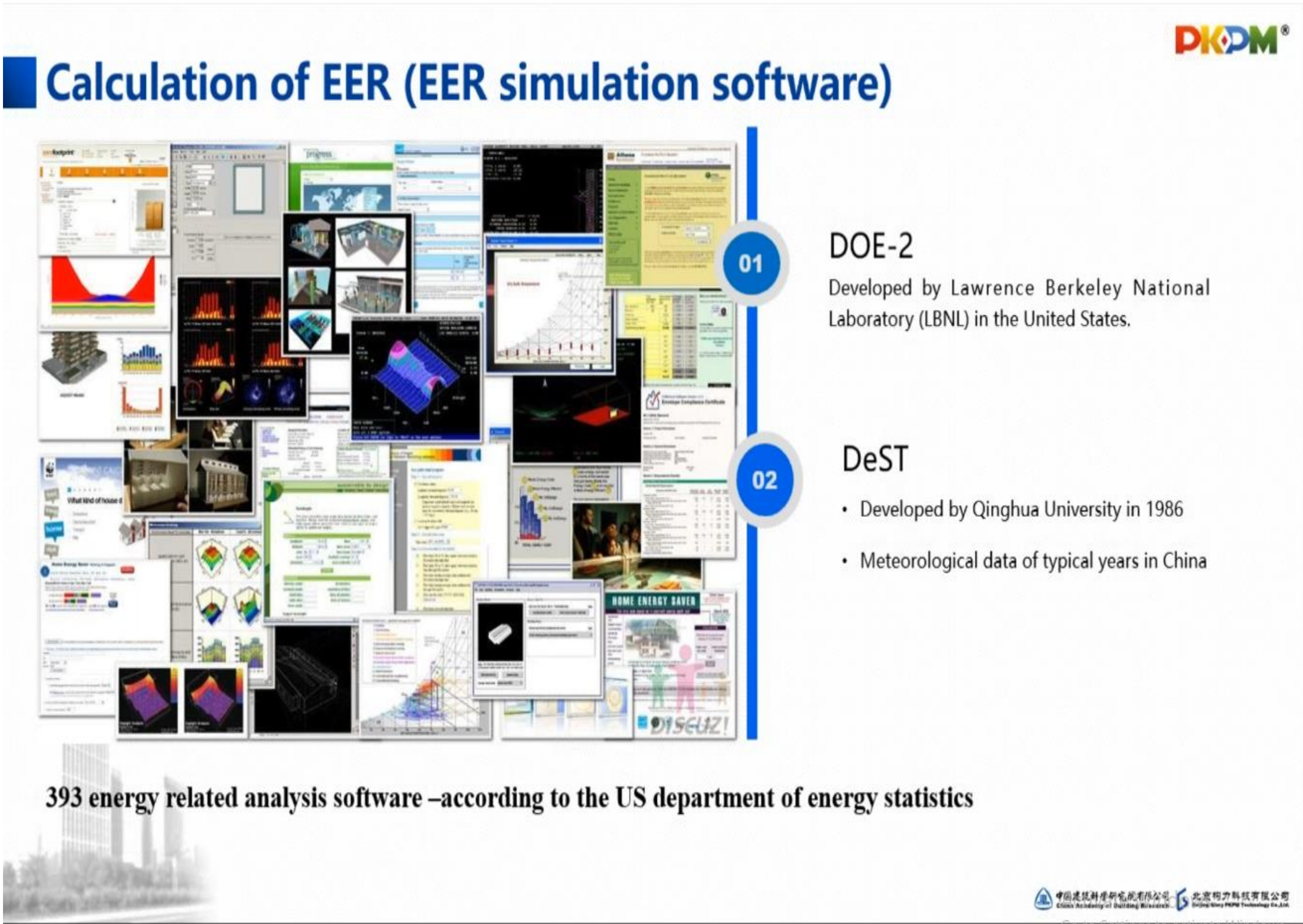
Team Catalyst
'Driving Sustainability through Teamwork'

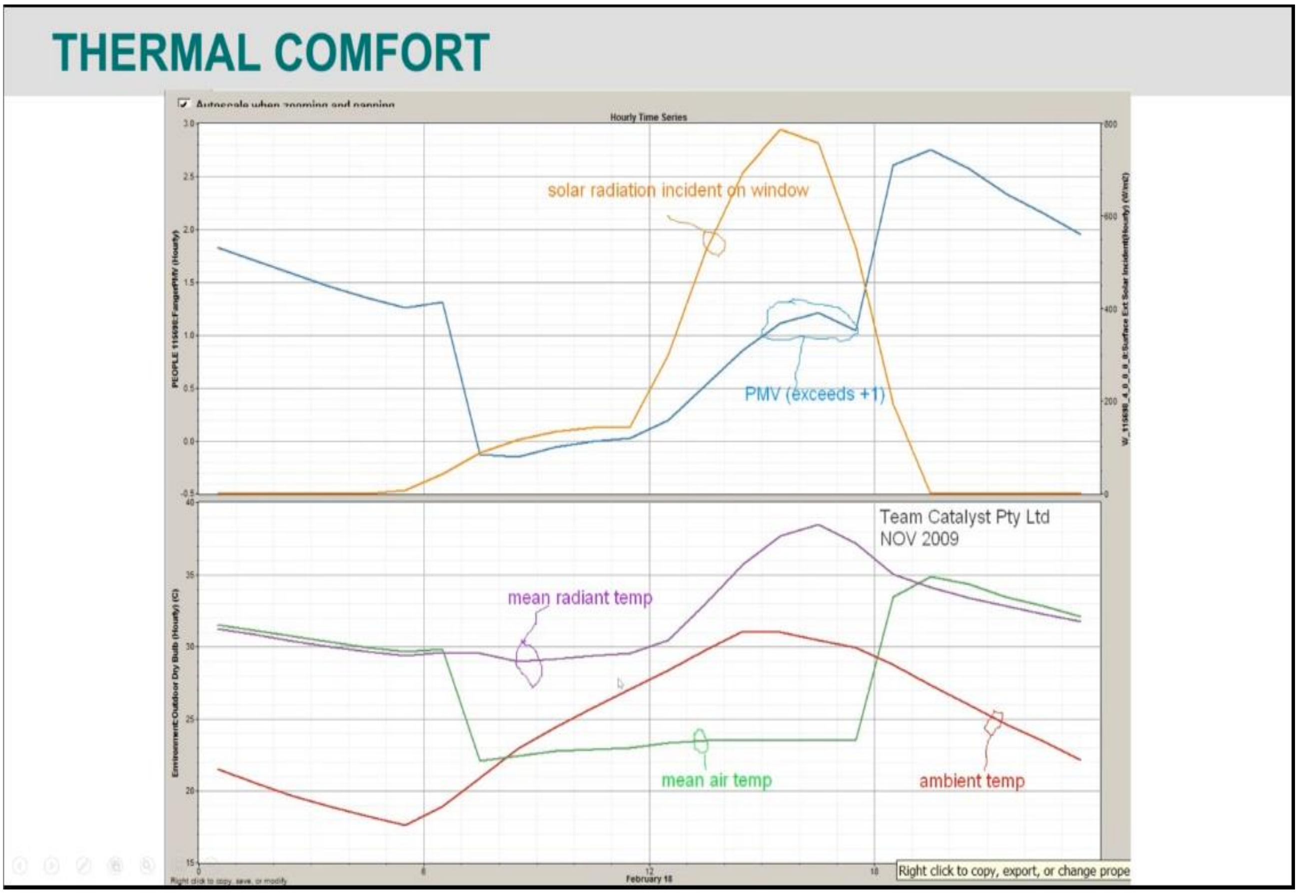
2. "China's building energy conservation development and the software application." by Mengling Wang, Product Manager, Beijing Glory PKPM Technology Co. Ltd. China

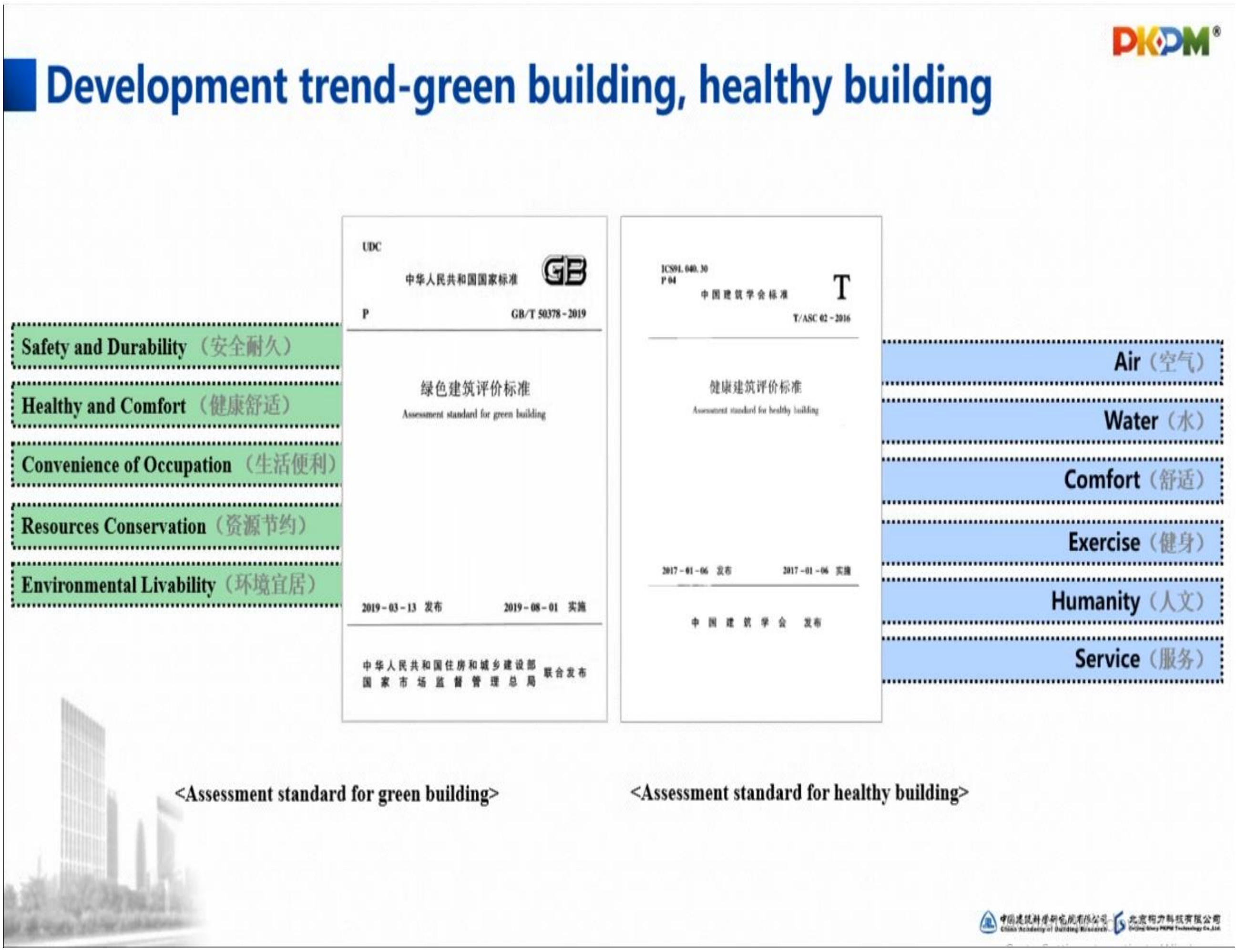

PKPM
Current Situation of China' s Building Energy Consumption
IEA Energy Consumption Structures
Other sectors 64%
Building Sectors 36%
Construction 6%
Operation 30%
other sectors
buidling construction
building operation
China's Energy Consumption Structures
Other Sectors 63%
Buiding Sectors 37%
Construction 14%
Operation 23%
other sectors
buidling construction
building operation
Data from IEA (International Energy Agency)
Data from Tsinghua University

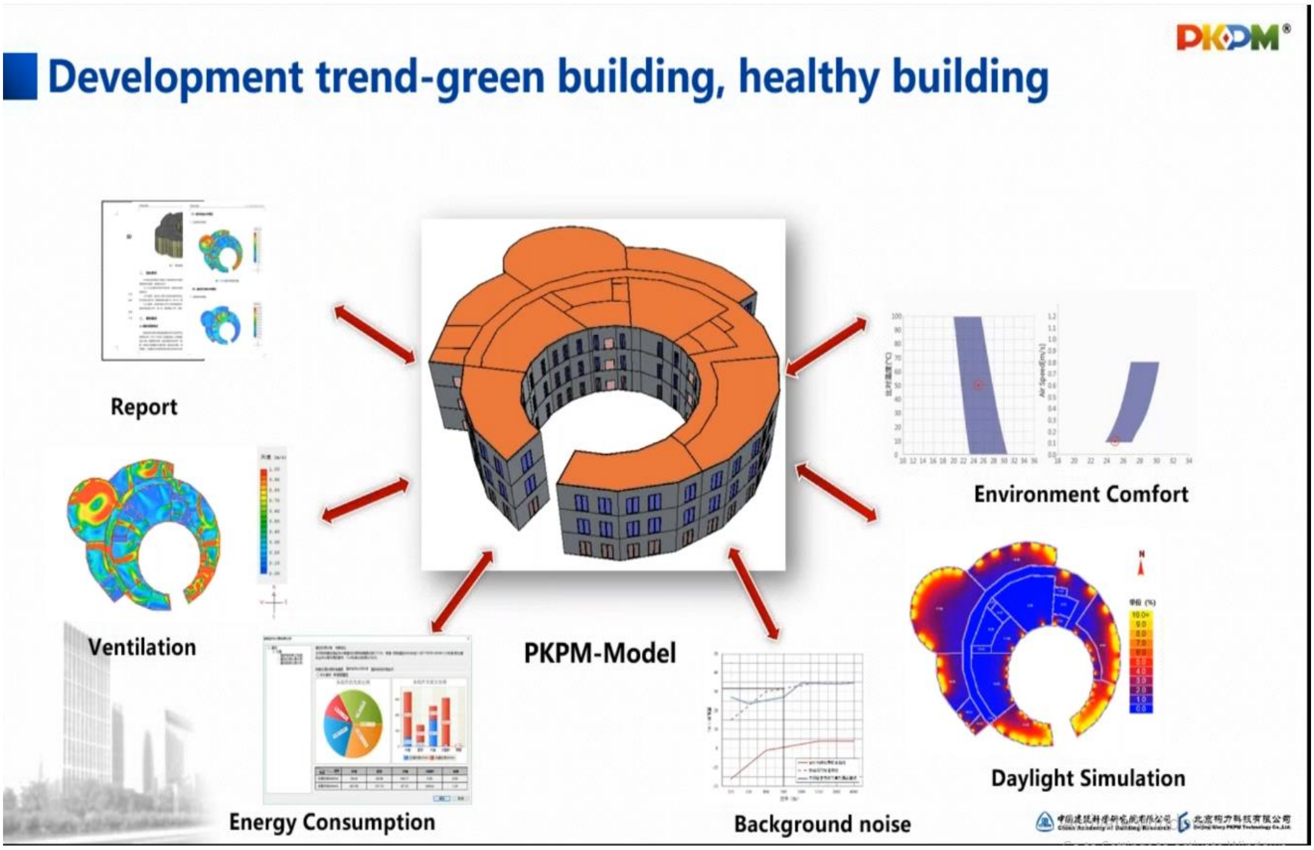

PKPM
About Energy Efficiency Rate (EER)
Building Envelope Load of New design building ≤ Building Envelope Load of Reference building *EER
Requirements of EER (30%, 50%, 65%, 70%, 75%, 80%)
Severe Cold 严寒
Cold 寒冷
Severe Cold 严寒
Severe Cold 严寒
Cold 寒冷
Cold 寒冷
Hot Summer&Cold Winter 夏热冬冷
Temperate 温和
夏热冬暖
民用建筑节能设计标准
公共建筑节能设计标准
夏热冬冷地区居住建筑节能设计标准
夏热冬暖地区居住建筑节能设计标准
Standards, codes in different climate zones


Calculation of EER (EER simulation software)
PKPM
建筑节能系列软件节能设计分析模块
PBECA
能耗分析
空调耗电量
采暖耗电量
1136800
852600
568400
284200
0
耗电量
1136662
697928
1135399
816864
实际建筑
参照建筑
各构件的负荷比例
各构件的负荷

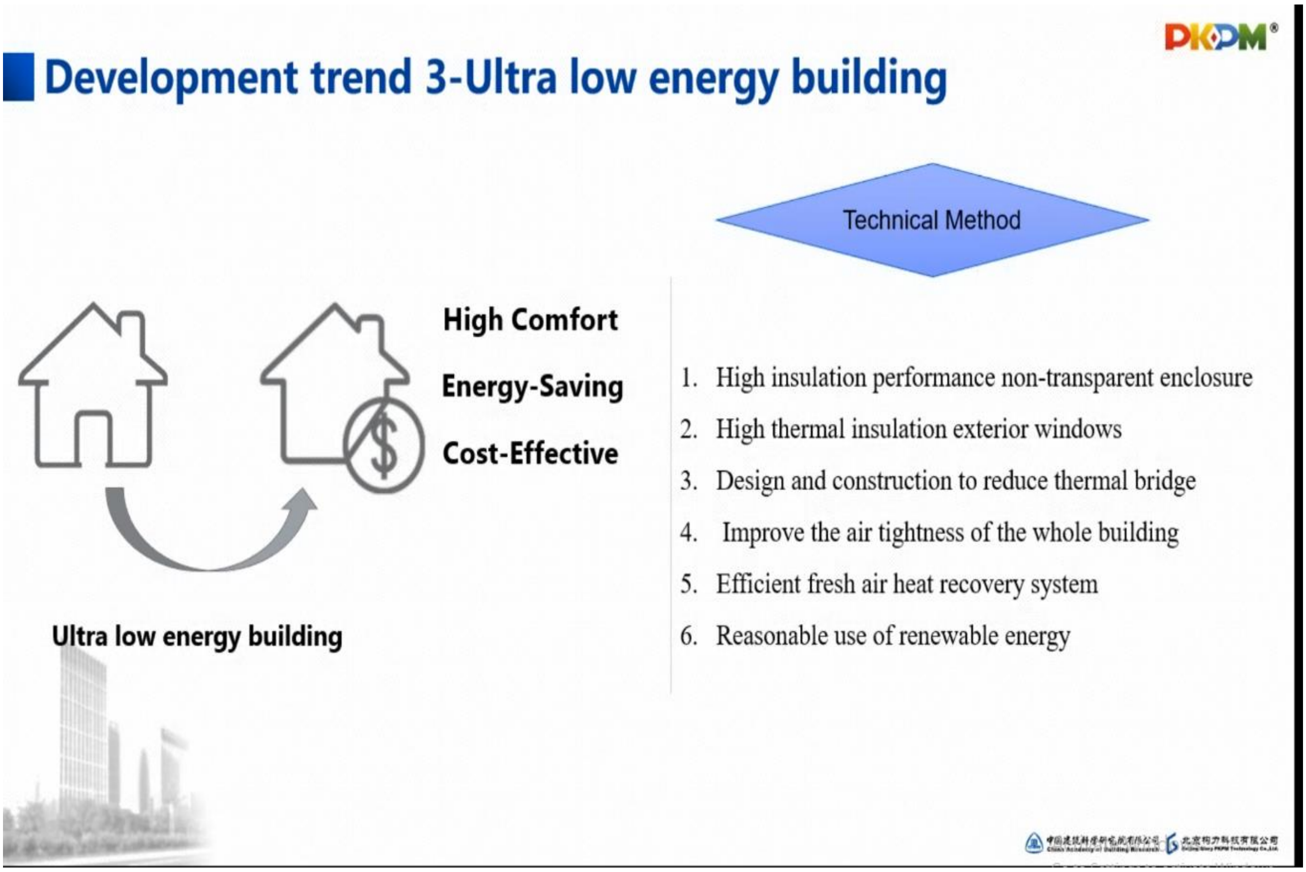

Calculation of EER (EER simulation software)
PKPM
01
DOE-2
Developed by Lawrence Berkeley National Laboratory (LBNL) in the United States.
02
DeST
• Developed by Qinghua University in 1986
• Meteorological data of typical years in China
393 energy related analysis software –according to the US department of energy statistics

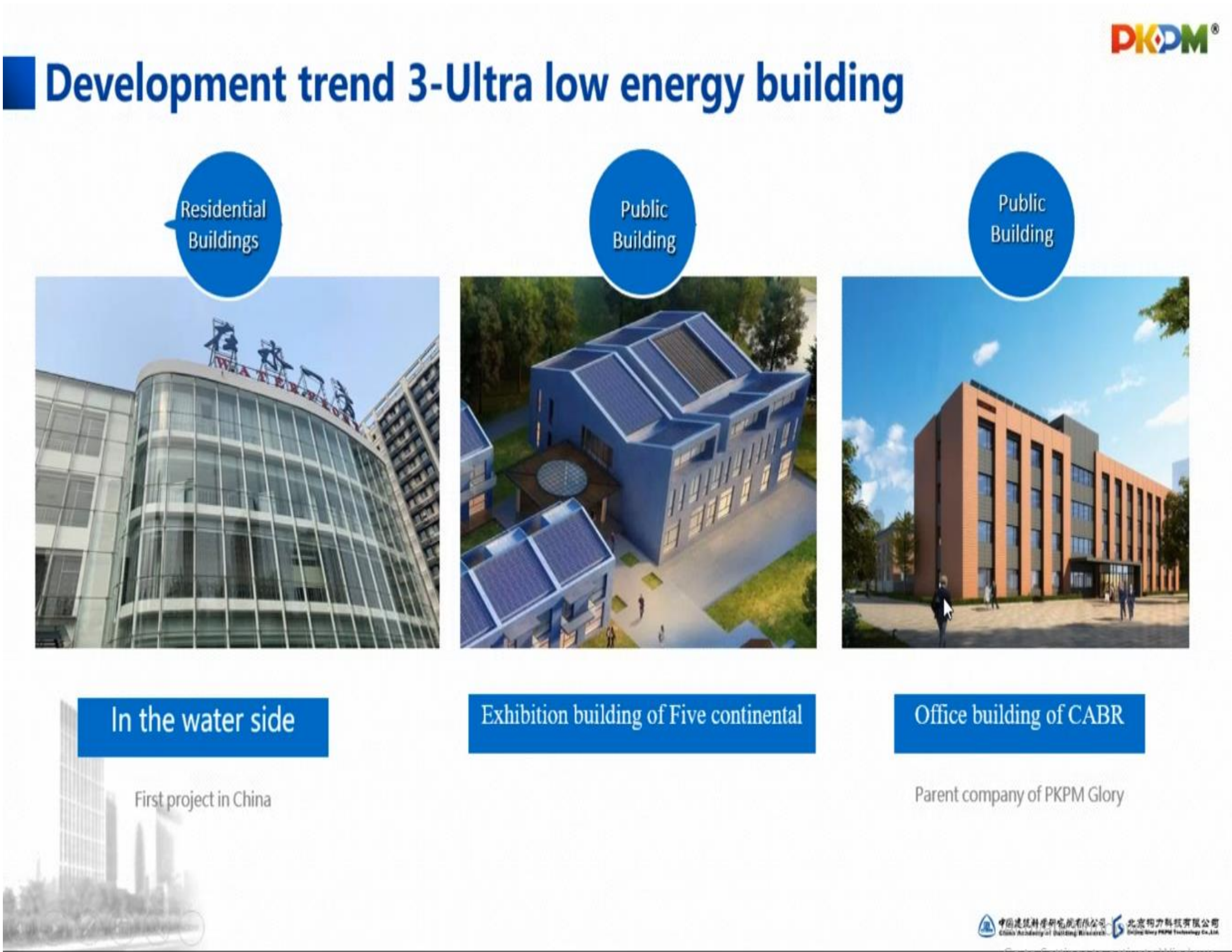

THERMAL COMFORT
Hourly Time Series
solar radiation incident on window
PMV (exceeds +1)
Team Catalyst Pty Ltd
NOV 2009
mean radiant temp
mean air temp
ambient temp
February 18
Right click to copy, export, or change prope


Development trend-green building, healthy building
PKPM
Safety and Durability（安全耐久）
Healthy and Comfort（健康舒适）
Convenience of Occupation（生活便利）
Resources Conservation（资源节约）
Environmental Livability（环境宜居）
中华人民共和国国家标准
GB
GB/T 50378-2019
绿色建筑评价标准
Assessment standard for green building
T
T/ASC 02-2016
健康建筑评价标准
Air（空气）
Water（水）
Comfort（舒适）
Exercise（健身）
Humanity（人文）
Service（服务）
<Assessment standard for green building>
<Assessment standard for healthy building>

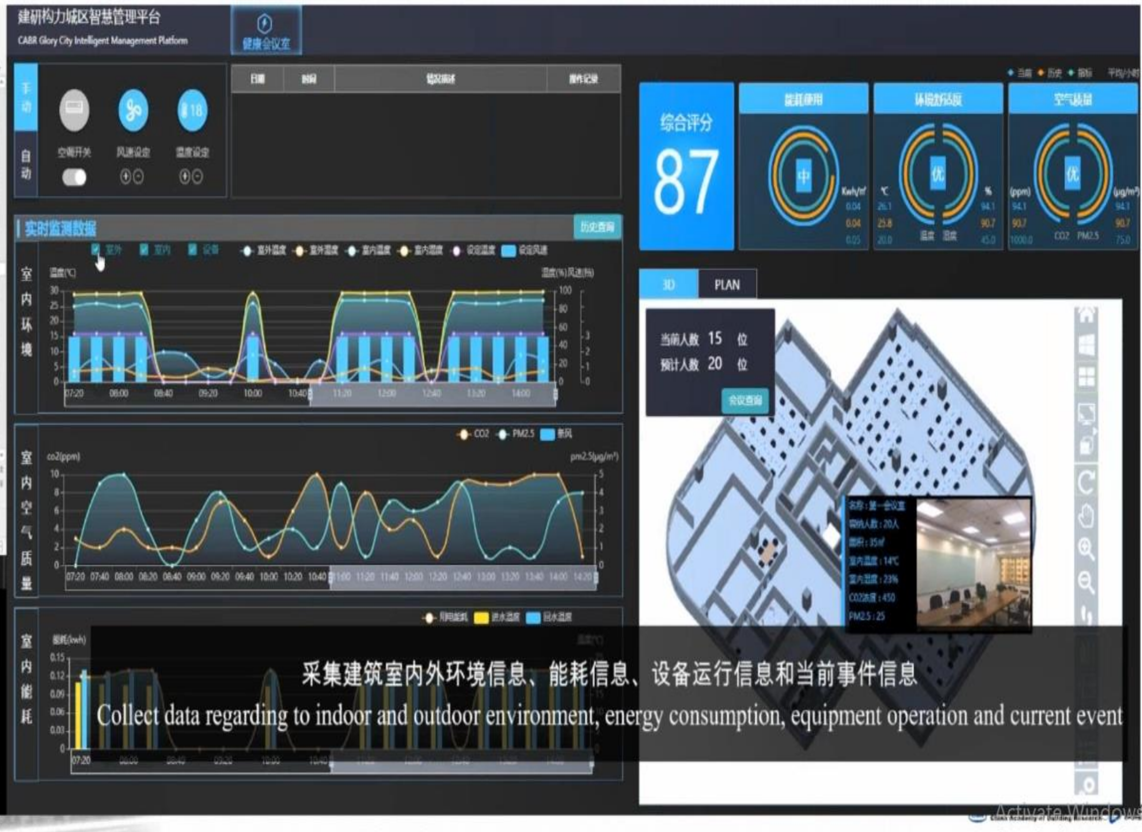

PKPM
Development trend-green building, healthy building
Report
Environment Comfort
Ventilation
PKPM-Model
Daylight Simulation
Energy Consumption
Background noise


PKPM
Development trend 2-green building, healthy building
AutoCAD
Sketchup
Revit
PKPM-BIM


Development trend 3-Ultra low energy building
PKPM
Technical Method
High Comfort
Energy-Saving
Cost-Effective
Ultra low energy building
1. High insulation performance non-transparent enclosure
2. High thermal insulation exterior windows
3. Design and construction to reduce thermal bridge
4. Improve the air tightness of the whole building
5. Efficient fresh air heat recovery system
6. Reasonable use of renewable energy


Development trend 3-Ultra low energy building
PKPM
Residential Buildings
Public Building
Public Building
In the water side
First project in China
Exhibition building of Five continental
Office building of CABR
Parent company of PKPM Glory

Development trend 4-Monitoring system & Submetering technology



Shenzhen Art Museum & Library building

- Location :Shenzhen ,China
- Total Construction Area：137，611m^2
- Design features: curtain wall，grand atrium
- Climate：hot in summer and warm in winter.

-annual average temperature: 22.5°C

-annual average relative humidity 77%

-annual precipitation 1966.5mm

- Code：

<Shenzhen green building assessment standard> SJG47-2018

<Shenzhen public building energy-saving design standard>SJG44-2018

Project Objectives

PKPM®

1、Provide reasonable parameter suggestions for the curtain wall selection;

2、Achieve a 16% less energy consumption comparing with the local mandatory requirements;

3、Improve the indoor environment comfort.

Step1: Hourly Building Load Simulation

PKPM®

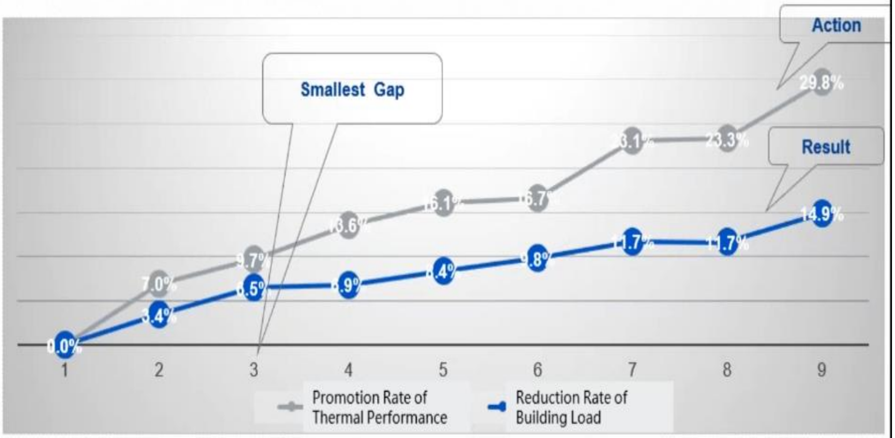
Original Design:

K（heat transfer coefficient)=3.0

Sc（shading Coefficient)=0.31

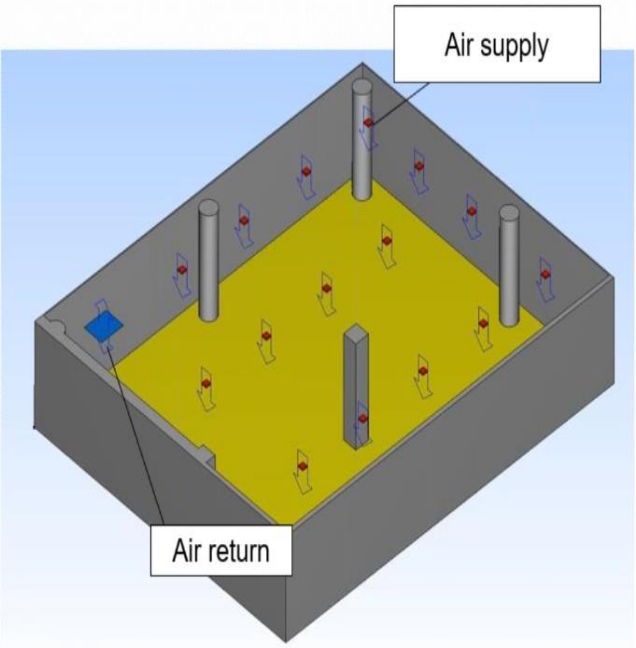
K-value：3.0、2.8、2.6

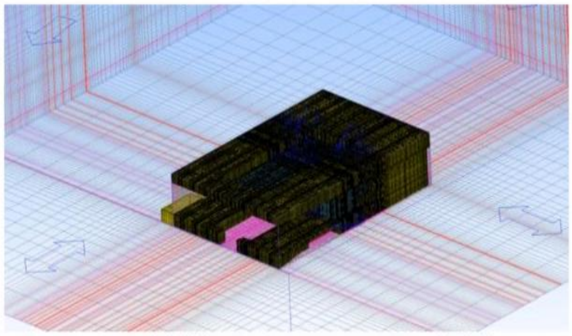
Sc：0.31、0.28、0.26

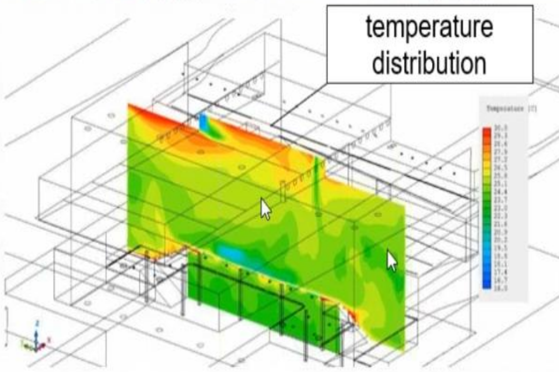


Scenario	Thermal Parameter Combination		Promotion Rate of Thermal Performance	Cooling load		
	K-value	Sc		Cooling load	Increased	Reduction Rate of Building Load
1 (original)	3.0	0.31	0.0%	352259	0	0.0%
2	2.8	0.31	7.0%	340196	12063	3.4%
3	3.0	0.28	9.7%	329373	22886	6.5%
4	2.6	0.31	13.6%	328093	24166	6.9%
5	3.0	0.26	16.1%	322712	29547	8.4%
6	2.8	0.28	16.7%	317772	34487	9.8%
7	2.8	0.26	23.1%	311000	41259	11.7%
8	2.6	0.28	23.3%	311219	41040	11.7%
9	2.6	0.26	29.8%	299725	52534	14.9%

Step2: Thermal Comfort Analysis







- HAVC: *VAV + Fan Coil Unit*
- Cooling and Heating Source: *centrifugal unit, heat pump*

Step2: Thermal Comfort Analysis

Area	Design Parameters			
	Summer		Winter	
	Temperature (℃)	Humidity (%)	Temperature (℃)	Humidity (%)
Atrium	26±2	55±5	18±2	55±5
Library 5th floor	22±2	55±5	18±2	55±5
Library 5th floor (sourthen)	24～26	55±5	18±2	55±5
Library 5th floor (Northen)	24～26	55±5	18±2	55±5
Art Museum	22±2	55±5	18±2	55±5

Library HAVC Suggestions:

1、Main Functional Area（B3-L6）：VAV system

2、Office Area（B1-B5）: Fan Coil

3、EER-6.52,COP=3.4,

Cooling load:1142.8MWH , Heating load=0.81MWH

Art Museum HAVC Suggestions:

1、 Main Functional Area（B3-L4）：VAV system

2、Office Area（B1-B5）: Fan Coil

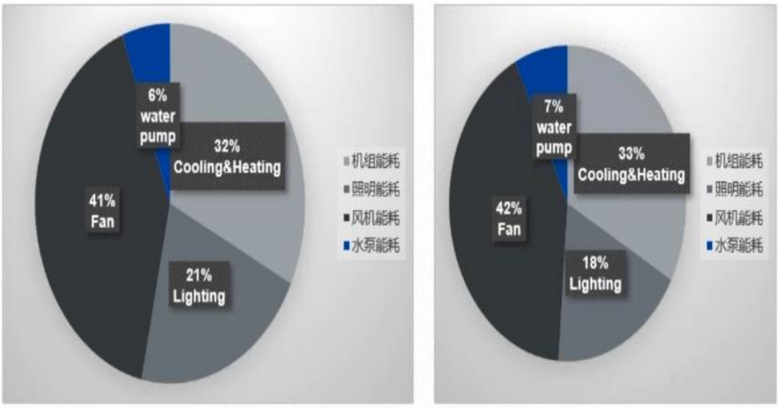
3、VRF system

4、COP: *centrifugal unit/6.52,VRF/4.0, Heating pump/3.4*

Cooling load:4318.13MWH , Heating load=2.65MWH

Step3: Energy Consumption Simulation

Design Building



Reference Building

Energy Consumption	Design Building		Reference Building	
Cooling & Heating equipment (kWh)	E_{1C}	2461881.711	E_{0C}	2994089.485
lighting (kWh)	E_{12E}	1665786.36	E_{02E}	1713550.98
Fan (kWh)	E_{12C}	2397977.53	E_{02C}	3077174.51
Water pump (kWh)	E_{1F}	812263.64	E_{0F}	1106716.3
Annual total energy consumption (kWh)	B_1	7337909.241	B_0	2994089.485
Annual energy consumption per construction area (kWh/㎡)	B1/A	109.87	B0/A	133.12
Reduction rate of energy consumption	17.5%			

Email: wangmenglin@pkpm.com.cn

PKPM Glory

PKPM Greenbuilding

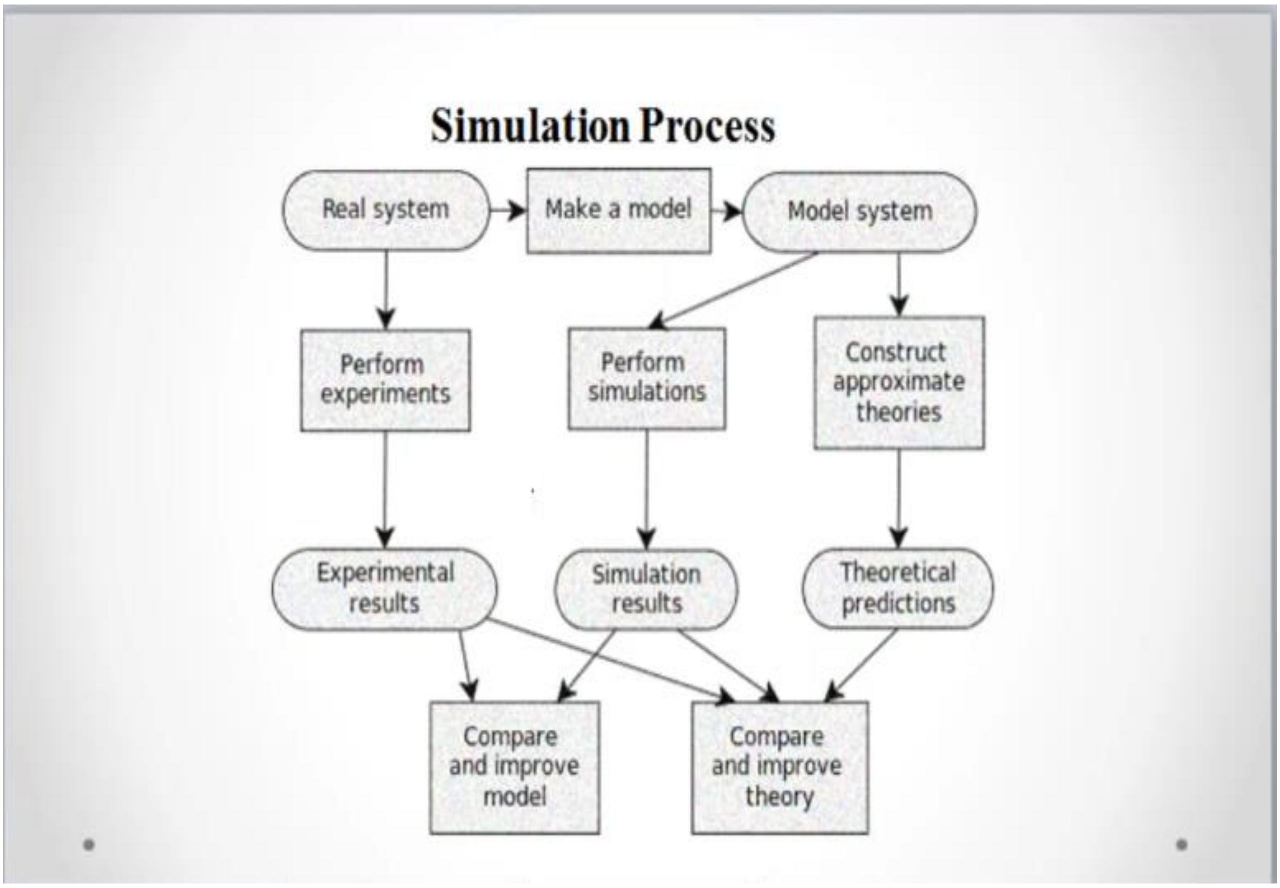
构築未来 力創卓越

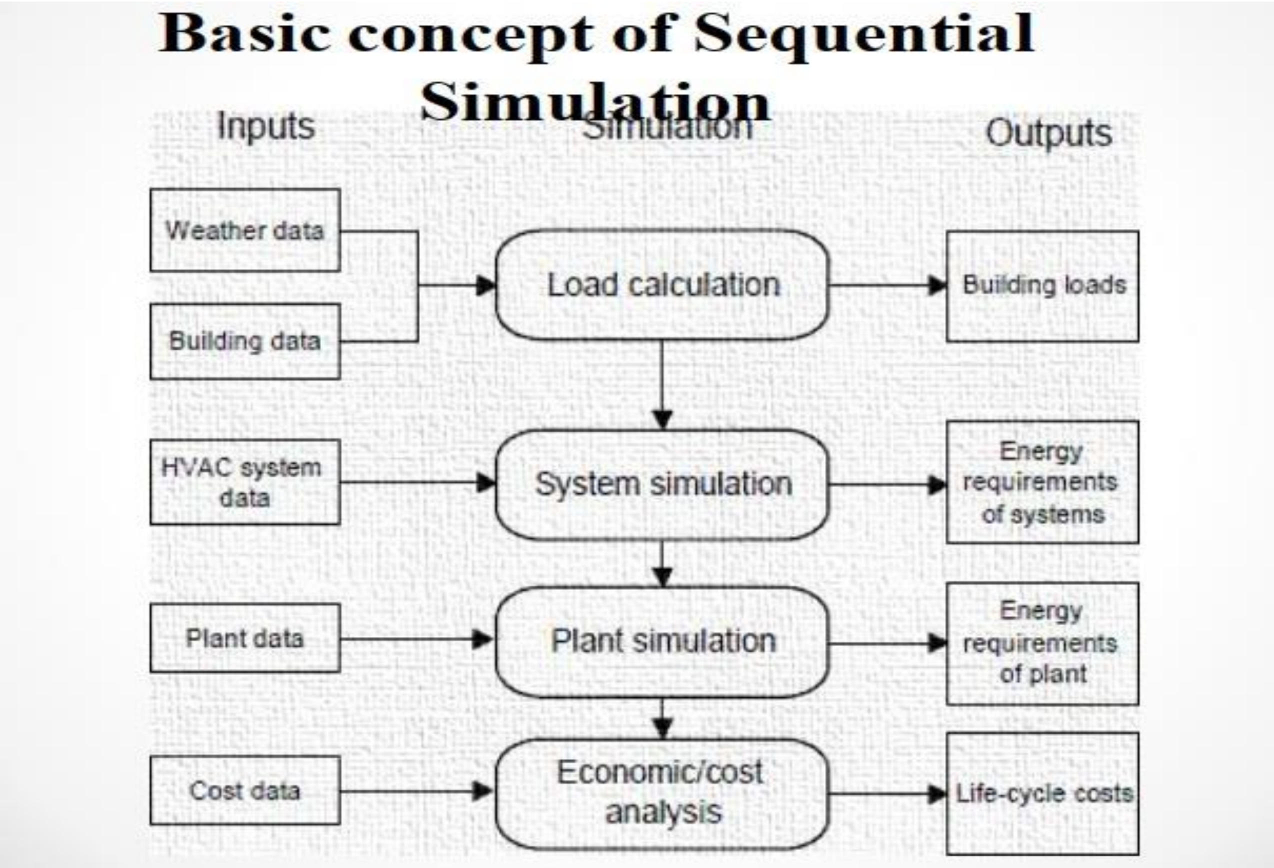
PKPM®

中国建筑科学研究院有限公司 China Academy of Building Research

北京构力科技有限公司 Beijing Glory PKPM Technology Co.,Ltd.

3. **Addressing Building Performance Simulation Challenges By Mr. Asad Mahmood,** National energy efficiency conservation Authority, Pakistan

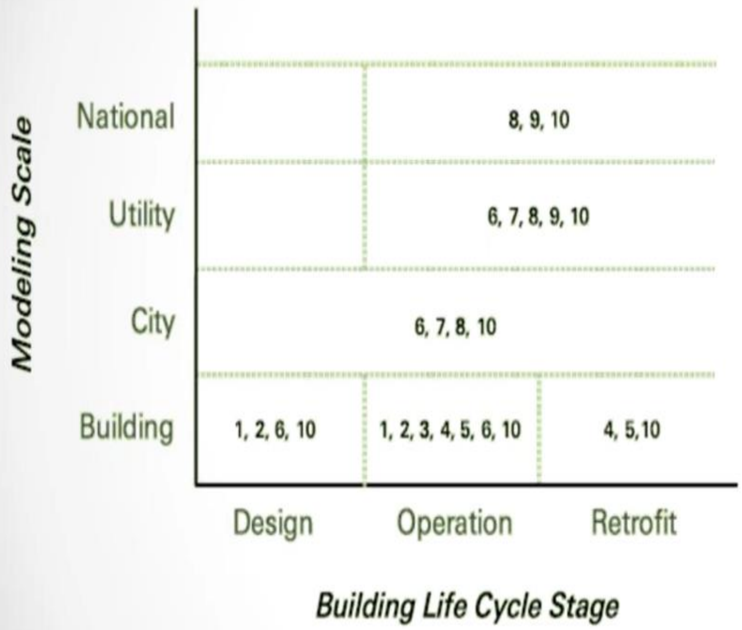




Softwares

- EnergyPlus+OpenStudio+Trimble Sketchup
- Trane TRACE 700
- Carrier HAP
- IES VE
- DesignBuilder
- eQUEST/DOE-2.2
- TRNSYS
- AECOsim Energy Simulator(Bentley)
- Autodesk Insight 360
- Autodesk Revit

- IES VE
- Carrier Hap
- Energy-10
- Solar Shoebox
- System Advisor Model(SAM)



Challenge

1. Addressing the building performance gap
2. Modeling human-building interactions
3. Model calibration
4. Modeling operation, controls and retrofits
5. Modeling operational faults
6. Modeling ZNE and grid-responsive buildings
7. Urban-scale building energy modeling
8. Evaluating national/regional building efficiency potential
9. Modeling building efficiency technology adoption
10. Integrated building performance simulation

The End