Seeing Green | TELUS Garden

Presented by: Goran Ostojic – Integral Group

May 14, 2015

TELUS Garden| Seeing Green

- Office Tower: 520 Georgia Street
    - 22-story tower
    - Commercial retail at street level
    - Four levels underground parking

- Residential Tower: 775 Richards Street
    - 48-story tower on three-story retail podium
    - Eight levels underground parking

- Owner: TELUS
- Developer: Westbank
- Architect: Henriquez Partners

TELUS Garden | North American Trends

- Focus → Lowest Capital Cost
  - Complex building technology
  - Airtight and lightweight envelope
  - Prescriptive energy targets
  - “All-Air” mechanical systems
    - Combined temperature control and ventilation
    - Complex and fast acting controls
- Result → High Energy Use & Operating Cost

TELUS Garden | European Trends

- Focus → Long-Term Performance
  - Passive and integrated technology
  - Massive envelope and operable windows
  - Energy performance target
  - "Hydronic" mechanical systems
  - Temperature control separated from ventilation
  - Simple slow acting controls
  - Stable IEQ
- Result → Low Energy Use & Operating Cost

Thermal Comfort

A condition of mind in which satisfaction is expressed with thermal environment.

Depends on:

- Environmental factors (operative temperature, humidity, air speed)
- Personal Factors (activity level, clothing, state of health, age)

Human comfort:

- 50% Radiation
- 30% Convection
- 20% Evaporation

TELUS Garden | Radiant Heating and Cooling

- Ancient technology over 2,000 years old
- Strictly temperature control function
- “Low-intensity” radiation
  - Cooling: Absorbs heat
  - Heating: Emits heat
- Independent of air temperature

TELUS Garden | Benefits of Radiant Systems

- Superior Thermal Comfort
- Maximum Energy Efficiency
- Independent of Ventilation System
- Low Maintenance Cost
- Easily coupled with low-grade Energy Sources
- Simple Controls

TELUS Garden | Paradigm Shifts: Comfort/IAQ

Original

- Heat with some ventilation
- High windows, local heating

Initial Cooling

- Summer comfort relief
- Cool air, with temperature 15°F below outdoor temperature

Old paradigm: 1950-1970

- Comfort is important

New paradigm: 1970-1990

- Indoor air quality is important

Emerging paradigm

- Productivity is important

Source: ASHRAE 1999-Chapter 2.2

TELUS Garden | Comfort Improves Productivity

- Performance metrics for "productivity" are difficult to define and measure
- Building energy cost ~ $2.00/ft2/year
- Occupants are paid ~$200/ft2/year

- Be careful when saving energy…
  - A 25% savings in energy would be negated by a 0.25% drop in productivity!
  - Productivity costs are 100 times more important

Source: ASHRAE 1999-Chapter 2.2

TELUS Garden| Indoor Air Quality Concerns

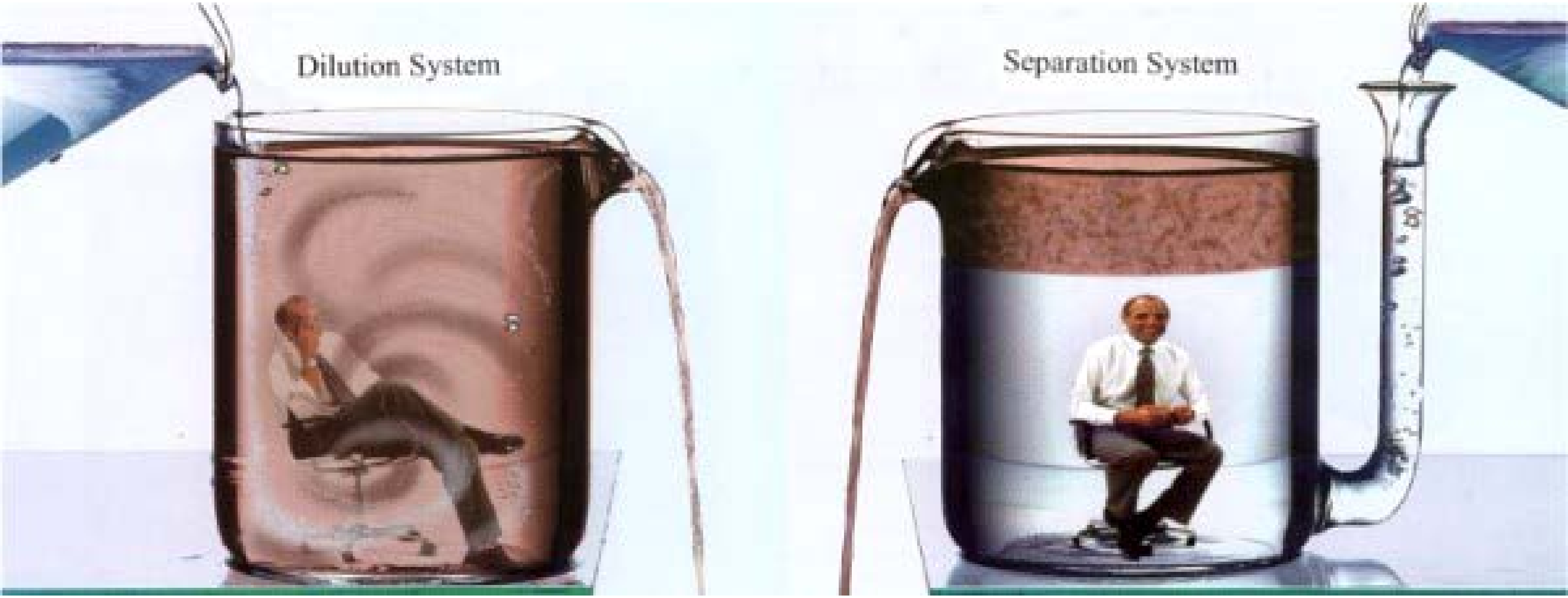
- 30% of commercial buildings have illness associated with them
- Poor indoor air quality → 18% lower productivity
- 150 million person-days/year lost to absenteeism due to poor indoor air quality
- Estimated cost: $8.1 billion → 21¢/sq./year

Source: ASHRAE 1999-Chapter 2.2

TELUS Garden | Displacement Ventilation Benefits

- Superior IAQ
- Max vent. effectiveness – 100% O/A no recirculation
- Absence of noise and draft
- Easily controlled space humidity
- Simple controls
- Minimal air volumes ← ASHRAE 62
- Suitable for efficient heat recovery
- Easily combined with natural ventilation

TELUS Garden | Displacement Ventilation

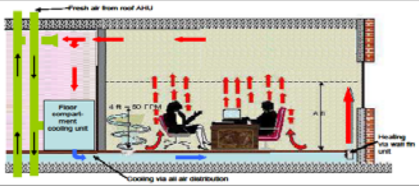
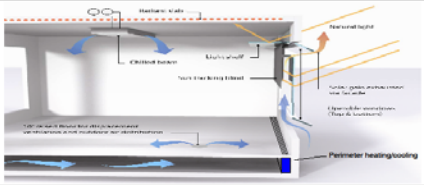
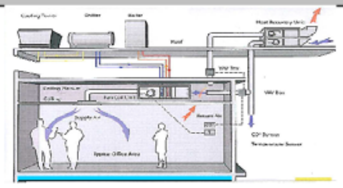


How do we decide which system to use?

- Level of control
- Sustainability
- Acoustics
- Thermal comfort
- Indoor air quality
- System flexibility
- Architectural/Electrical/Structural impact
- Integrated design process

NOTE: There is no "one system fits all"

TELUS Garden | HVAC Comparison Matrix

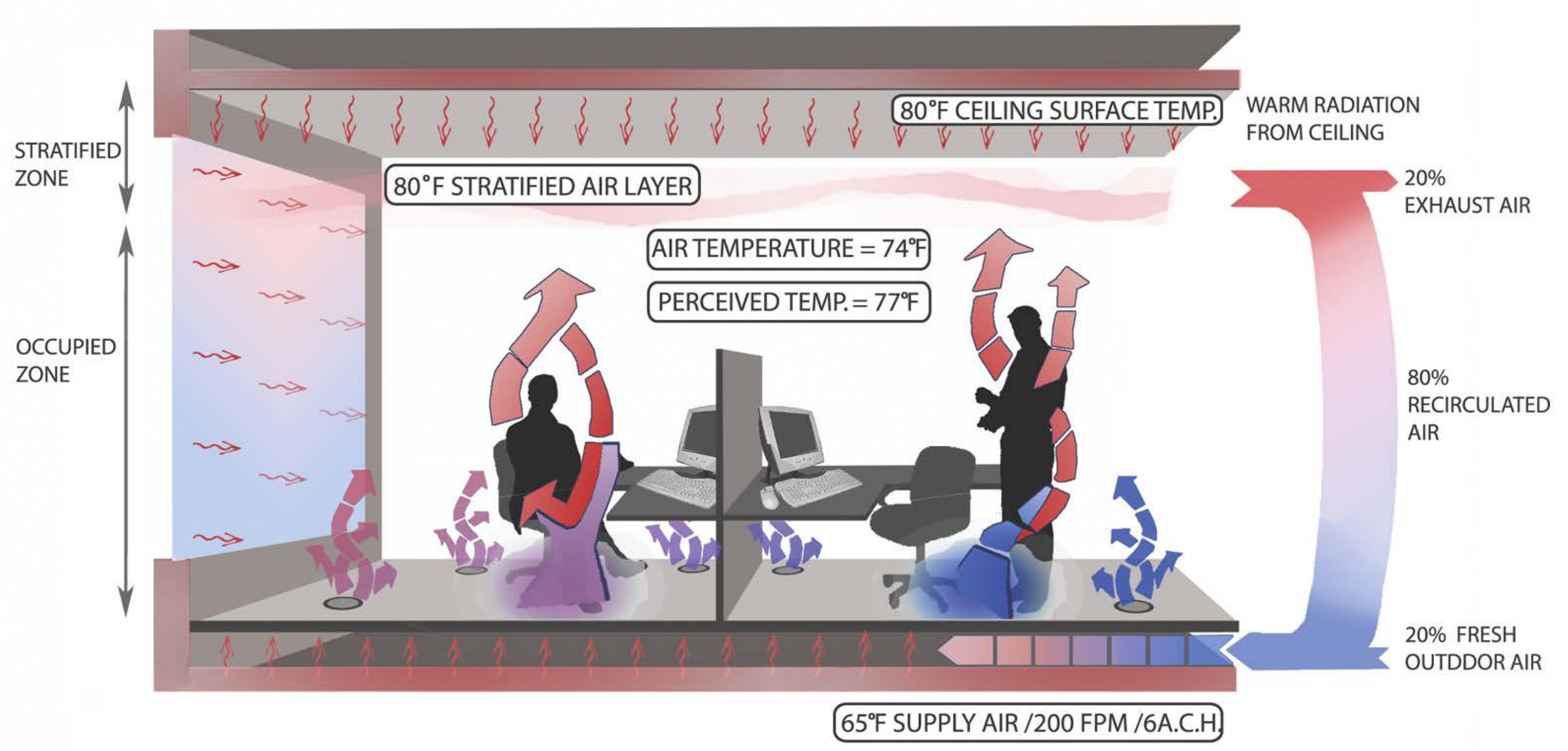
Criteria	Baseline			Alternative 1			Alternative 2		
	Cooling via Underfloor Air Distribution (UFAD) with dedicated ventilation from AHU on roof.			**Underfloor air distribution with displacement ventilation. Radiant slab and chilled beams at ceiling level.**			**Four-pipe Fan-Coils in ceiling. Raised floor used for electrical distribution only.**		
Image									
1. Main Features	Central Plant: High efficiency Ground Source Heat Pumps with Condensing Boilers and Heat Recovery from Existing TELUS Building Zone Distribution: Cooling via Floor Compartment units on every floor with Underfloor Air Distribution. Perimeter wall fin heating units Ventilation: Fresh air ventilation and extract via central AHU's and Floor Compartment Units on each floor. Personalized air vent control.			Central Plant: High efficiency Ground Source Heat Pumps with Condensing Boilers and Heat Recovery from Existing TELUS Building Zone Distribution: Two-pipe chilled beams c/w supplementary heating gives local heating and cooling. Ventilation: Fresh air ventilation and extract via central AHU's c/w heat recovery or HRU's on each floor with demand controlled ventilation by CO2 sensors.			Central Plant: Centrifugal Free Cooling Chillers, Cooling Tower with Condensing Boilers. Zone Distribution: Four-pipe Fan Coil Units for local heating and cooling. Ventilation: Fresh air ventilation and extract via heat recovery units local to each floor. Demand control of outdoor air via CO2 sensors.		
Modification	Fan coils under floor Heat Recovery units under floor			Increased local cooling can be provided by: Chilled Beams Capillary Mats In floor fan coils			Active chilled beams Water cooled VRF		
		Rating	Weight		Rating	Weight		Rating	Weight
2. Thermal Comfort	Higher space temperature fluctuations (in areas exposed to transient loads, e.g. solar radiation); Good air distribution with ducted diffusers; Radiant component of human comfort is ignored. High air flow rates can cause drafts. High fan energy requirement. Radiant component of comfort ignored. Space feels warmer than air temperature.	3		Very good; localized cooling. Radiant component of comfort addressed. Space feels cooler than air temperature. Air temperature can be increased, saving energy.	4		Higher space temperature fluctuations (in areas exposed to transient loads, e.g. solar radiation); Good air distribution with ducted diffusers; Radiant component of human comfort is ignored	2	
3. Indoor Air Quality	Low level ventilation system with medium levels of IAQ. Less fresh air required due to low level supply.	3		Dedicated low level dry air ventilation system with high levels of IAQ. Less fresh air required due to low level supply.	4		Standard overhead ventilation system with standard levels of IAQ	2	
4. Control	Controls simple to maintain and reconfigure; Personalized air vent control	3		Controls simple to maintain and reconfigure; One chilled beam per 25 sqm of area	4		Controls simple in concept but actually complex to install, maintain and reconfigure; Relatively good individual control	2	
5. Flexibility	Very flexible. Floor diffusers and VAV/CAV boxes need to be relocated.	4		Very flexible because of the quantity of chilled beams. Therefore office can usually be configured to avoid moving beams.	4		Very flexible, high level of space versatility. Costly to move fan coils, diffusers and duct work.	2	
6. Acoustics	Acoustic treatment will be required to eliminate noise from Floor Compartment Unit.	2		No local fan noise and low velocity. Only noise is from air nozzles.	4		Noise from central plant cooling equipment and circulating pumps; Low noise from FCUs in occupied space	2	
7. Marketability	Good features. System is more popular in Eastern Canada.	3		New and innovative. Some advanced marketing potential.	4		Traditional system with some good features (high-efficiency condensing boilers and efficient central chiller plant)	2	
8. Ease of Operation	Central plant requires regular maintenance Floor compartment units require regular maintenance	2		Central plant requires regular maintenance Very little maintenance required on floor	3		Central plant requires regular maintenance Fan coils require regular maintenance. Fan coil filters require regular cleaning.	2	
9. Architectural Impacts	Roof-top mechanical room required for central AHU. Risers required through the building for pipes and ventilation ducts. Floor space required on each floor for Floor Compartment Unit. Only standard building envelope performance is required. Less primary air duct distribution. Common shaft can be used for smoke exhaust and exhaust air. Raised floor needs to be air tight to allow good heating and cooling control.	3		High standard building envelope performance is required to avoid perimeter cooling units. If standard building envelope used, supplementary mechanical cooling is required at perimeter. No common floor space required on each floor. Central plant space required on roof (or at two levels, roof and GF) EXTRA FLOOR	4		Larger roof-top mechanical room required (for boilers) and exposed equipment on roof (cooling towers); ceiling space required for horizontal fan coil and ductwork; risers required through the building for pipes; no common floor space required on each floor; Only standard building envelope performance is required. Increased storey height required - may loose a floor.	1	
10. Structural Impacts	Heavy roof loading requires added structural strength. Need to build rooftop mechanical room. Co-ordination with internal structural beams.	3		Heavy roof loading requires added structural strength in penthouse due to AHU's. Can reduce ceiling space required on floor.	3		Heavy roof loading requires added structural strength. Need to build rooftop mechanical room. Co-ordination with internal structural beams.	3	
11. Electrical Impacts	Distributed loads on every floor and penthouse.	2		Reduced electrical installation costs (no electrical distribution needed to indoor units). Lighting requires close coordination due to size of chilled beams.	4		Gas heating results in greatly reduced incoming electrical service; Reduced electrical installation costs.	3	
12. Proof of System	Similar systems in place worldwide.	3		Used extensively in Europe but relatively new in Canada and becoming more popular	3		Similar systems in place worldwide.	4	
13. Local Experience and Representation	Not very popular in BC and Lower Mainland.	3		Used extensively in Europe but relatively new in Canada. Only 2 main manufacturers. More manufacturers are becoming available.	3		Lower Mainland contractors, owners and building operators all familiar with this type of system; local representation.	4	
14. Sustainability and LEED Impact	Moderate energy efficiency results in less possible LEED EAc1 points available.	3		Very good energy efficiency results in more possible LEED EAc1 points available	4		Moderate energy efficiency results in less possible LEED EAc1 points available.	2	
16. Normalized 2011 HVAC Cost per Square Area ($/sqft)	$24	2.0		$22	2		$25	3	
17. a) Example Project	TELUS House, Toronto/RBC			Electronic Arts			Pricewater House		
17 b) Year of Construction	2006			Design Stage			2007		
17 c) Description	- 29 Storey office development - 790,000 sqft			- 20 Storey office development - 500,000 sqft			- 27 Storey Office Development - 400,000 sqft - High End Offices		
18. Average Rating	Good Overall Performance.	2.8		Very Good Overall Performance. Increased building envelope requirements.	3.5		Acceptable overall performance. High capital cost.	2.4	

Rating Scale:

1 = Undesirable or Not Meeting Minimum Standards
2 = Acceptable or Just Meeting Minimum Standards
3 = Desirable or Exceeding Minimum Standards
4 = Highly Desirable or Optimized Solution Achieving Maximum Possible Standards

Cobalt has assigned a rating to every option under every criterion. But not every criterion has equal importance - the client can therefore attribute a weight to each one. The rating for each option is then multiplied by the weight for that criterion to reach the weighted rating. The totals of the weighted ratings for each option than then be compared.

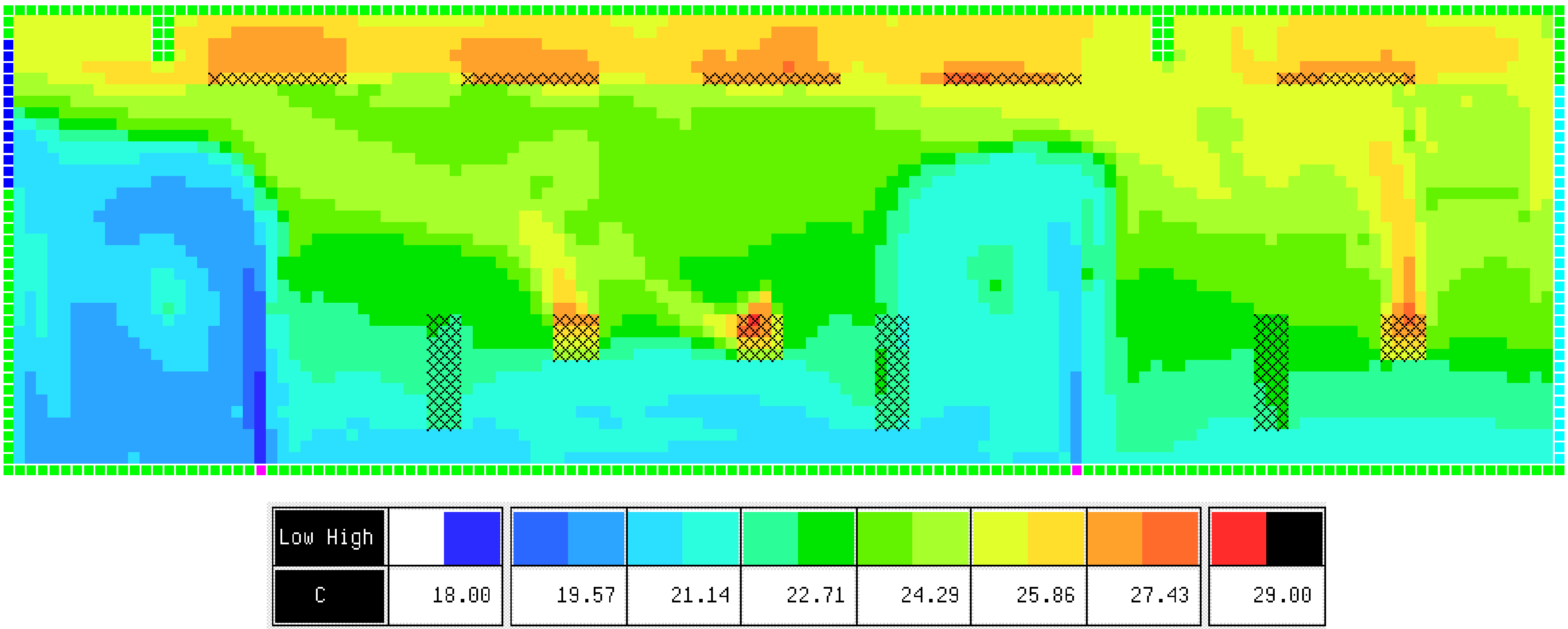
TELUS Garden | All-Air UFAD System



H&C by "Convection" : Q_C = CFM x 1.08 x (T_{RA}-T_{SA})

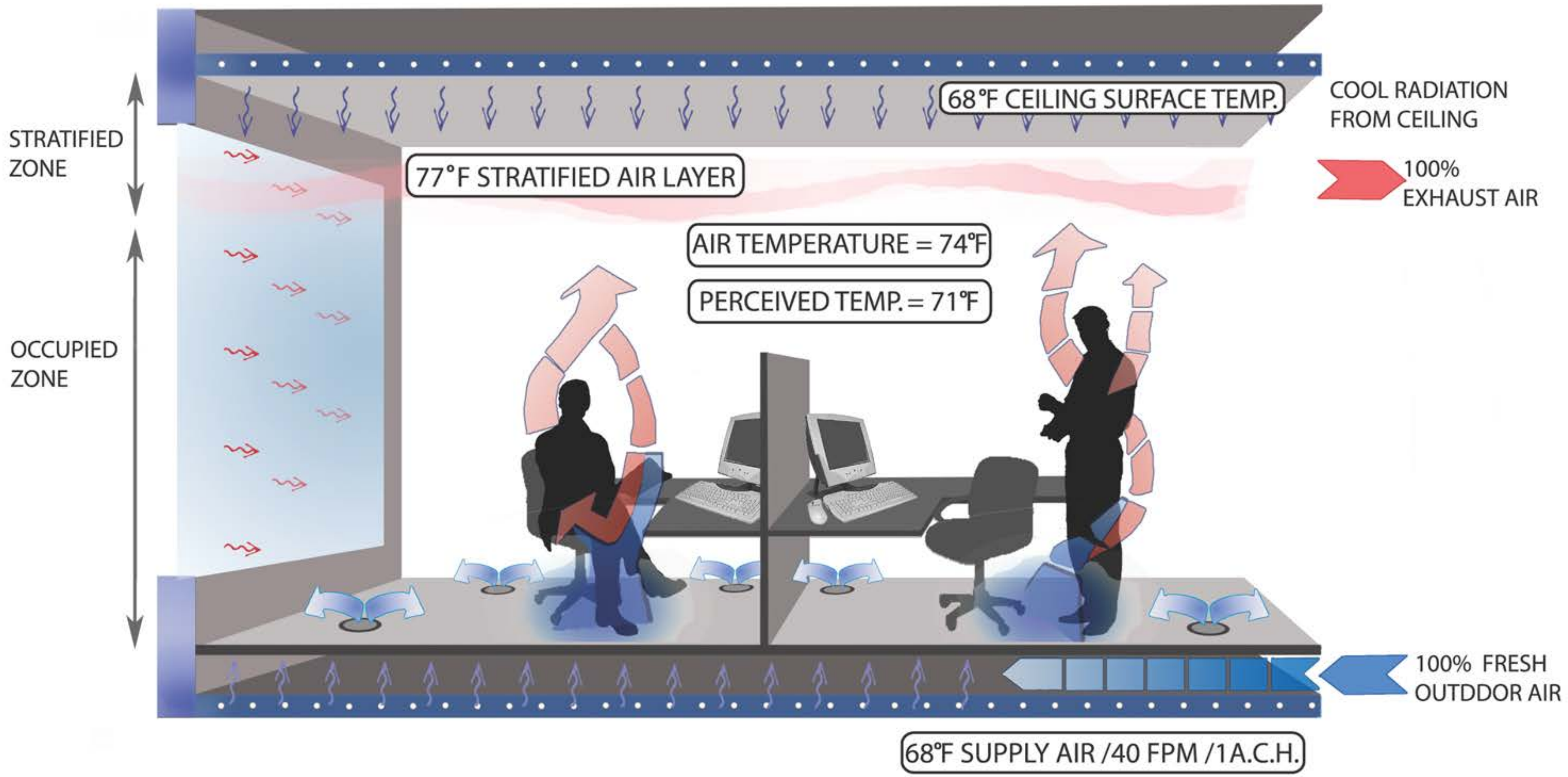
TELUS Garden | CFD Simulation Results

UFAD System – Peak Summer Conditions



"Resultant" Temperatures

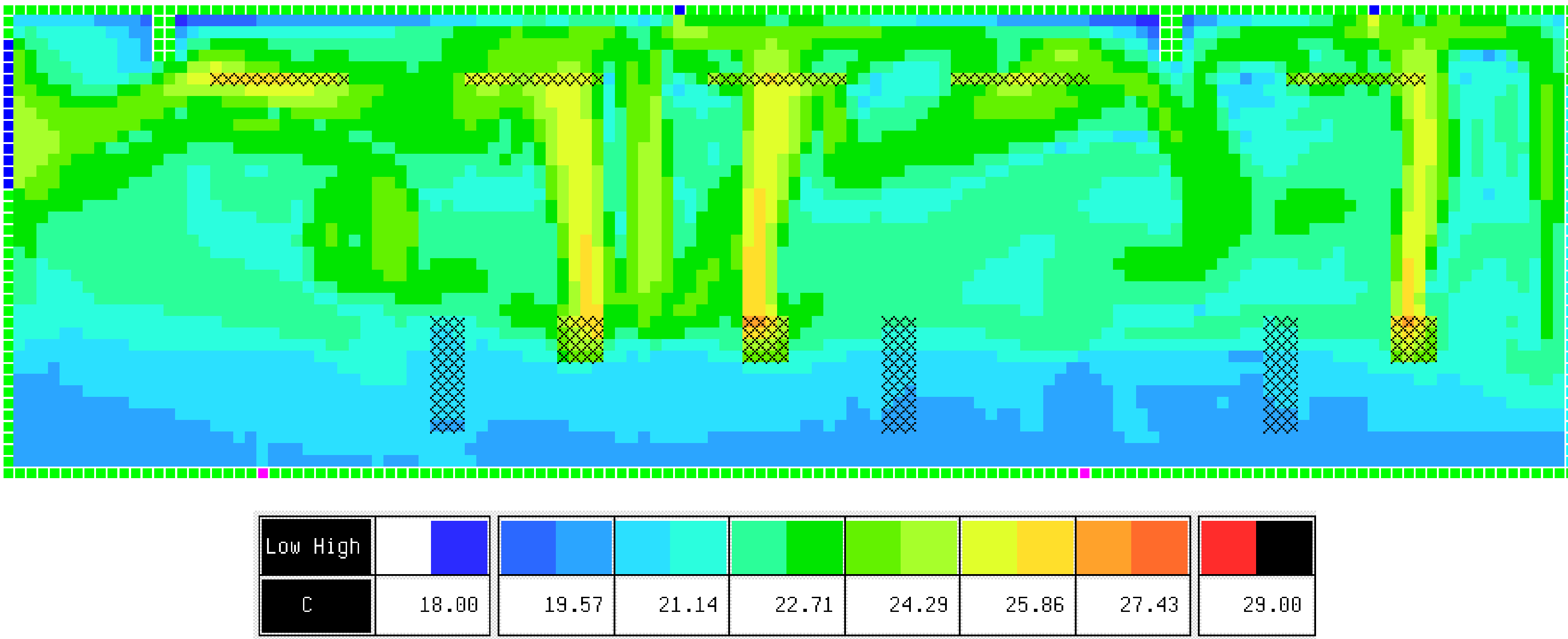
TELUS Garden | Rad. Slab H&C and DV System



H&C by "Radiation & Convection" : $Q_C = A_{CLG} \times h \times (T_{SP}-T_{CLG})^{1.1} + CFM \times 1.08 \times (T_{RA}-T_{SA})$

TELUS Garden | TAS – CFD Simulation Results

EA-II RS & DV System – Peak Summer Conditions



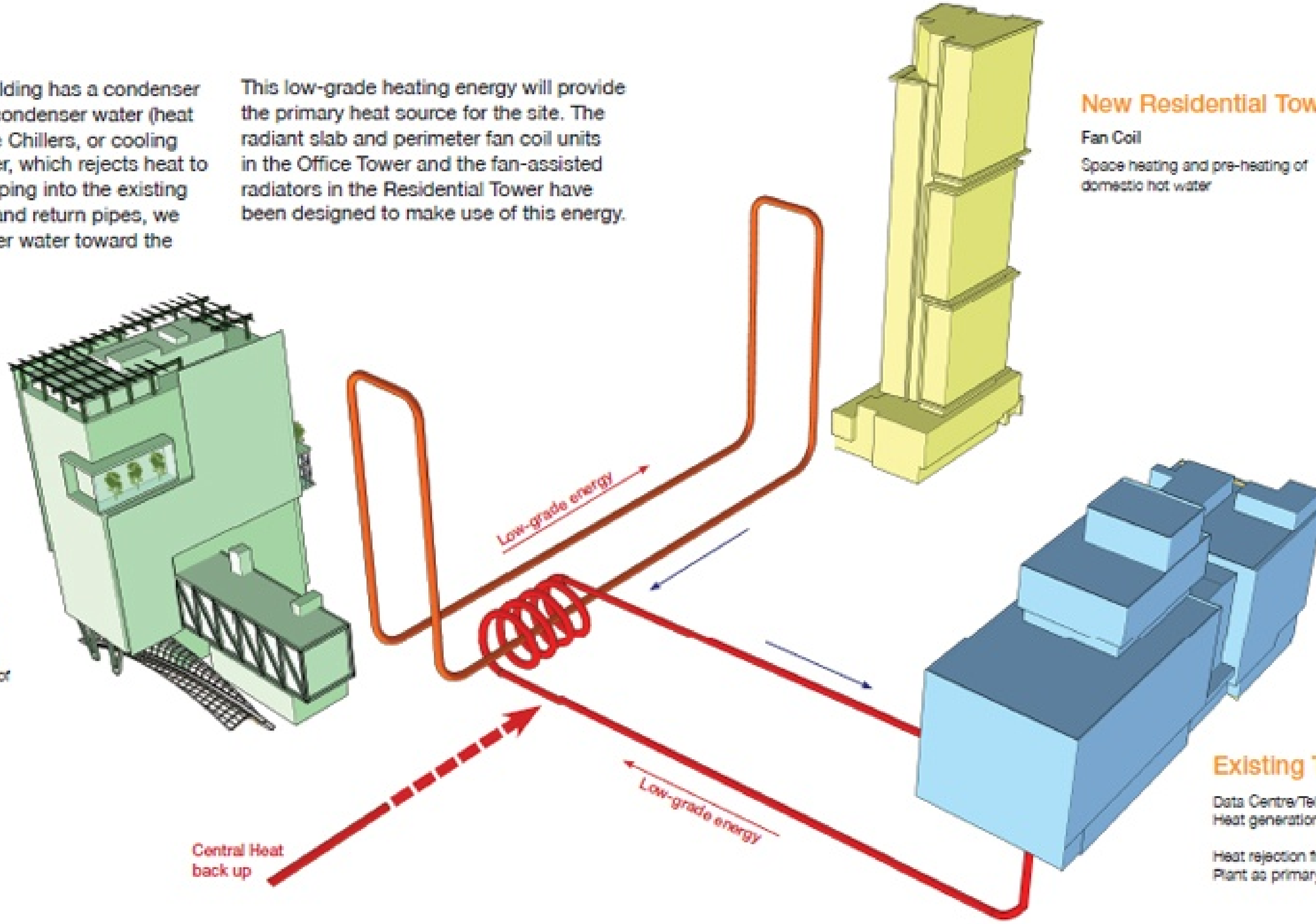
"Resultant" Temperatures

TELUS Garden | Energy Exchange

How It Works

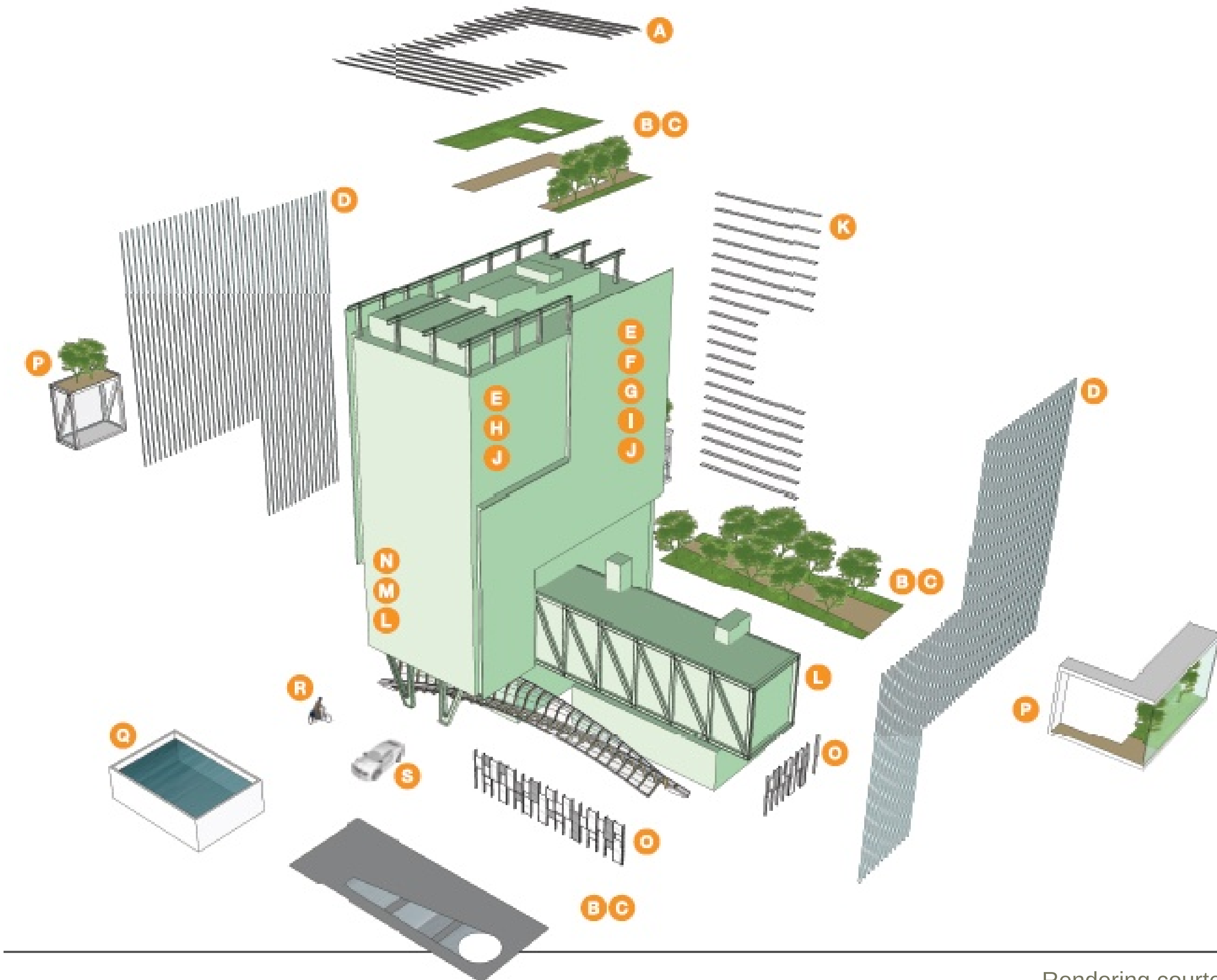
The existing TELUS Building has a condenser loop that transfers the condenser water (heat rejection cycle) from the Chillers, or cooling plant, to the Fluid Cooler, which rejects heat to the atmosphere. By tapping into the existing risers with new supply and return pipes, we will direct that condenser water toward the new heat exchanger.

This low-grade heating energy will provide the primary heat source for the site. The radiant slab and perimeter fan coil units in the Office Tower and the fan-assisted radiators in the Residential Tower have been designed to make use of this energy.



Rendering courtesy of Henriquez Partners Architects

TELUS Garden | Office Tower



- **A** Photovoltaic panels
- **B** Stormwater management
- **C** Rainwater harvesting
- **D** Exterior vertical glass solar shade fins
- **E** High-performance triple-glazed curtain wall
- **F** 70/30 Glass/solid wall ratio
- **G** Fritted glass
- **H** 80/20 Glass/solid wall ratio
- **I** Operable windows (natural ventilation)
- **J** Interior automated shading system
- **K** Exterior horizontal aluminum solar shades
- **L** Concrete and steel with recycled content
- **M** High-efficiency heating and cooling with hydronic radiant floor (heavy mass) and fan coils
- **N** Demand control and displacement ventilation
- **O** 50/50 Glass/solid wall ratio
- **P** Sky Gardens—preheat of ventilation air
- **Q** Cistern for non-potable water
- **R** End-of-trip facilities
- **S** Electric car charging station (3%)
- **T** Exhaust air heat recovery

Rendering courtesy of Henriquez Partners Architects

TELUS Garden | Office Tower

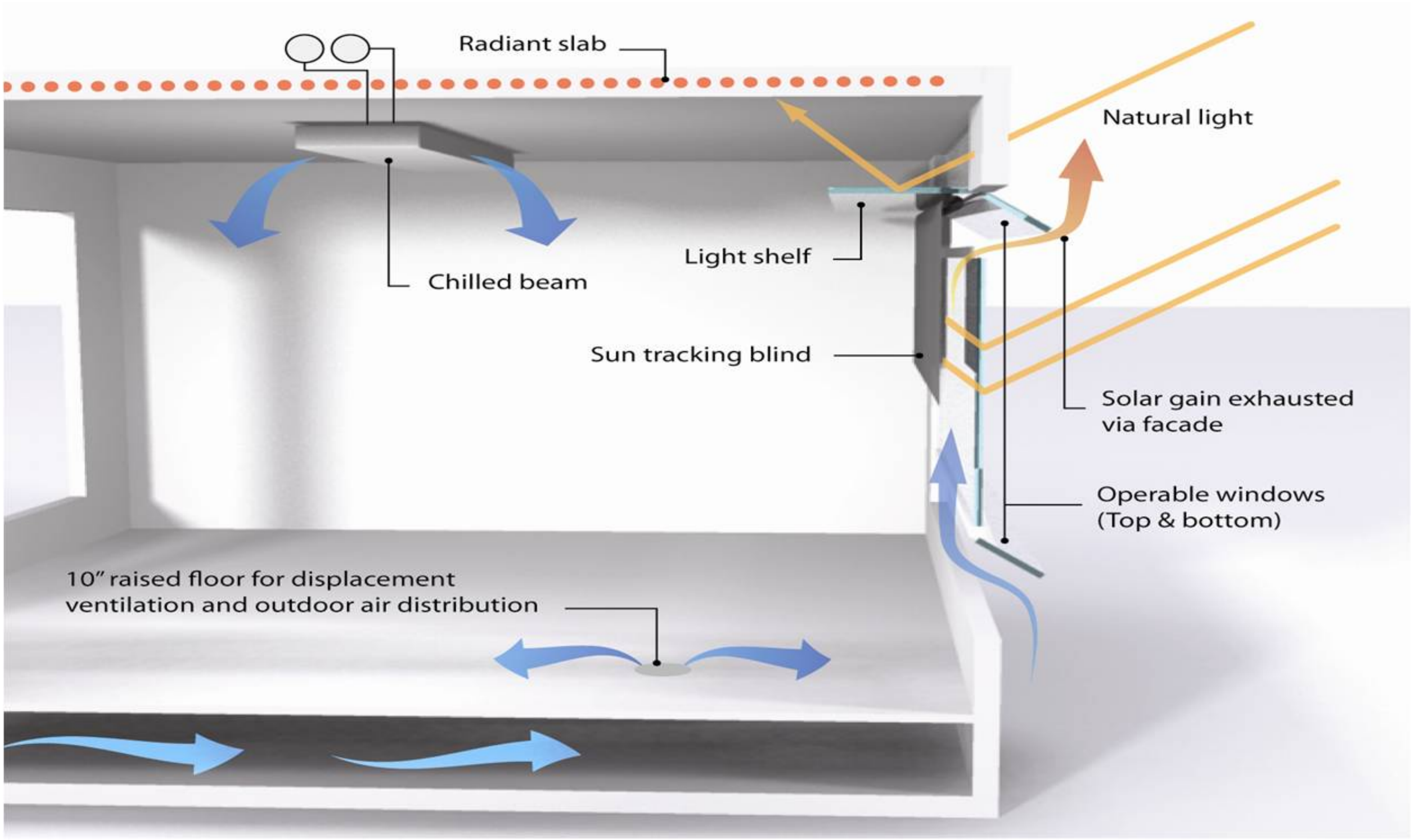
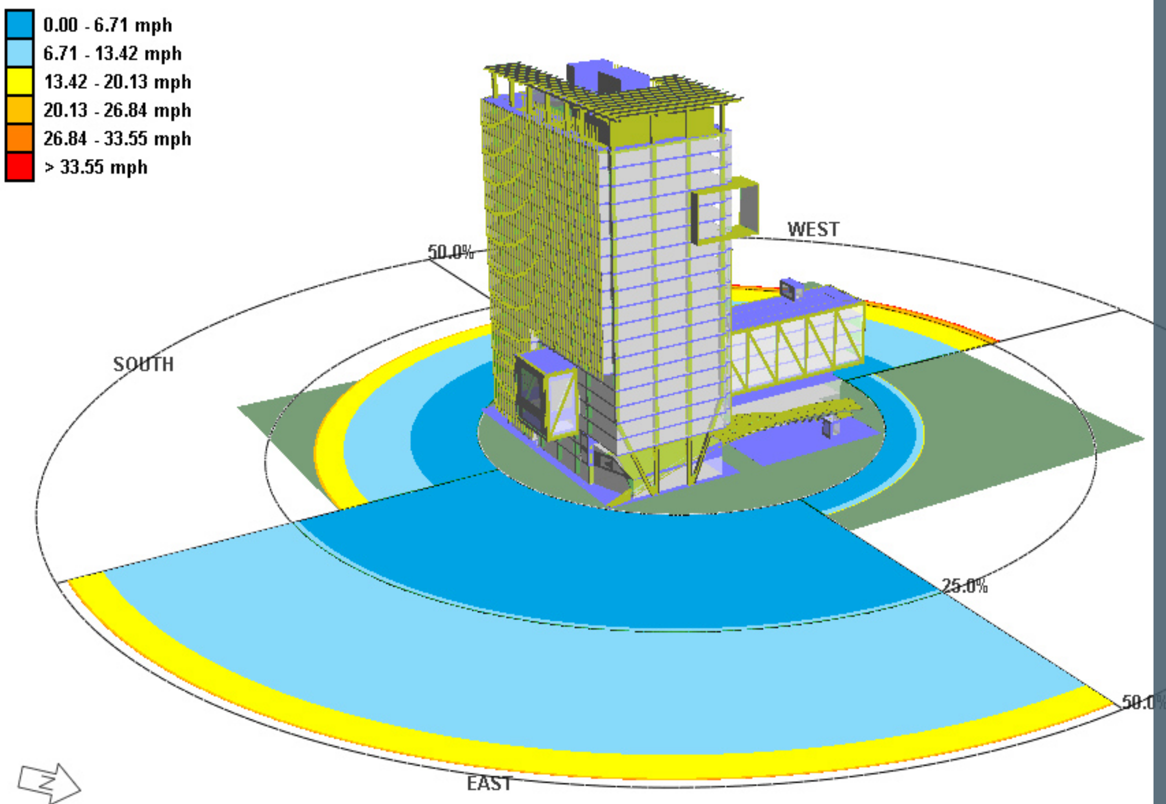


Illustration by Integral Group

TELUS Garden | Office Energy Modeling



Energy Modeling Design by Integral Group

Energy Saving Measures

- Waste heat recovery from the adjacent existing data center
- Triple Glazing System
- Demand Control Ventilation
- Displacement Ventilation
- Exhaust Air Heat Recovery
- Radiant Slab Heating and Cooling System
- Reduce Lighting Power Density
- Occupancy Sensors and Daylight Control
- Low Consumption Plumbing Fixtures
- Photovoltaic Panels for Renewable Energy

TELUS Garden | LEED Energy Point Estimator

	HEATING & COOLING			ENVELOPE			LIGHTING		WATER EFFICIENCY	GREENING	
	Mechanical System	Energy Source	Plant & Heat Recovery	Solar Shading	Glazing Ratio	Thermal Resistance	Control	Power Density			LEED Scale
PLATINUM	☐ Radiant heating and cooling w/ natural vent.	☐ Alternate energy source such as solar, geothermal, sewer, biomass, waste heat recovery, etc.	☐ High efficiency plant with ventilation heat recovery	☐ Double skin or External shading on South and West glazing w/ triple glaze	☐ Glazing ratio 50% or below	☐ U-values reduced by 25% over ASHRAE 90.1-2007	☐ Integrated control system using daylight sensors occupancy sensors and scheduling	☐ 25% or more reduction in lighting intensity over the baseline	☐ Rainwater harvesting for irrigation and toilet flushing and low flow plumbing fixtures	☐ Measure-ment & verification ☐ Tenant sub metering ☐ Green power ☐ FSC Wood Light/ ventiation tube ☐ Green education	80-100 Points
GOLD	☐ Variable Refrigerant Flow (VRF) or 4 pipe fan coil	☐ Partial offset using alternate energy sources (<10%)	☐ Standard efficiency plant with heat recovery	☐ Partial external shading on South and West glazing	☐ Glazing ratio between 50% and 60%	☐ U-values per ASHRAE 90.1-2007	☐ Occupancy sensors and scheduling	☐ 10-25% reduction in lighting intensity over the baseline	☐ low flow plumbing fixtures and rainwater harvesting for irrigation	☐ Measure-ment & verification ☐ Green education	60-79 Points
SILVER	☐ Four-pipe fan coil or Water based heat pump	☐ Electricity or natural gas	☐ Standard efficiency plant without heat recovery	☐ Aesthetic or no external shading, or internal shading	☐ Glazing ratio over 60%	☐ U-values per ASHRAE 90.1-2004	☐ Simple on/off controls	☐ Lighting intensity per ASHRAE 90.1-2007	☐ Low flow plumbing fixtures		50-59 Points

TELUS Garden | LEED Platinum Score Card

LEED Canada-CS 2009 Project Checklist

Project Name - Target: LEED Platinum
CaGBC Registration #: 14256

INTEGRAL GROUP

Issued: 5/14/2015

Targeted	High Potential	Low Potential	NO			
84	10	10	7	**Project Totals** (pre-certification estimates)		110 Possible Points

Certified 40-49 points **Silver** 50-59 points **Gold** 60-79 points **Platinum** 80 points and above

Targeted	High Potential	Low Potential	NO			Points
26	1	1		**Sustainable Sites**		28 Points
				Prereq 1	Construction Activity Pollution Prevention	Required
1				Credit 1	Site Selection	1
5				Credit 2	Development Density and Community Connectivity	3, 5
	1			Credit 3	Brownfield Redevelopment	1
6				Credit 4.1	Alternative Transportation: Public Transportation Access	3, 6
2				Credit 4.2	Alternative Transportation: Bicycle Storage & Changing Rooms	2
3				Credit 4.3	Alternative Transportation: Low-Emitting & Fuel-Efficient Vehicles	3
2				Credit 4.4	Alternative Transportation: Parking Capacity	2
1				Credit 5.1	Site Development: Protect and Restore habitat	1
1				Credit 5.2	Site Development: Maximize Open Space	1
1				Credit 6.1	Stormwater Design: Quantity Control	1
1				Credit 6.2	Stormwater Design: Quality Control	1
1				Credit 7.1	Heat Island Effect: Non-Roof	1
1				Credit 7.2	Heat Island Effect: Roof	1
		1		Credit 8	Light Pollution Reduction	1
1				Credit 9	Tenant Design and Construction Guidelines	1

Targeted	High Potential	Low Potential	NO			Points
10				**Water Efficiency**		10 Points
				Prereq 1	Water Use Reduction	Required
4				Credit 1	Water Efficient Landscaping	2, 4
2				Credit 2	Innovative Wastewater Technologies	2
4				Credit 3	Water Use Reduction	2 - 4

Targeted	High Potential	Low Potential	NO			Points
20	8	10		**Energy & Atmosphere**		37 Points
				Prereq 1	Fundamental Commissioning of Building Energy Systems	Required
				Prereq 2	Minimum Energy Performance	Required
				Prereq 3	Fundamental Refrigerant Management	Required
10	4	8		Credit 1	Optimize Energy Performance	3 - 21
	2	2		Credit 2	On-Site Renewable Energy	2, 4
2				Credit 3	Enhanced Commissioning	2
2				Credit 4	Enhanced Refrigerant Management	2
3				Credit 5.1	Measurement and Verification: Base Building	3
3				Credit 5.2	Measurement and Verification: Tenant Submetering	3
	2			Credit 6	Green Power	2

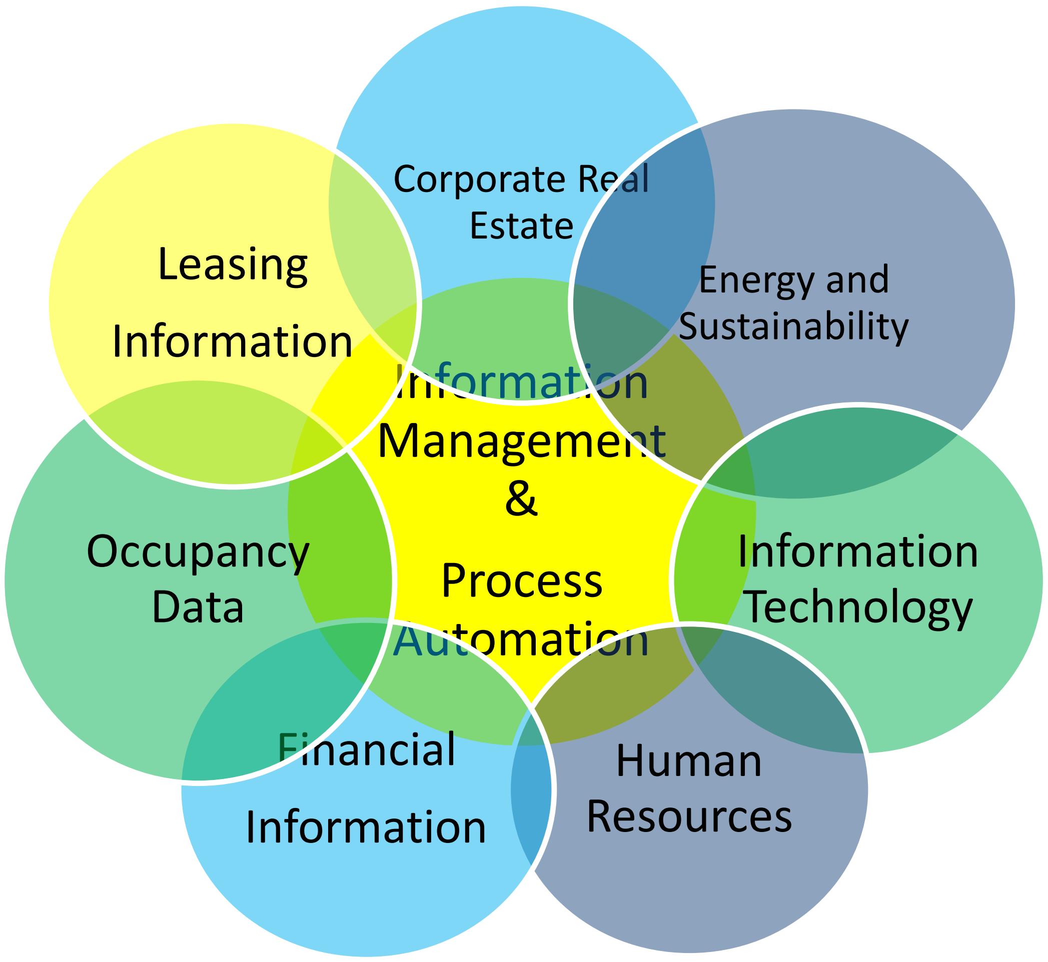
Targeted	High Potential	Low Potential	NO			Points
6	1		6	**Materials & Resources**		13 Points
				Prereq 1	Storage and Collection of Recyclables	Required
			5	Credit 1	Building Reuse: Maintain Existing Walls, Floors, and Roof	1 - 5
2				Credit 2	Construction Waste Management	1 - 2
			1	Credit 3	Materials Reuse	1
2				Credit 4	Recycled Content	1 - 2
1	1			Credit 5	Regional Materials	1 - 2
1				Credit 6	Certified Wood	1

Targeted	High Potential	Low Potential	NO			Points
12				**Indoor Environmental Quality**		12 Points
				Prereq 1	Minimum Indoor Air Quality Performance	Required
				Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
1				Credit 1	Outdoor Air Delivery Monitoring	1
1				Credit 2	Increased Ventilation	1
1				Credit 3	Construction IAQ Management Plan: During Construction	1
1				Credit 4.1	Low-Emitting Materials: Adhesives and Sealants	1
1				Credit 4.2	Low-Emitting Materials: Paints and Coatings	1
1				Credit 4.3	Low-Emitting Materials: Flooring Systems	1
1				Credit 4.4	Low-Emitting Materials: Composite Wood and Agrifibre Products	1
1				Credit 5	Indoor Chemical and Pollutant Source Control	1
1				Credit 6	Controllability of System: Thermal Comfort	1
1				Credit 7	Thermal Comfort: Design	1
1				Credit 8.1	Daylight and Views: Daylight	1
1				Credit 8.2	Daylight and Views: Views	1

Targeted	High Potential	Low Potential	NO			Points
6				**Innovation in Design**		6 Points
1				Credit 1.1	Exemplary Performance	1
1				Credit 1.2	Exemplary Performance	1
1				Credit 1.3	Exemplary performance	1
1				Credit 1.4	Innovation in Design: Green Building Education Program	1
1				Credit 1.5	Innovation in Design: Green Housekeeping	1
1				Credit 2	LEED® Accredited Professional	1

Targeted	High Potential	Low Potential	NO			Points
4				**Regional Priority**		4 Points
1				Credit 1	Durable Building	1
1				Credit 2.1	Regional Priority Credit: SSc2 Project Density and Community Conne	1
1				Credit 2.2	Regional Priority Credit: WEc3 Water Use Reduction	1
1				Credit 2.3	Regional Priority Credit: MRc2 Construction Waste Management	1

TELUS Garden | Smart Building & Information



TELUS Garden | The Challenge

- Multiple control networks
- Sup-optimal information
- Lower performing

TELUS Garden | Technology

Complex **Simple**

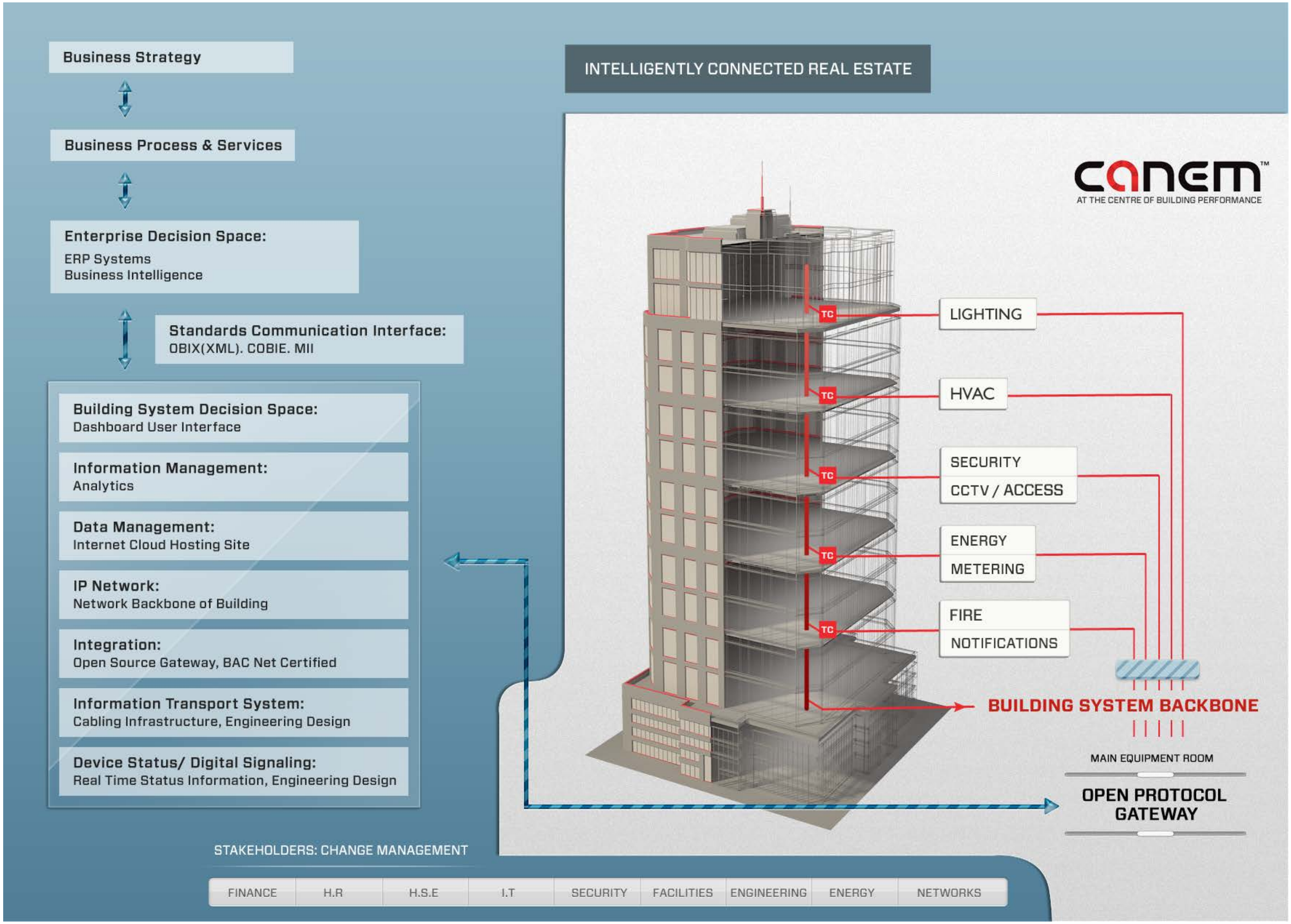
BOTH

Simple solutions that take advantage of new technologies and design strategies can reduce energy use, reduce costs and increase occupant control.

Services:

- Telecommunication networks
- Lighting & Power Control Systems
- Digital Metering
- HVAC Controls
- Fire Alarm
- Security
- Access Control
- CCTV

TELUS Garden | Integration



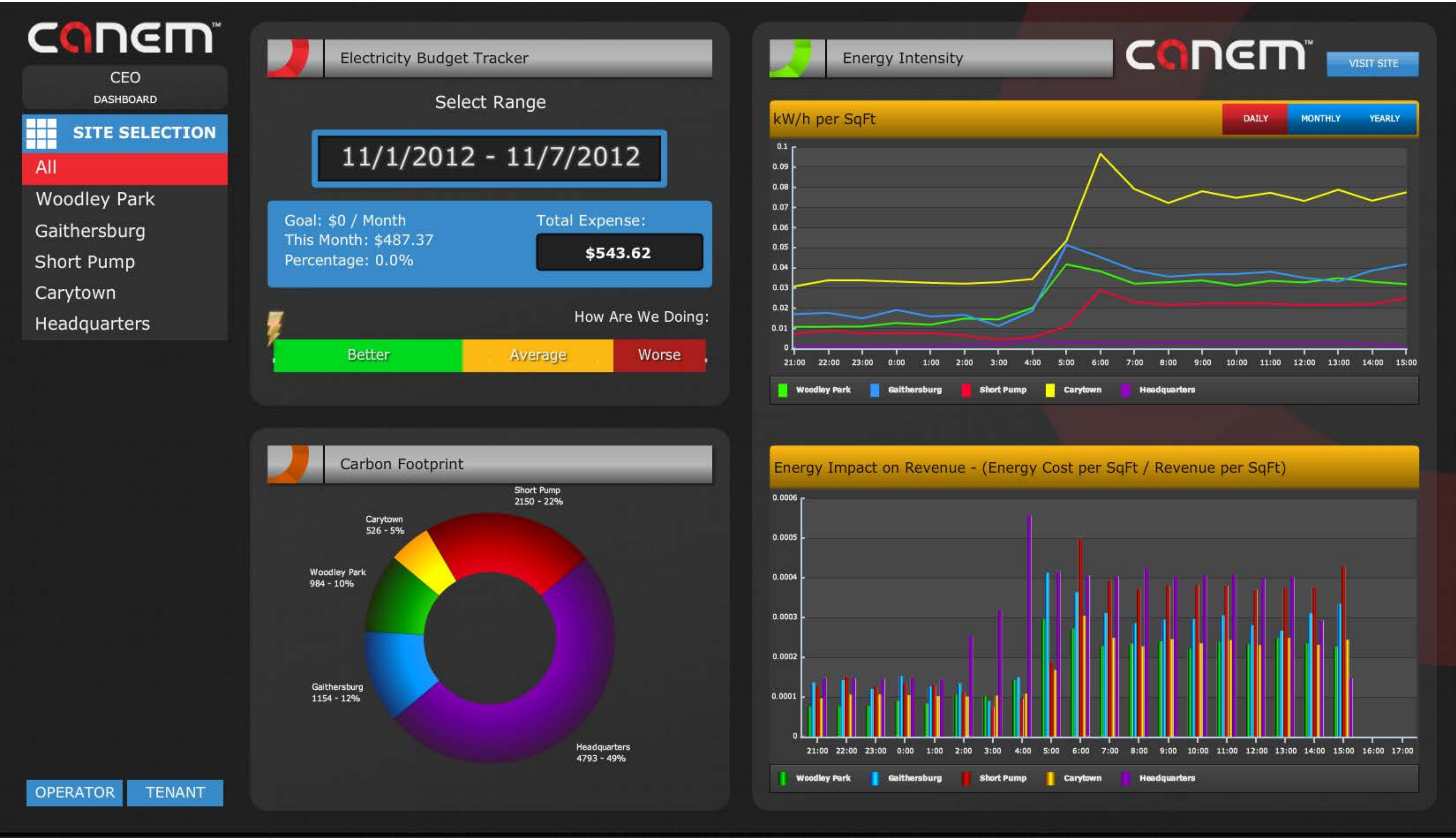
TELUS Garden| Improved Decision Making

- Graphic navigation for all systems
- Energy charts for analysis
- Improved executive decision making through dashboards

TELUS Garden | **Future Benefits**

- The systems that we use tomorrow may not have been invented
- With normalized wide bandwidth networks those future solutions can be incorporated

TELUS Garden | Information Management



TELUS Garden | PxENG

- Active Asset Management
- Digital Active Commissioning
- Active Operation and Maintenance
- Measurement and Verification + Analysis

TELUS Garden | Non-Traditional Approach

- Need to change design mentality
- Reduce vs. efficiency
- Back to basics and simple principals
- Passive vs. high-tech
- KISS principle
- Less is better

THANK YOU

Questions?