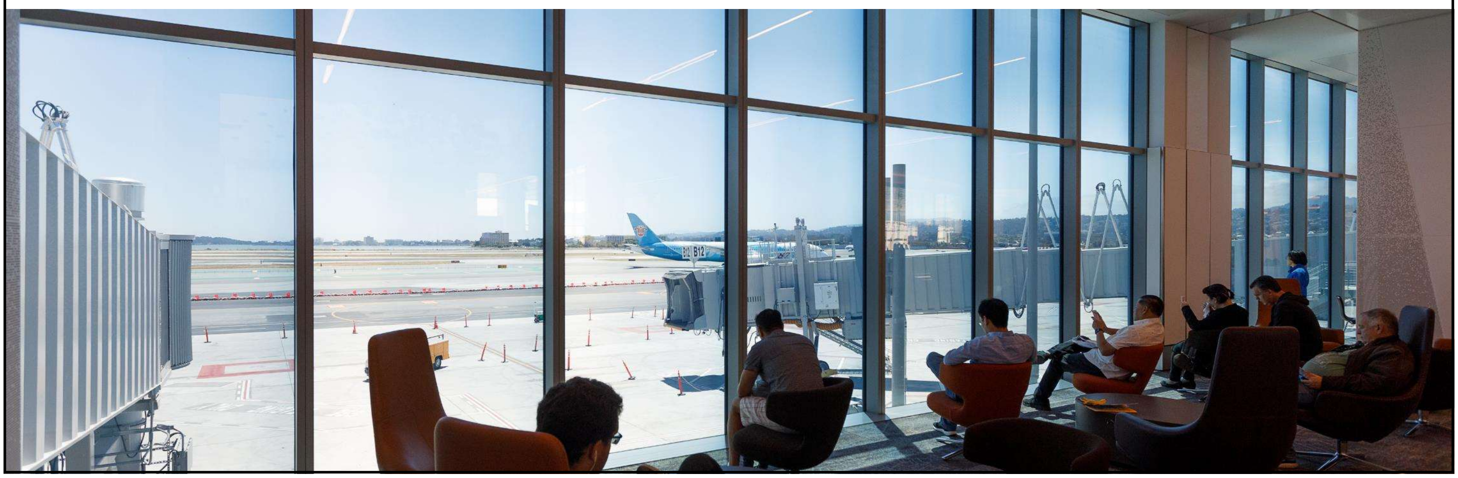
view

Building Smart Airports:
A Case Study Look at Smart Glass Impacts on Passenger Experience, Revenue, Operations and Sustainability



1

Webinar summary

Today's traveling public demands technology and service standards in the airport terminal that rival those outside the travel experience. Airports work to identify solutions that improve the passenger experience, while reducing operational expenses and improving revenue streams. Smart glass is one solution. The high-tech glass system reduces glare and unwanted heat within a terminal, provides a comfortable environment for passengers, and reduces an airport's carbon footprint and operations. Today we look at two airport case studies: SFO and DFW.

2

Learning Objectives

- Understand how smart glass enhances sustainability initiatives
- Explore the benefits to airport operations with smart glass
- Learn how smart glass can positively impact passenger experience
- Learn how smart glass increases non-aeronautical revenue

3

Speaker Bios

Brandon Tinianov

Dr. Tinianov's 25-year career has been dedicated to product innovation in building technology and real estate. He currently serves as View's VP of Industry Strategy where he leads their industry research. His work spans current trends in commercial real estate, workplace strategy, and the impact of the built environment on the health and wellness of today's workforce. Prior to joining View, Brandon was the Chief Technology Officer at Serious Energy and prior to that, a senior researcher at the Johns Manville Corporation.

Brandon is the Chair of the Advisory Council of the US Green Building Council and a the Board of Directors Treasurer. He has a PhD in Engineering Systems, is a registered PE and a LEED AP.

Kirsten Ritchie

Kirsten Ritchie, a Principal and Director of Sustainable Design at Gensler, has over 30 years of experience in the world of green building and sustainable materials. She is a passionate advocate for innovative, science based approaches to assess performance. She is currently leading a number of projects focused on delivering exceptional experience and low carbon impact - both embodied and operational carbon.

In her role as Director of Sustainable Design, Ms. Ritchie works with a broad range of clients including San Francisco International Airport, Facebook, and Google. She is a past USGBC Board and MR-TAG member and currently serves on the advisory board of the Ecological Building Network and the Materials Carbon Action Network. Ms. Ritchie is a registered Professional Engineer and LEED O+M AP.

4

Agenda

- Introduction of View & Gensler
- SFO Case Study
- DFW Case Study
- Questions

 Confidential view

View is shaping the future of modern buildings

50M	50M	96%	450	250
Building SF	Occupants	Occupant delight	Projects completed	More in progress

Founded: **2007**
Funding: **$2B**
Employees: **900**
Patents: **850**

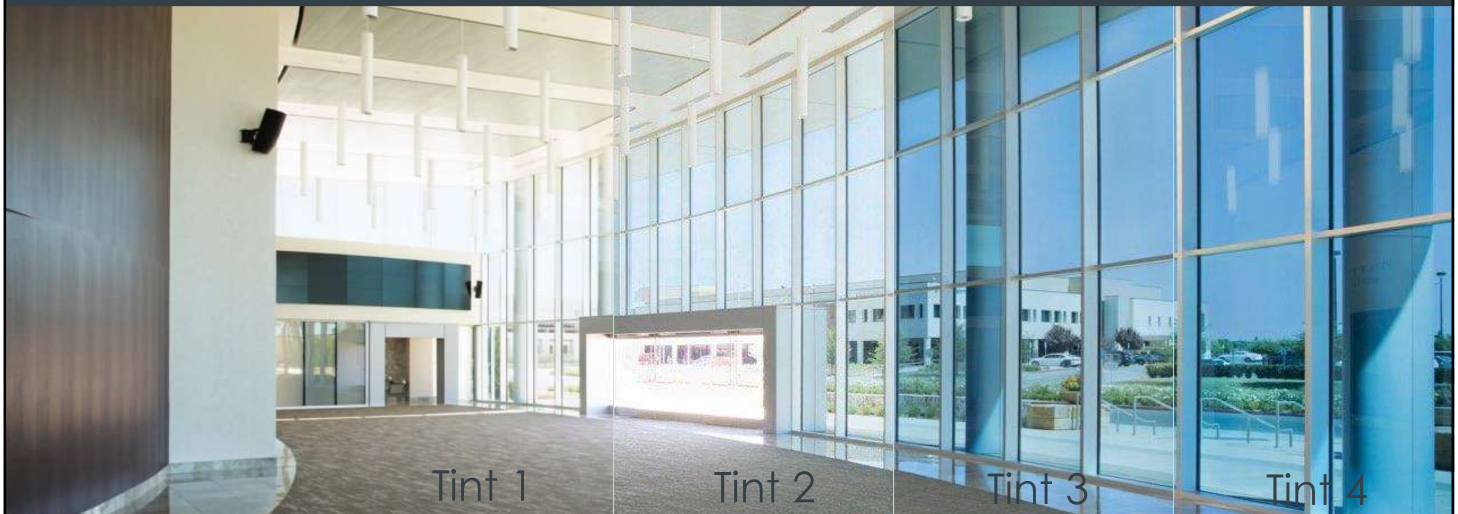
Headquarters | R&D
Milpitas, CA

Manufacturing
Olive Branch, MS

Select Investors:

BainCapital · MADRONE CAPITAL PARTNERS · NZSUPERFUND Te Kaitiaki Tāhua Penihana Kaumatua o Aotearoa · SoftBank · TIAA

View Smart Glass intelligently changes tint

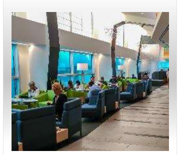


	Tint 1	Tint 2	Tint 3	Tint 4
Visible Light Transmission	58%	40%*	6%*	1%*
Solar Heat Gain Coeff.	0.42	0.29	0.12	0.10
UV Transmission	4%	2%	1%	0%

* Tint 4 transmission can be decreased to 0.5%; transmission in Tint 2 and 3 can also be adjusted upon request

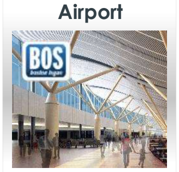
7

Current Aviation Projects

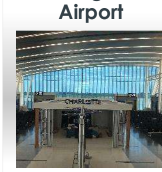
Alaska Airlines Lounge Seattle

Sea-Tac

Delta Sky Club Seattle


Sea-Tac

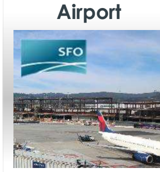
Logan International Airport


Terminal B

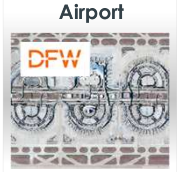
Charlotte Douglas Airport

Concourse A

Meacham International Airport

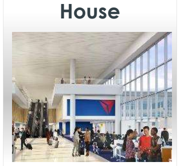
All Terminals

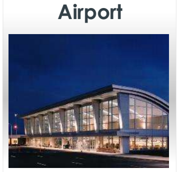
San Francisco International Airport


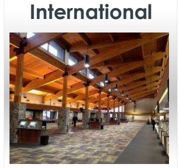
Terminal 1

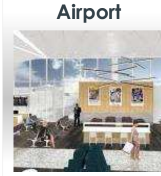
DFW International Airport


All Terminals
in progress

LaGuardia Delta Head House

All Terminals
in progress

Spokane International Airport

All Terminals
in progress

Bozeman Yellowstone International

All Terminals
in progress

Memphis International Airport

B Concourse
In progress

8 Confidential view

8

About Gensler

For more than 50 years, Gensler has been a leading global architecture, interiors, planning, and strategic consulting firm that partners with public and private sector clients to achieve measurable results through design.

9

About Gensler's Aviation Expertise

Gensler has roots centered in three decades of aviation facilities experience, planning and architectural design. We know that each square foot in an airport represents a significant investment and must justify itself in performance and productivity.

Gensler provides specialized services that enhance the passenger experience through improved efficiency, level of service and integration at the airport. Crafting a distinct, enjoyable journey through an authentic experience positively affects passenger efficiency and safety, enhances revenue development and creates an airport that is proudly representative of the local culture.

The airport experience needs to communicate the city's vibrant and energetic character to the passenger, as well as the sophistication and reliability that constitutes that city's brand.

Gensler's design teams are widely recognized for an "inside-out" approach that carefully integrates stakeholder needs, practicality, and airport strategic business goals, while delivering innovation to a demanding industry. With achievements in airport planning, retail and organization planning, our success in aviation design rests in strong, effective management, and the ability to coordinate the various professional disciplines required to successfully complete complex projects.

Among Gensler's notable credentials are:

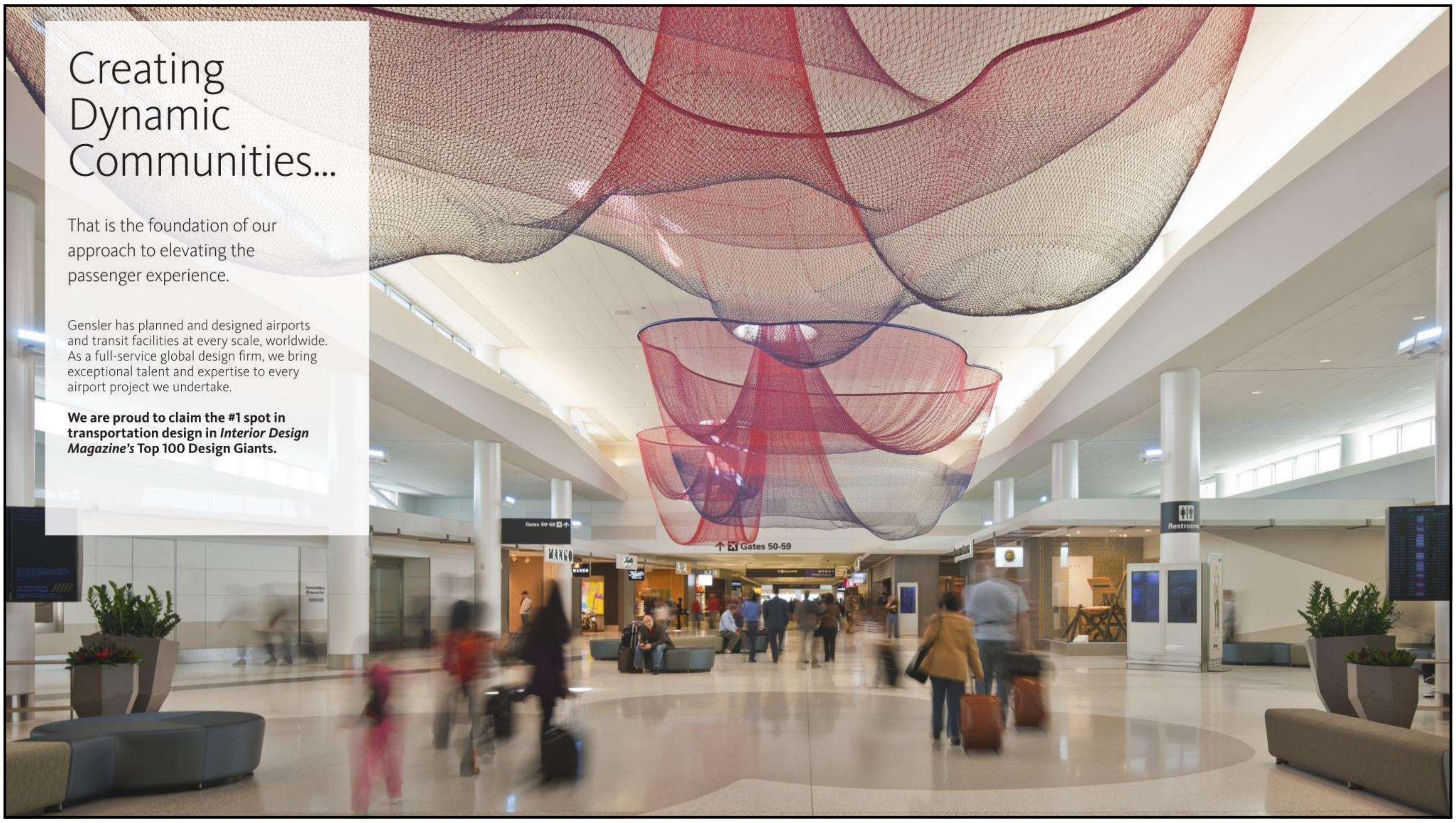
- Completed terminal design and planning assignments at nearly every major passenger airport in California, including built work at non-hub (Carlsbad), small-hub (Palm Springs), medium-hub (John Wayne) and large-hub airports (San Diego and LAX).
- Design of more than 43 domestic and international airport terminal projects for 50 clients in the last 30 years, and more than 21 million square feet of airport terminal space.
- Understanding the key operational and business drivers in aviation design that, coupled with an understanding of the needs of stakeholders, offers insight into future trends.
- Additional experience in specialty design areas such as interior design, concession/retail, executive terminals, cargo facilities, and graphics/signage.

Portland International Jetport, Portland, ME—name Best Airport under 2 Million Passengers in North America in 2017 by Airport Council International

List of Selected Aviation Projects

Project	Location	Completed	Size (sf)	Service: Architecture	Interior Design	Brand Design	Product Design	Consulting	Planning + Urban Design
San Francisco International Airport Terminal 1	San Francisco, CA	Ongoing	860,000	■	■	■	■	■	■
American Airlines Terminal 5	Los Angeles, CA	Ongoing	357,377	■	■	■	□	■	□
LAX, Midfield Satellite Concourse	Los Angeles, CA	2019	1,200,000	■	■	■	□	□	■
Delta Sky Way at LAX	Los Angeles, CA	2019	687,278	■	■	■	□	■	□
San Diego International Airport FIS	San Diego, CA	2019	125,010	■	□	□	□	□	□
Incheon International Airport	Incheon, South Korea	2018	4,144,106	■	■	□	□	■	■
San Francisco International Airport Terminal 3	San Francisco, CA	2014	412,297	■	■	■	□	□	□
Chennai International Airport	Chennai, India	2013	1,378,000	■	■	□	□	□	□
San Francisco International Airport Terminal 2	San Francisco, CA	2012	640,000	■	■	■	□	■	□
Tulsa International Airport	Tulsa, OK, USA	2012	100,000	■	■	□	□	□	□
Jackson Hole Wyoming Airport	Jackson Hole, WY, USA	2011	100,000	■	□	□	□	■	■
Los Angeles International Airport	Los Angeles, CA, USA	2011	n/a	■	■	■	□	■	□
Hartsfield-Jackson Atlanta Int'l Airport	Atlanta, GA, USA	2011	900,000	■	□	□	□	■	■
John Wayne Airport	Orange County, CA, USA	2011	588,000	■	■	□	□	□	□
San Jose International Airport	San Jose, CA, USA	2010	775,000	■	■	□	□	□	□
Portland International JetPort	Portland, ME, USA	2010	140,000	■	■	□	□	□	□
Harbin International Airport (competition)	Harbin, China	2010	2,000,000	■	■	□	□	□	□
New Lisbon International Airport (competition)	Lisbon, Portugal	2009	2,000,000	■	■	■	□	□	□
JetBlue Terminal 5, JFK International Airport	Jamaica, NY, USA	2008	640,000	■	■	■	■	□	■
Detroit Metropolitan Wayne County Airport	Detroit, MI, USA	2008	800,000	■	■	■	□	□	■
Austin-Bergstrom International Airport	Austin, TX, USA	2008	600,000	■	■	□	□	□	■
Palm Springs Regional Airport	Palm Springs, CA, USA	2006	220,000	■	□	■	□	■	■
London City Airport	London, United Kingdom	2006	250,000	■	■	■	□	□	■
Salt Lake City International Airport	Salt Lake City, UT, USA	2005	800,000	■	□	□	□	■	■
Long Island Islip MacArthur Airport	Islip, NY, USA	2005	90,000	■	■	□	□	□	■
Singapore Changi International Airport	Changi, Singapore	2004	3,853,480	■	■	■	□	□	□
Corpus Christi International Airport	Corpus Christi, TX, USA	2003	110,000	■	■	■	□	□	□
Chicago O'Hare International Airport	Chicago, IL, USA	2003	750,000	■	■	□	□	□	□
Will Rogers World Airport	Oklahoma City, OK, USA	2003	242,000	■	■	□	□	□	□
Louisville International Airport	Louisville, KY, USA	2003	180,000	■	■	■	□	□	□
Washington Dulles International Airport	Chantilly, VA, USA	2001	n/a	■	■	■	□	□	□
San Diego International Airport	San Diego, CA, USA	1996	365,000	□	□	■	□	□	□

10


Creating
Dynamic
Communities...
That is the foundation of our approach to elevating the passenger experience.
Gensler has planned and designed airports and transit facilities at every scale, worldwide. As a full-service global design firm, we bring exceptional talent and expertise to every airport project we undertake.
We are proud to claim the #1 spot in transportation design in Interior Design Magazine's Top 100 Design Giants.
Gates 50-59
Restroom

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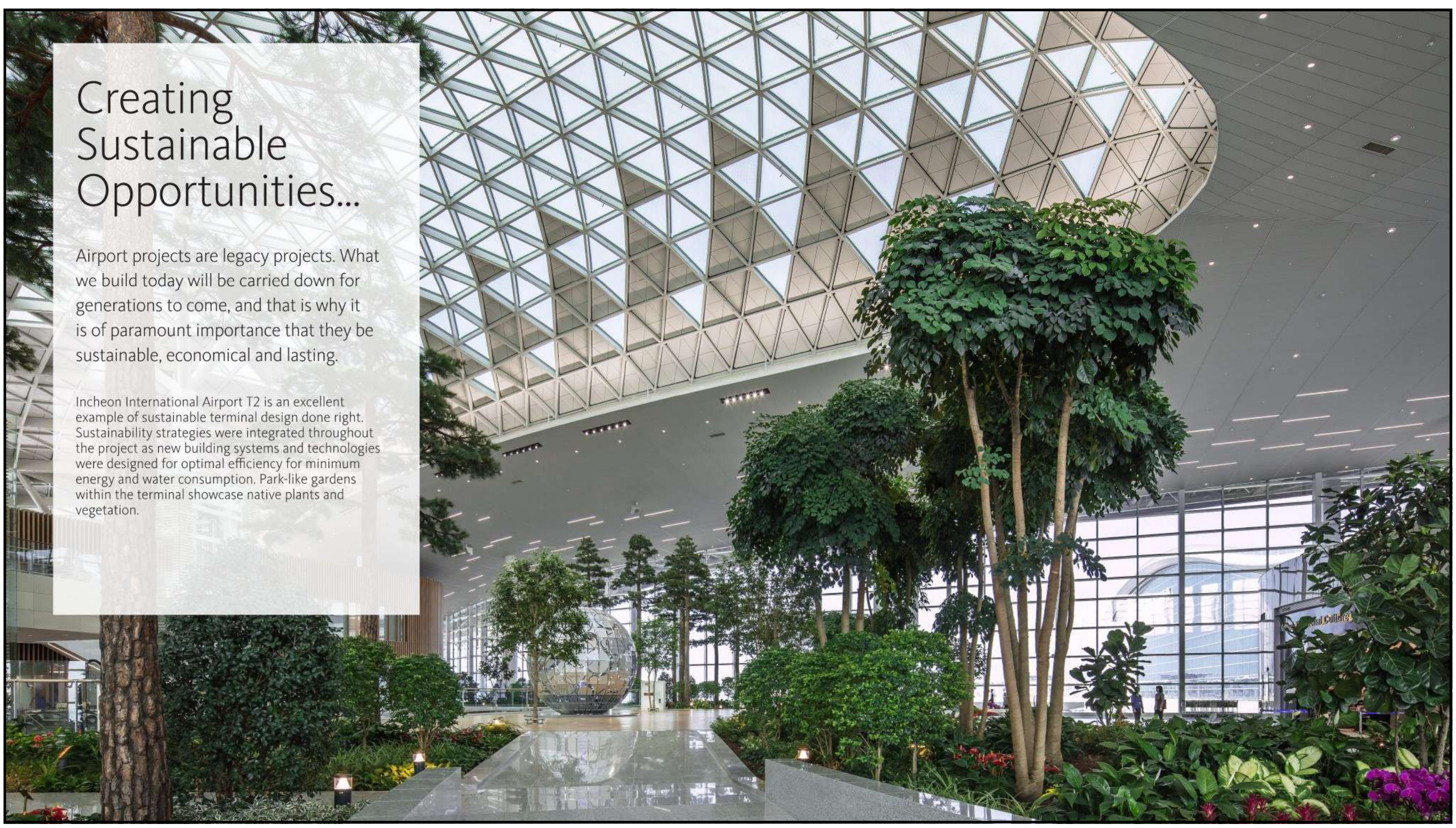

Creating
Sustainable
Opportunities...
Airport projects are legacy projects. What we build today will be carried down for generations to come, and that is why it is of paramount importance that they be sustainable, economical and lasting.
Incheon International Airport T2 is an excellent example of sustainable terminal design done right. Sustainability strategies were integrated throughout the project as new building systems and technologies were designed for optimal efficiency for minimum energy and water consumption. Park-like gardens within the terminal showcase native plants and vegetation.

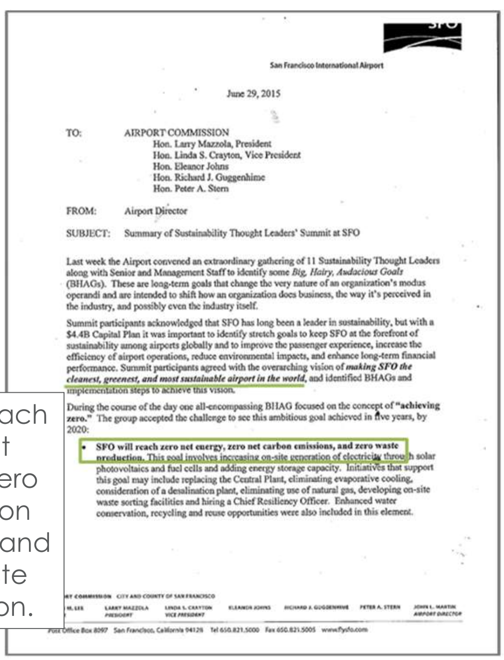
12

Impact by Design

SMART AIRPORTS | SMART GLASS

13

BHAG's



SFO

San Francisco International Airport

June 29, 2015

TO: AIRPORT COMMISSION
Hon. Larry Mazzola, President
Hon. Linda S. Crayton, Vice President
Hon. Eleanor Johns
Hon. Richard J. Guggenhime
Hon. Peter A. Stern

FROM: Airport Director

SUBJECT: Summary of Sustainability Thought Leaders' Summit at SFO

Last week the Airport convened an extraordinary gathering of 11 Sustainability Thought Leaders along with Senior and Management Staff to identify some *Big, Hairy, Audacious Goals* (BHAGs). These are long-term goals that change the very nature of an organization's modus operandi and are intended to shift how an organization does business, the way it's perceived in the industry, and possibly even the industry itself.

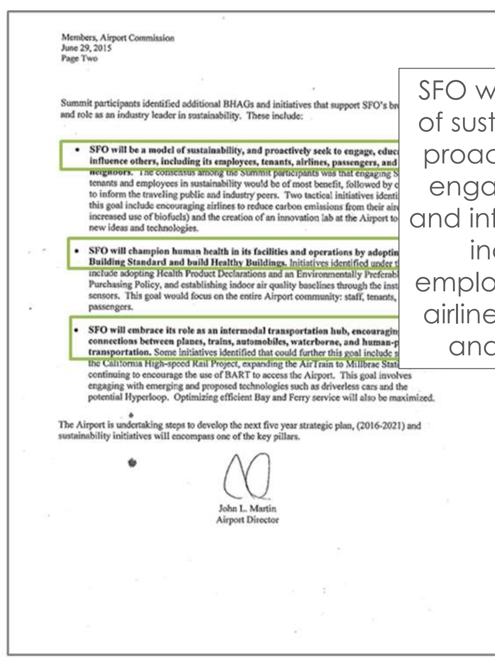
Summit participants acknowledged that SFO has long been a leader in sustainability, but with a $4.4B Capital Plan it was important to identify stretch goals to keep SFO at the forefront of sustainability among airports globally and to improve the passenger experience, increase the efficiency of airport operations, reduce environmental impacts, and enhance long-term financial performance. Summit participants agreed with the overarching vision of ***making SFO the cleanest, greenest, and most sustainable airport in the world***, and identified BHAGs and implementation steps to achieve this vision.

During the course of the day one all-encompassing BHAG focused on the concept of **"achieving zero."** The group accepted the challenge to see this ambitious goal achieved in five years, by 2020:

- **SFO will reach zero net energy, zero net carbon emissions, and zero waste production.** This goal involves increasing on-site generation of electricity through solar photovoltaics and fuel cells and adding energy storage capacity. Initiatives that support this goal may include replacing the Central Plant, eliminating evaporative cooling, consideration of a desalination plant, eliminating use of natural gas, developing on-site waste sorting facilities and hiring a Chief Resiliency Officer. Enhanced water conservation, recycling and reuse opportunities were also included in this element.

...T COMMISSION CITY AND COUNTY OF SAN FRANCISCO
...M. LEE LARRY MAZZOLA PRESIDENT LINDA S. CRAYTON VICE PRESIDENT ELEANOR JOHNS RICHARD J. GUGGENHIME PETER A. STERN JOHN L. MARTIN AIRPORT DIRECTOR
Post Office Box 8097 San Francisco, California 94128 Tel 650.821.5000 Fax 650.821.5005 www.flysfo.com

SFO will reach zero net energy, zero net carbon emissions, and zero waste production.



Members, Airport Commission
June 29, 2015
Page Two

Summit participants identified additional BHAGs and initiatives that support SFO's br... and role as an industry leader in sustainability. These include:

- **SFO will be a model of sustainability, and proactively seek to engage, educ... influence others, including its employees, tenants, airlines, passengers, and neighbors.** The consensus among the Summit participants was that engaging S... tenants and employees in sustainability would be of most benefit, followed by c... to inform the traveling public and industry peers. Two tactical initiatives identi... this goal include encouraging airlines to reduce carbon emissions from their air... increased use of biofuels) and the creation of an innovation lab at the Airport to... new ideas and technologies.
- **SFO will champion human health in its facilities and operations by adoptin... Building Standard and build Healthy Buildings.** Initiatives identified under t... include adopting Health Product Declarations and an Environmentally Preferab... Purchasing Policy, and establishing indoor air quality baselines through the inst... sensors. This goal would focus on the entire Airport community: staff, tenants, ... passengers.
- **SFO will embrace its role as an intermodal transportation hub, encouragin... connections between planes, trains, automobiles, waterborne, and human-p... transportation.** Some initiatives identified that could further this goal include s... the California High-speed Rail Project, expanding the AirTrain to Millbrae Stat... continuing to encourage the use of BART to access the Airport. This goal involves engaging with emerging and proposed technologies such as driverless cars and the potential Hyperloop. Optimizing efficient Bay and Ferry service will also be maximized.

The Airport is undertaking steps to develop the next five year strategic plan, (2016-2021) and sustainability initiatives will encompass one of the key pillars.

John L. Martin
Airport Director

SFO will be a model of sustainability and proactively seek to engage, educate and influence others, including its employees, tenants, airlines, passengers and neighbors.

14

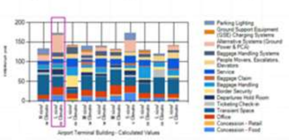
The SFO T1C/N renovation project, encompassing over 770,000 sf is designed to enable the terminal to handle a **70% increase in passengers** (from the current 10 million to a planned 17 million), while **improving** employee and passenger **satisfaction and delight**, **increasing revenues** from retail, food and beverage operations, and **lowering energy use and carbon emissions** more than **75%** from current operations.

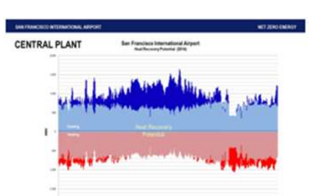
15

Rigorous Analysis

SFO OPERATIONAL DATA COLLECTION AND ANALYSIS

Both quantitative and qualitative data were collected and analyzed in order to understand and identify the best energy use reduction opportunities for the project.

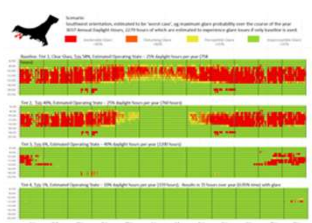


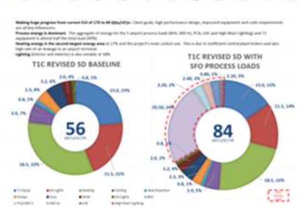


SIMULATION AND MODELING

Numerous simulation and modeling tools we used to understand the energy, carbon and comfort performance of design and technology solutions. Some of the tools used include:

1. Revit
2. Energy Pro
3. IES
4. Light Stanza
5. Revit Energy Modeiling
6. Autodesk 360
7. Tally
8. Rhino
9. Grasshoper
10. Diva

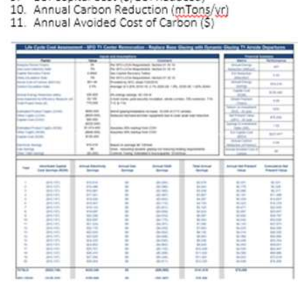




LIFE CYCLE COST ANALYSIS

Integrating energy modeling results with capital costs, utility costs and other operational factors, a life cycle cost analysis was completed for each technology study. The LCCA ouput provides the following environmental and financial performance results:

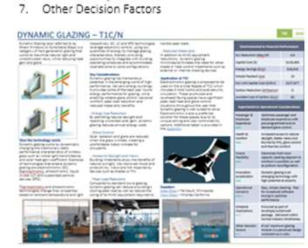
1. Annual Energy Reduction (kbtu/yr)
2. EUI Reduction (kbtu/sf/yr)
3. Annual Energy Savings ($)
4. Capital Cost , COW and ROM ($)
5. Simple Payback (years)
6. Return on Investment (%)
7. Net Present Value ($)
8. Savings to Investment Ratio (%)
9. EUI Capital Cost ($/EUI Reduced)
10. Annual Carbon Reduction (mTons/yr)
11. Annual Avoided Cost of Carbon ($)



TECHNOLOGY SNAPSHOTS

For each technology evaluated, a technology snapshot was prepared providing a summary of the technology, key considerations , applicability in the T1C/N project, key environmental and financial metrics from the LCCA and a summary of the following Experiential and Operations Considerations:

1. Passenger and Employee Experience
2. Health & Comfort
3. Future Flexibility
4. Innovation Acceleration
5. Operational Concerns
6. Schedule Implications
7. Other Decision Factors

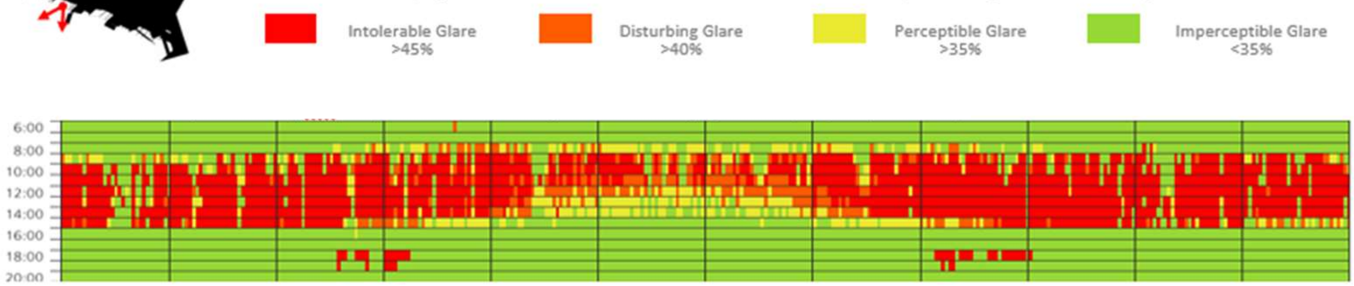


Contractor
Hensel Phelps
Design Team
Gensler/Kuth Ranieri JV
Engineer
Meyers+

16

A Little Glare Problem

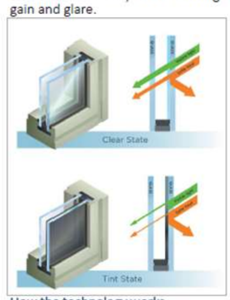
Scenario:
Southwest orientation, estimated to be 'worst case', eg maximum glare probability over the course of the year
3037 Annual Daylight Hours, 2279 hours of which are estimated to experience glare issues if only baseline is used.



17

Technology Snapshot: Dynamic Glazing

Dynamic Glazing (also referred to as Smart Windows or Switchable Glass) is a category of next generation glazing that works to maximize natural light and unobstructed views, while reducing heat gain and glare.



How the technology works
Dynamic glazing works by dynamically changing the traditionally static performance characteristics of window glass such as visible light transmittance and solar heat gain coefficient. Examples of technologies that enable dynamic glazing are electrochromic (EC), thermochromic, photochromic, liquid crystal (LC) and suspended particle devices (SPD).

Thermochromic and photochromic technologies change their properties based on ambient temperature and light respectively. EC, LC and SPD technologies leverage electronic control, using low quantities of energy to manage glazing characteristics, thereby providing opportunities to integrate with building operating schedules and accommodate localized zone by zone configurations.

Key Considerations
Dynamic glazing has tremendous potential in the emerging world of high performance, net zero energy buildings. It provides some of the best year round energy performance for glazing, while enabling notable glare control. personal comfort, peak load reduction and reduced materiality benefits.

- Energy Use Reduction
By admitting natural daylight and rejecting unwanted solar gain, dynamic glazing reduces annual energy costs.

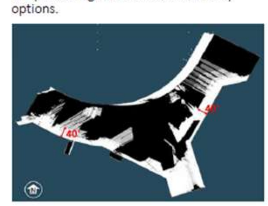
- Glare Control
Solar radiation and glare are reduced when the glass is tinted, creating a comfortable indoor climate for occupants.

- Access to Daylight and Views
Building inhabitants enjoy the benefits of natural sunlight, like improved mood and productivity. Views are not impaired by devices such as shades or frit.

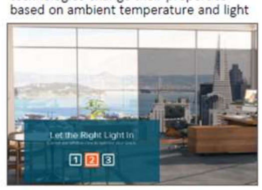
- Peak Load Reduction
Compared to standard low-e glazing, dynamic glazing can reduce a building's cooling peak load as well as reduce the sizing of its HVAC equipment required to handle peak loads

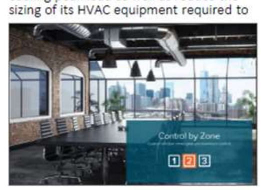
- Reduced Materiality
In addition to HVAC equipment reductions, dynamic glazing minimizes/eliminates the need for other shade or heat control treatments such as external or internal shading devices.

Application at T1C
Electrochromic glazing is proposed to be used on the airside façade of T1C which includes 4 hold rooms and post-security circulation. These southwest and southeast facing spaces have significant peak load heat and glare control situations throughout the year that dynamic glazing is well suited to solve. Electrochromic is also a preferred solution for these spaces due to its unique zoning and user controllability options.



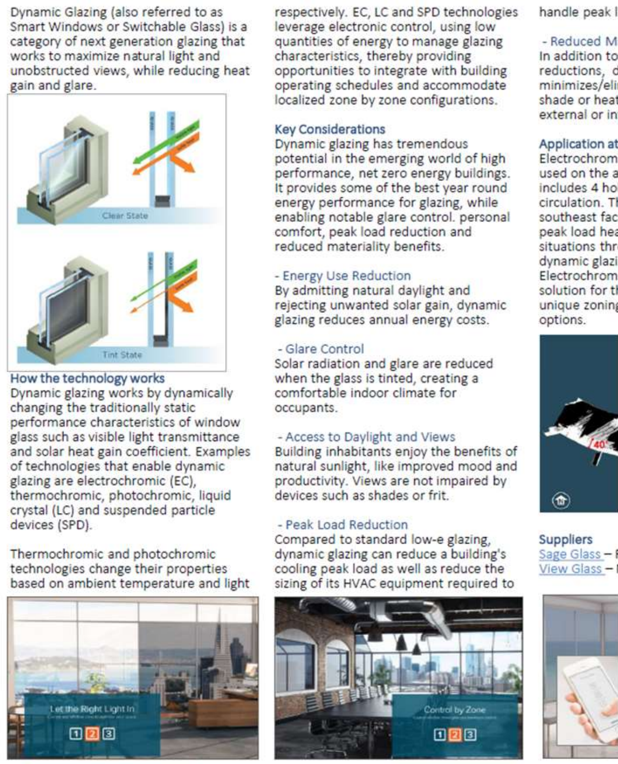
Suppliers
Sage Glass – Faribault, Minnesota
View Glass – Milpitas California





18

Drilling Down on the Experiential and Operational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Thermochromic and photochromic technologies change their properties based on ambient temperature and light respectively. EC, LC and SPD technologies leverage electronic control, using low quantities of energy to manage glazing characteristics, thereby providing opportunities to integrate with building operating schedules and accommodate localized zone by zone configurations.

Key Considerations
Dynamic glazing has tremendous potential in the emerging world of high performance, net zero energy buildings. It provides some of the best year round energy performance for glazing, while enabling notable glare control. personal comfort, peak load reduction and reduced materiality benefits.

- Energy Use Reduction
By admitting natural daylight and rejecting unwanted solar gain, dynamic glazing reduces annual energy costs.

- Glare Control
Solar radiation and glare are reduced when the glass is tinted, creating a comfortable indoor climate for occupants.

- Access to Daylight and Views
Building inhabitants enjoy the benefits of natural sunlight, like improved mood and productivity. Views are not impaired by devices such as shades or frit.

- Peak Load Reduction
Compared to standard low-e glazing, dynamic glazing can reduce a building's cooling peak load as well as reduce the sizing of its HVAC equipment required to handle peak loads

- Reduced M
In addition to
reductions, d
minimizes/eli
shade or heat
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Application at
Electrochrom
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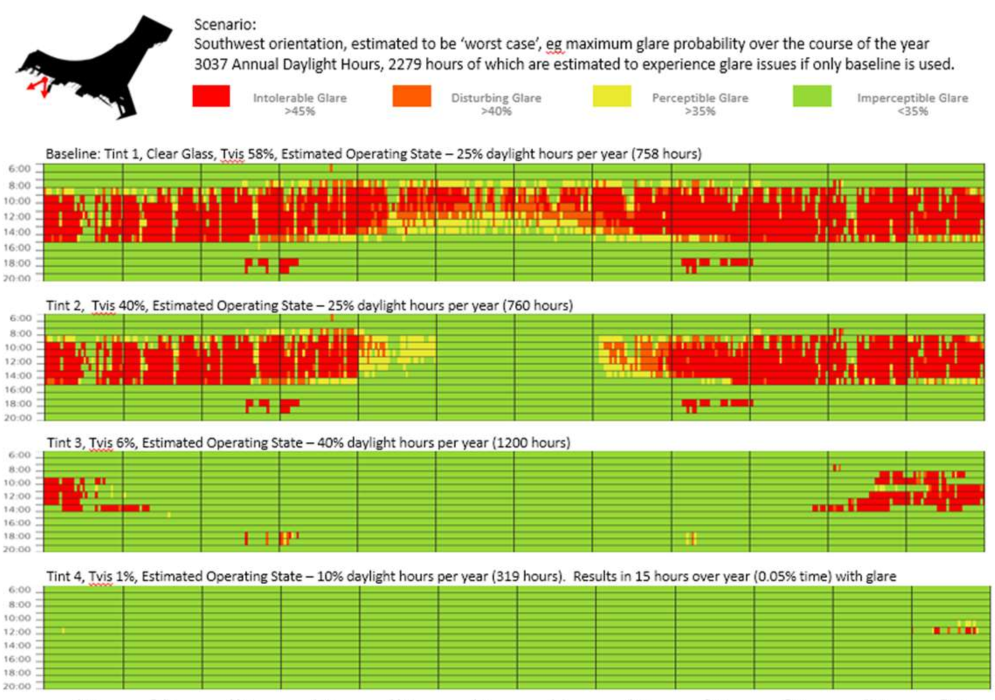
includes 4 ho
circulation. T
southeast fac
peak load hea
situations thr
dynamic glazi
Electrochrom
solution for t
unique zoning
options.

Suppliers
Sage Glass –
View Glass –

Experiential & Operational Considerations	
Passenger & Employee Experience +++	Optimizes passenger and employee experience with pre-programmed and on demand glare control.
Health & Comfort +++	Increased access to natural daylight, better views (not blurred by frit), glare control and thermal comfort.
Future Flexibility +++	Maximizes hold room capacity (seating adjacent to windows is possible) as well as podium reconfiguration.
Innovation Acceleration +++	Dynamic glazing is an emerging technology with high potential at airports.
Operational Concerns +++ \ -	Easy, simple cleaning. Plan for occasional software tuning to optimize performance
Schedule Implications + \ -	Procured as part of envelope/curtainwall package. Delivered within normal industry timeframes.
Other Decision Factors + \ -	6'x10' maximum glazing module is a perceived design constraint as is color.

19

Electrochromic Performance



20

Electrochromic LCCA

Life Cycle Cost Assessment - SFO T1 Center Rennovation - Replace Base Glazing with Electrochromic on T1 Airside Departures

Inputs and Assumptions

Factor	Value	Comment
Analysis Period (Years)	20	Per SFO LCCA Requirement, Section 01 35 10
Disccount (Interest) Rate	5%	Per SFO LCCA Requirement, Section 01 35 10
Capital Recovery Factor	0.0802	See Capital Recovery Tables
Utilitiy Escalation Rate	3%	Per SFO LCCA Requirement, Section 01 35 10
Social Cost of Carbon ($/mTon)	$51.48	Provided by SFO, email 7/20/2016
Carbon Escalation Rate	2.5%	
Annual Energy Reduction (kbtu)	373,555	7% energy savings, 82,100 sf
Area Impacted by Efficiency Measure (sf)	82,100	4 hold rooms, post-security circulation, departures level
Total Project Area (sf)	770,000	T1C & T1N
Estimated Product CapEx (COW)	$680,000	$40/sf glazing/installation increase, 17,000 sf (T1C airside)
Other CapEx (COW)	($600,000)	Reduced mechanical/chiller equipment due to solar peak load reduction
Capital Cost (COW)	$80,000	
Estimated Product CapEx (ROM)	$1,074,400	Assumes 58% markup from COW
Other CapEx (ROM)	($948,000)	Assumes 58% markup from COW
Capital Cost (ROM)	$126,400	
Electricity Savings	$14,014	Based on average $0.128/kwh
Gas Savings	$0	None - Assuming dynamic glazing not reducing heating requirements
Other O&M Savings	($3,200)	Controls Tuning: Estimated 8 hours/quarter, $100/hour

Financial Summary

Metric	Performance
Annual Energy Reduction (Mbtu/yr)	374
EUI Reduction (kbtu/sf/yr)	0.49
Annual Energy Savings	$14,014
Capital Cost (ROM)	$126,400
Simple Payback (Years)	9.02
Return on Investment (ROI) - 20 year	37%
Net Present Value (NPV) - 20 year	$46,307
Savings to Investment Ratio (SIR)	1.37
EUI Capital Cost ($/EUI)	$260,545
Annual Carbon Reduction (mTons/yr)	0.00
Annual Avoided Cost of Carbon	$0

Year	Amortized Capital Cost Savings (ROM)	Annual Electricity Savings	Annual Gas Savings	Annual O&M Savings	Total Annual Savings	Annual Net Present Value	Cumulative Net Present Value
1	($10,137)	$14,014	$0	($3,200)	$677	$644	$644
2	($10,137)	$14,434	$0	($3,296)	$1,001	$908	$1,552
3	($10,137)	$14,867	$0	($3,395)	$1,335	$1,153	$2,705
4	($10,137)	$15,313	$0	($3,497)	$1,679	$1,382	$4,087
5	($10,137)	$15,773	$0	($3,602)	$2,034	$1,593	$5,680
6	($10,137)	$16,246	$0	($3,710)	$2,399	$1,790	$7,470
7	($10,137)	$16,733	$0	($3,821)	$2,775	$1,972	$9,443
8	($10,137)	$17,235	$0	($3,936)	$3,162	$2,140	$11,583
9	($10,137)	$17,752	$0	($4,054)	$3,561	$2,296	$13,879
10	($10,137)	$18,285	$0	($4,175)	$3,972	$2,439	$16,317
11	($10,137)	$18,833	$0	($4,301)	$4,396	$2,570	$18,887
12	($10,137)	$19,398	$0	($4,430)	$4,832	$2,690	$21,578
13	($10,137)	$19,980	$0	($4,562)	$5,281	$2,800	$24,378
14	($10,137)	$20,580	$0	($4,699)	$5,743	$2,901	$27,279
15	($10,137)	$21,197	$0	($4,840)	$6,220	$2,992	$30,270
16	($10,137)	$21,833	$0	($4,985)	$6,710	$3,074	$33,344
17	($10,137)	$22,488	$0	($5,135)	$7,216	$3,148	$36,493
18	($10,137)	$23,163	$0	($5,289)	$7,736	$3,215	$39,707
19	($10,137)	$23,858	$0	($5,448)	$8,272	$3,274	$42,981
20	($10,137)	$24,573	$0	($5,611)	$8,825	$3,326	$46,307
TOTALS	**($202,746)**	**$376,556**	**$0**	**($85,985)**	**$87,825**	**$46,307**	
NPV (2016)	*($126,333)*	*$223,727*	*$0*	*($51,087)*	*$46,307*		

21

Thermochromic LCCA

Life Cycle Cost Assessment - SFO T1 Center Rennovation - Replace Base Glazing with Thermo Glazing T1 Airside Departures

Inputs and Assumptions

Factor	Value	Comment
Analysis Period (Years)	20	Per SFO LCCA Requirement, Section 01 35 10
Disccount (Interest) Rate	5%	Per SFO LCCA Requirement, Section 01 35 10
Capital Recovery Factor	0.0802	See Capital Recovery Tables
Utilitiy Escalation Rate	3%	Per SFO LCCA Requirement, Section 01 35 10
Social Cost of Carbon ($/mTon)	$51.48	Provided by SFO, email 7/20/2016
Carbon Escalation Rate	2.5%	
Annual Energy Reduction (kbtu)	266,825	5% energy savings, 82,100 sf
Area Impacted by Efficiency Measure (sf)	82,100	4 hold rooms, post-security circulation, departures level
Total Project Area (sf)	770,000	T1C & T1N
Estimated Product CapEx (COW)	$170,000	$10/sf glazing/installation increase, 17,000 sf (T1C airside)
Other CapEx (COW)	$0	No reduced mechanical/chiller equipment savings.
Capital Cost (COW)	$170,000	
Estimated Product CapEx (ROM)	$268,600	Assumes 58% markup from COW
Other CapEx (ROM)	$0	Assumes 58% markup from COW
Capital Cost (ROM)	$268,600	
Electricity Savings	$10,010	Based on average $0.128/kwh
Gas Savings	$0	None - Assuming dynamic glazing not reducing heating requirements
Other O&M Savings	$0	

Financial Summary

Metric	Performance
Annual Energy Reduction (Mbtu/yr)	267
EUI Reduction (kbtu/sf/yr)	0.35
Annual Energy Savings	$10,010
Capital Cost (ROM)	$268,600
Simple Payback (Years)	26.83
Return on Investment (ROI) - 20 year	-40%
Net Present Value (NPV) - 20 year	($108,652)
Savings to Investment Ratio (SIR)	0.60
EUI Capital Cost ($/EUI)	$775,122
Annual Carbon Reduction (mTons/yr)	0.00
Annual Avoided Cost of Carbon	$0

Year	Amortized Capital Cost Savings (ROM)	Annual Electricity Savings	Annual Gas Savings	Annual O&M Savings	Total Annual Savings	Annual Net Present Value	Cumulative Net Present Value
1	($21,542)	$10,010	$0	$0	($11,532)	($10,983)	($10,983)
2	($21,542)	$10,310	$0	$0	($11,232)	($10,187)	($21,170)
3	($21,542)	$10,619	$0	$0	($10,922)	($9,435)	($30,605)
4	($21,542)	$10,938	$0	$0	($10,604)	($8,724)	($39,329)
5	($21,542)	$11,266	$0	$0	($10,276)	($8,051)	($47,380)
6	($21,542)	$11,604	$0	$0	($9,938)	($7,416)	($54,796)
7	($21,542)	$11,952	$0	$0	($9,589)	($6,815)	($61,611)
8	($21,542)	$12,311	$0	$0	($9,231)	($6,248)	($67,858)
9	($21,542)	$12,680	$0	$0	($8,862)	($5,712)	($73,571)
10	($21,542)	$13,061	$0	$0	($8,481)	($5,207)	($78,777)
11	($21,542)	$13,452	$0	$0	($8,089)	($4,730)	($83,507)
12	($21,542)	$13,856	$0	$0	($7,686)	($4,280)	($87,787)
13	($21,542)	$14,272	$0	$0	($7,270)	($3,855)	($91,642)
14	($21,542)	$14,700	$0	$0	($6,842)	($3,456)	($95,098)
15	($21,542)	$15,141	$0	$0	($6,401)	($3,079)	($98,177)
16	($21,542)	$15,595	$0	$0	($5,947)	($2,724)	($100,901)
17	($21,542)	$16,063	$0	$0	($5,479)	($2,390)	($103,291)
18	($21,542)	$16,545	$0	$0	($4,997)	($2,076)	($105,368)
19	($21,542)	$17,041	$0	$0	($4,501)	($1,781)	($107,149)
20	($21,542)	$17,552	$0	$0	($3,989)	($1,504)	($108,652)
TOTALS	**($430,834)**	**$268,968**	**$0**	**$0**	**($161,866)**	**($108,652)**	
NPV (2016)	*($268,457)*	*$159,805*	*$0*	*$0*	*($108,652)*		

22

Triple Bottom Line Analysis - BAB

	Financial NPV		Social & Environmental NPV		Sustainable NPV	Sustainable BCR
Green Roof	-$1,052,555	+	$6,340,104	=	5,287,549	4.07
Electrochromic Glazing	-$3,287,126	+	$6,255,624	=	2,968,498	1.90
Motorized Window Shades	-$7,593,481	+	$6,255,624	=	-1,337,857	0.84
Interior Landscaping	-$8,480,450	+	$11,392,549	=	2,912,099	1.34
Radiant Heating and Cooling	-$2,842,986	+	$435,498	=	-2,407,488	0.61
Ground Source Heat Pump	-$5,821,573	+	$594,152	=	-5,227,421	0.40

Boarding Area B

BAB Team
Contractor
Austin Webcor JV
Design Team
HKS/Woods Bagot
Engineer
ARUP

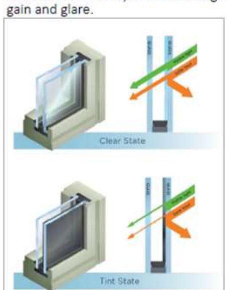
NPV: Financial Net Present Value
BCR: Benefit Cost Ratio - >1 = Benefits exceed Costs

23

Putting It All Together:

IT'S A GO!

Dynamic Glazing (also referred to as Smart Windows or Switchable Glass) is a category of next generation glazing that works to maximize natural light and unobstructed views, while reducing heat gain and glare.



How the technology works
Dynamic glazing works by dynamically changing the traditionally static performance characteristics of window glass such as visible light transmittance and solar heat gain coefficient. Examples of technologies that enable dynamic glazing are electrochromic (EC), thermochromic, photochromic, liquid crystal (LC) and suspended particle devices (SPD).

Thermochromic and photochromic technologies change their properties based on ambient temperature and light respectively. EC, LC and SPD technologies leverage electronic control, using low quantities of energy to manage glazing characteristics, thereby providing opportunities to integrate with building operating schedules and accommodate localized zone by zone configurations.

Key Considerations
Dynamic glazing has tremendous potential in the emerging world of high performance, net zero energy buildings. It provides some of the best year round energy performance for glazing, while enabling notable glare control. personal comfort, peak load reduction and reduced materiality benefits.

- Energy Use Reduction
By admitting natural daylight and rejecting unwanted solar gain, dynamic glazing reduces annual energy costs.

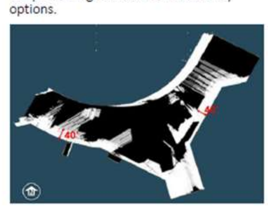
- Glare Control
Solar radiation and glare are reduced when the glass is tinted, creating a comfortable indoor climate for occupants.

- Access to Daylight and Views
Building inhabitants enjoy the benefits of natural sunlight, like improved mood and productivity. Views are not impaired by devices such as shades or frit.

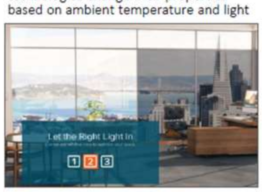
- Peak Load Reduction
Compared to standard low-e glazing, dynamic glazing can reduce a building's cooling peak load as well as reduce the sizing of its HVAC equipment required to handle peak loads

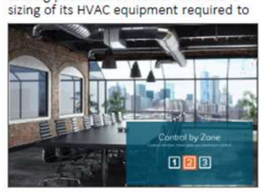
- Reduced Materiality
In addition to HVAC equipment reductions, dynamic glazing minimizes/eliminates the need for other shade or heat control treatments such as external or internal shading devices.

Application at T1C
Electrochromic glazing is proposed to be used on the airside façade of T1C which includes 4 hold rooms and post-security circulation. These southwest and southeast facing spaces have significant peak load heat and glare control situations throughout the year that dynamic glazing is well suited to solve. Electrochromic is also a preferred solution for these spaces due to its unique zoning and user controllability options.



Suppliers
Sage Glass – Faribault, Minnesota
View Glass – Milpitas California



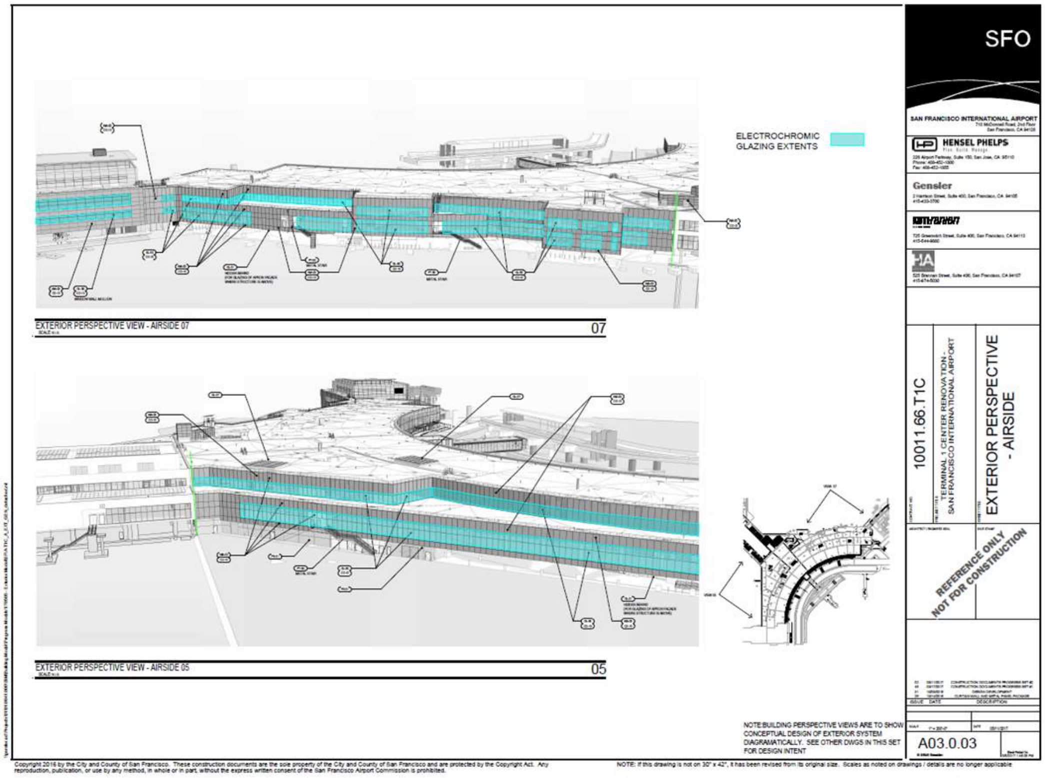


Environmental & Financial Performance	
EUI Reduction (kbtu/sf)	0.6
Capital Cost ($)	$126,400
Energy Savings ($/yr)	$16,016
Simple Payback (yrs)	10
EUI Unit Capital Cost ($/EUI)	$227,977
Carbon Reduction (mTons/yr)	0
Avoided Cost of Carbon ($/yr)	$0

Experiential & Operational Considerations	
Passenger & Employee Experience +++	Optimizes passenger and employee experience with pre-programmed and on demand glare control.
Health & Comfort +++	Increased access to natural daylight, better views (not blurred by frit), glare control and thermal comfort.
Future Flexibility +++	Maximizes hold room capacity (seating adjacent to windows is possible) as well as podium reconfiguration.
Innovation Acceleration +++	Dynamic glazing is an emerging technology with high potential at airports.
Operational Concerns +++ \ -	Easy, simple cleaning. Plan for occasional software tuning to optimize performance
Schedule Implications + \ -	Procured as part of envelope/curtainwall package. Delivered within normal industry timeframes.
Other Decision Factors + \ -	6'x10' maximum glazing module is a perceived design constraint as is color.

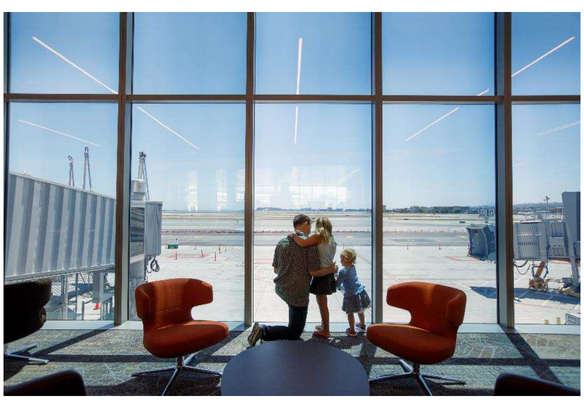
24

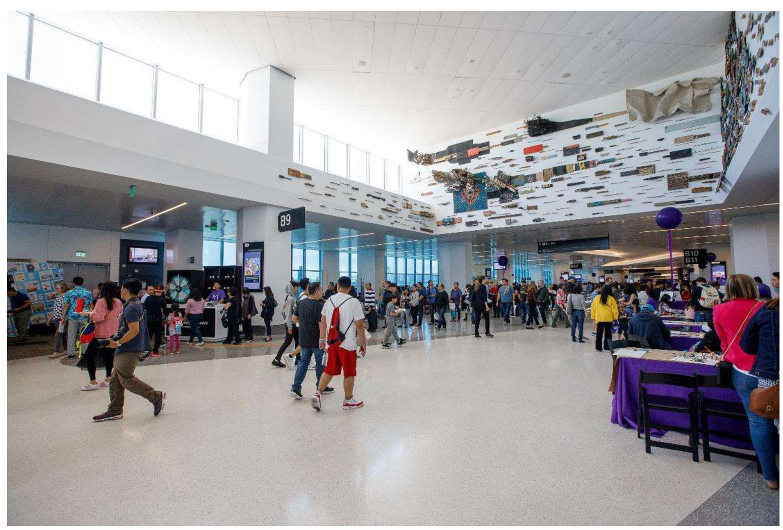
Departures + Mezz + Sterile Corridor

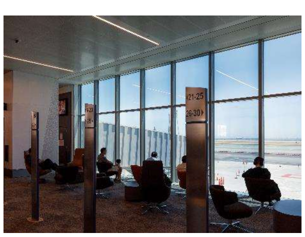


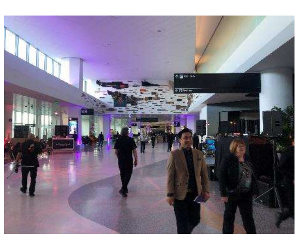
25

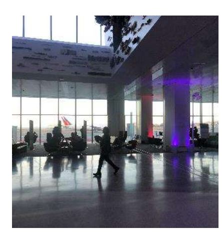
First to Launch: BAB











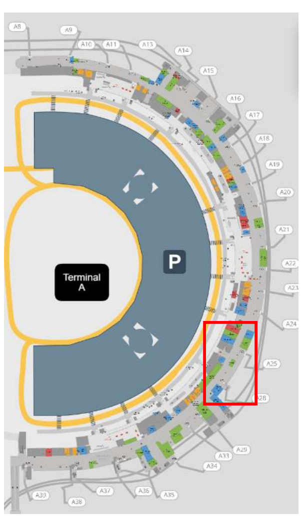
26

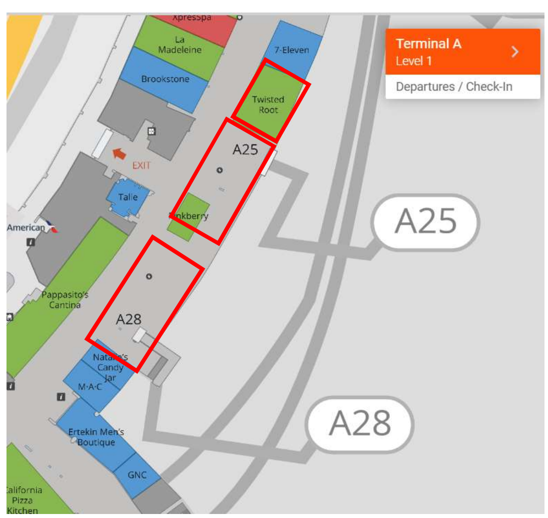
DFW Airport Terminal Comfort Study

- **Subjects:** 500 Total over 5 weeks A-28(View) = 250, A-25 = 250
- **Survey Method:** live, in-gate interviews
- **Evaluation Period:** 7am-11am every clear day
- **Survey Content:** 20 questions regarding comfort & seating priorities
- **Survey Integrity:** Voluntary subjects, no compensation offered

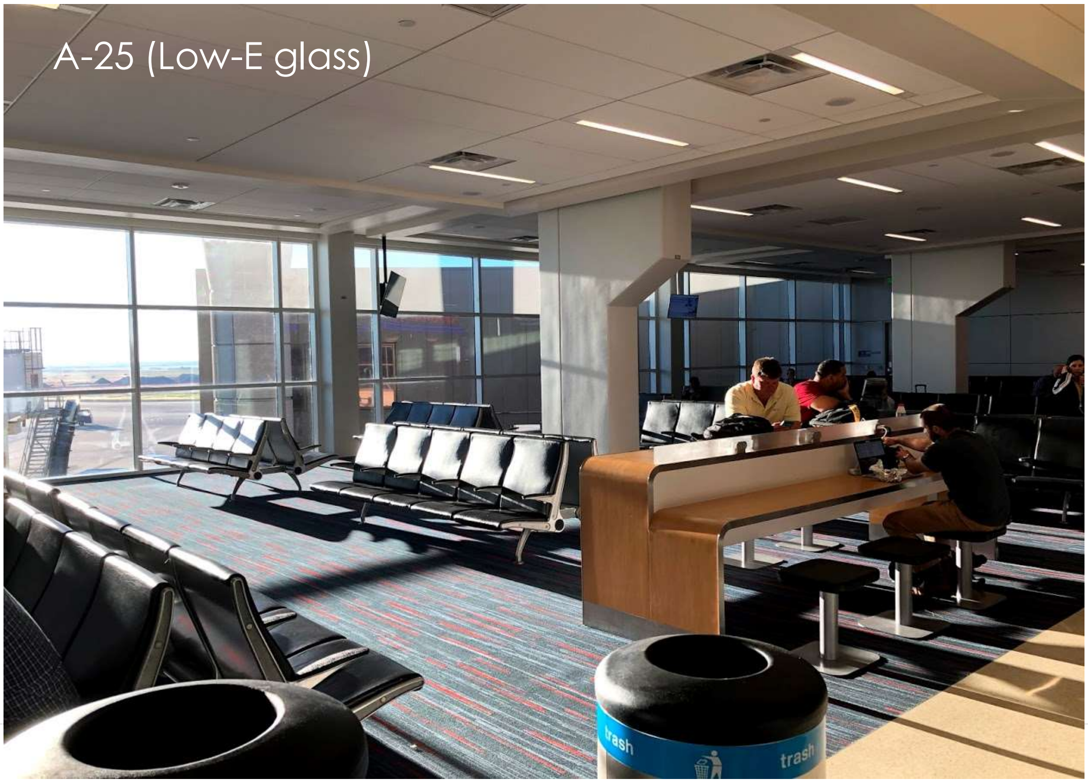
Cornell University DFW NATIONAL SERVICE RESEARCH MARKET RESEARCH

DFW Airport Terminal Comfort Study



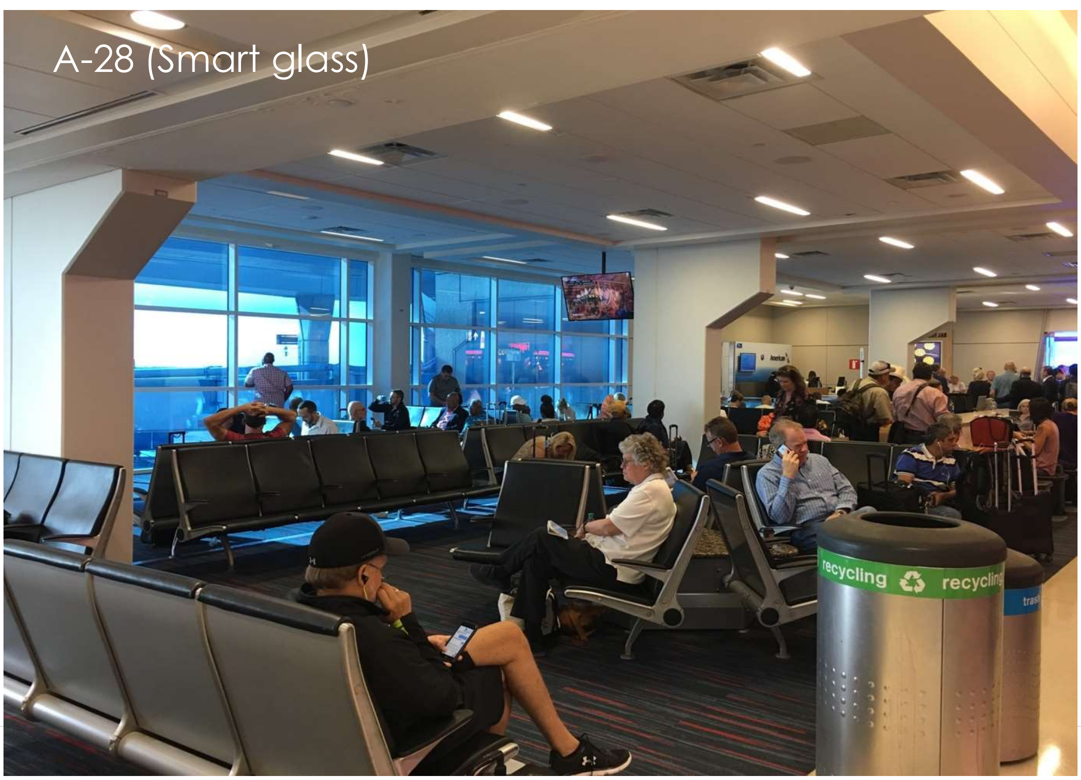


North



view | Dynamic Glass

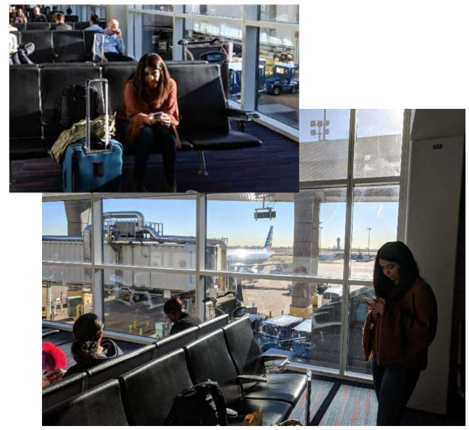
29



view | Dynamic Glass

30

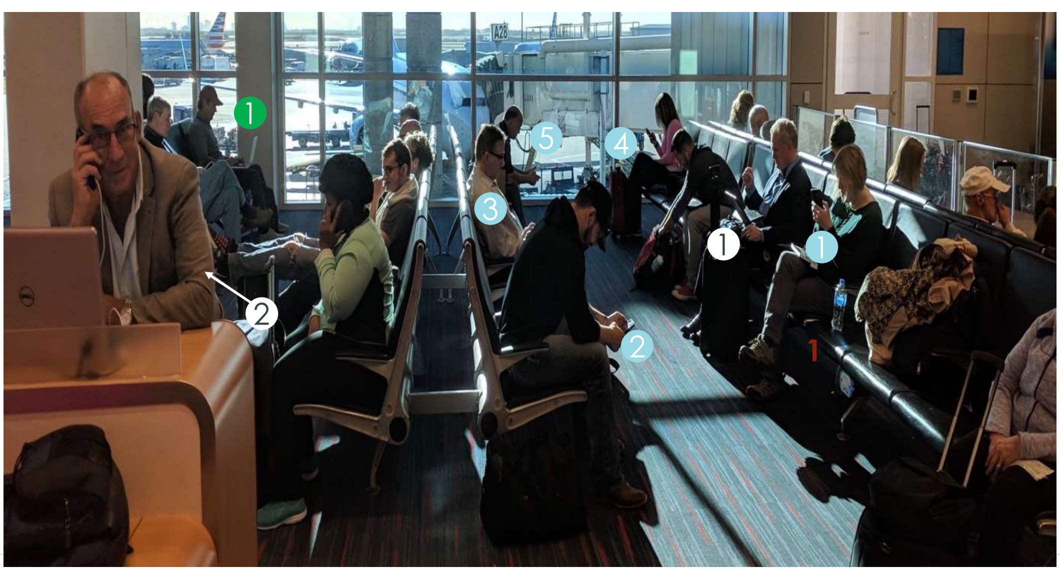
Researcher Observation:
Gate A25 passengers show discomfort



31 Confidential view | Dynamic Glass

31

Researcher Observation:
Gate A28 passengers work comfortably



Device in use

Phone (5)

Tablet (2)

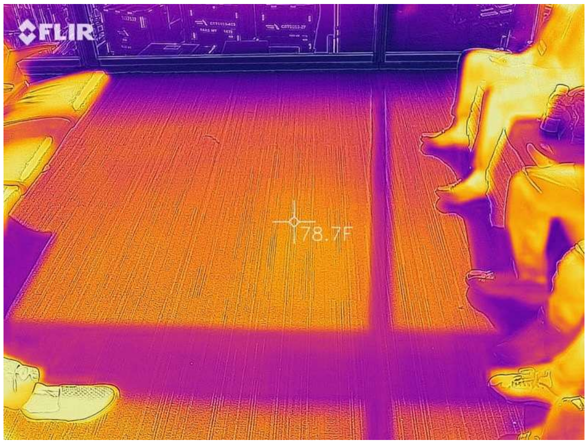
Laptop (1)

32 **A28 - 9:24AM** Confidential view | Dynamic Glass

32

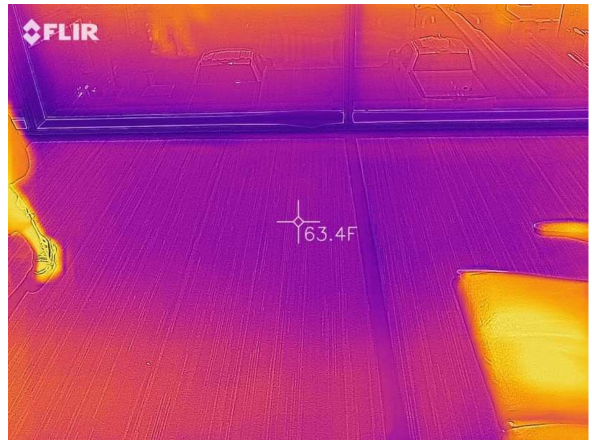
Floor Temperatures are 15 degrees cooler

Gates A25, A28



A25 - 9:52AM

78.7F



A28 - 9:52AM

63.4F

Unoccupied Seat Temperatures are 12 degrees cooler

A25 - 10:03AM

89.5F

A28 - 10:03AM

78.7F

Hold Room Results:

Up to
83%
longer gate dwell time near dynamic glass vs standard glass

3:1
Preference for dynamic glass

#2
Access to views as a gate seating priority

15°
Cooler temps at gate with dynamic glass

35

Smart glass impact on Concession Revenue

36

37

Dallas Fort Worth Study Results:

Up to
83%
longer gate dwell time near dynamic glass vs standard glass

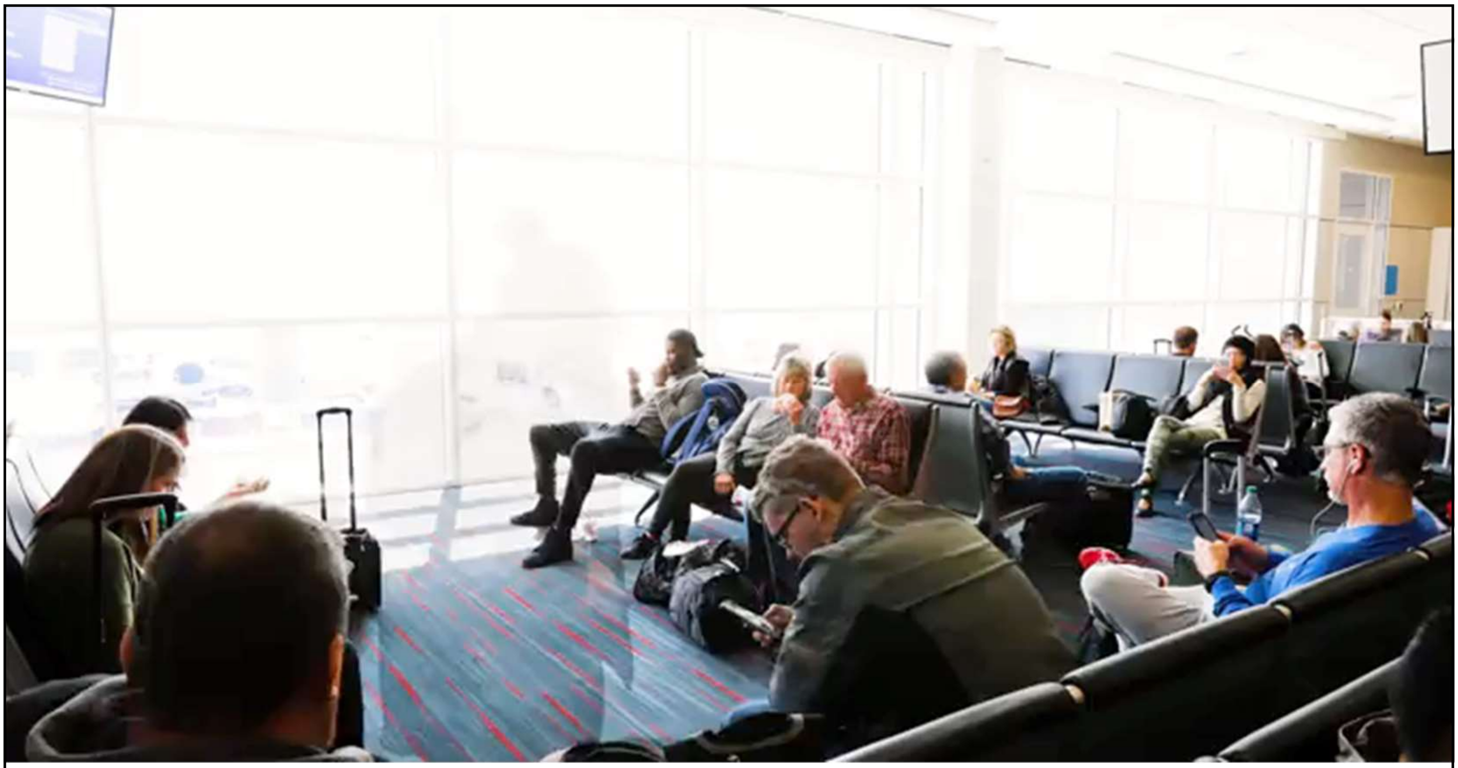
102%
More spending at concession

#2
Access to views as a gate seating priority

15°
Cooler temps at gate with dynamic glass

38 Confidential view | Dynamic Glass

38



39 Confidential view | Dynamic Glass

39

Smart glass provides the platform for Improved Passenger Experience, Increased Revenue and Operational Efficiency

Increased Passenger Comfort

- More access to comfortable seating and views
- Optimized environment for device & technology usage
- More efficient/flexible space utilization

Increased Revenue

- Increased dwell time leads to more spending
- Increase in revenue per enplanement
- Smart Glass provides healthy project ROI

Operational Efficiency

- Reduced energy costs
- Reduced carbon footprint - Carbon Neutral/LEED
- Reduced maintenance costs

“ When we looked at technologies that fit all three (People, Planet, Profit), that’s a win for our airport. View really fit that bill.”
- Chad Makovsky, Executive Vice President of Operations - DFW

40 view | Dynamic Glass

40

Thank You for Participating Today!

Questions?

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VP Industry Strategy

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kirsten_ritchie@gensler.com

41