Streamlining Data Center Design with Advanced Computational Tools

Amanda Gioia

IHED

Technology in Architectural Practice (TAP) +
Professional Practice Committees

AIA Los Angeles

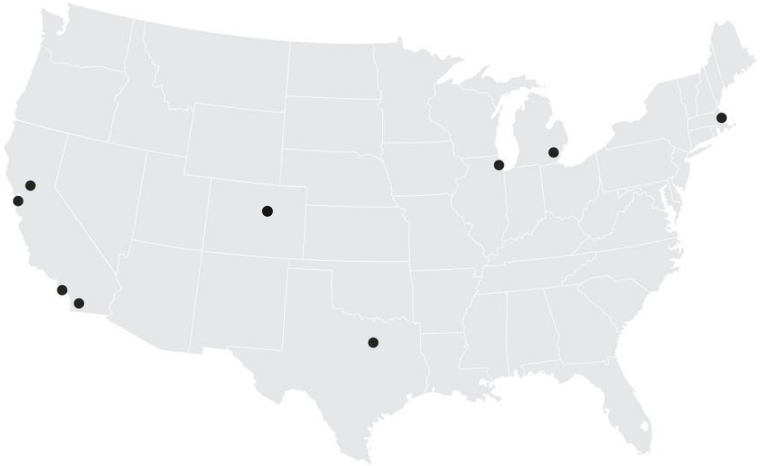
About the speaker

- Associate Practice Technology Leader at HED
- Registered Architect, Texas
- Master of Architecture, McGill University
- Master's in Advanced Computation for Architecture & Design, IAAC

HED

About HED

Since its founding in 1908, HED has earned a reputation for excellence in all facets of the designed and built environment, including planning, architecture, engineering and consulting services. Now a firm of more than 400 professionals, HED serves clients in a broad range of markets from nine U.S. locations.



What is Practice Technology?

Practice Technology refers to the digital tools leveraged for project design & delivery.

At HED, the Practice Technology Team is a group dedicated to the management of those tools, workflows and standards.

The goal of HED's Practice Technology team is to **advance the use of technology** in the practice of Architecture and Engineering.

HED

Introduction

The Power of Computational Tools

Implementing the Workflow

Hypar

Skema

TestFit

Comparison of Computational Tools

Integration and Future Potential

HED

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Motivation for the Initiative

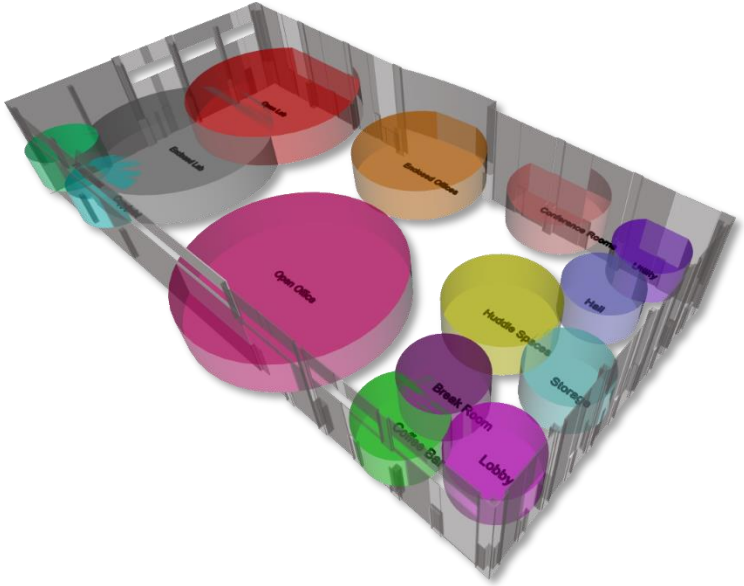
- Rise of AI is driving the need for extensive physical infrastructure.
- Opportunity to research and develop computational tools that would optimize the process of developing data center design options.
- Computational tools allow designers to explore more options, faster and facilitate optimization.

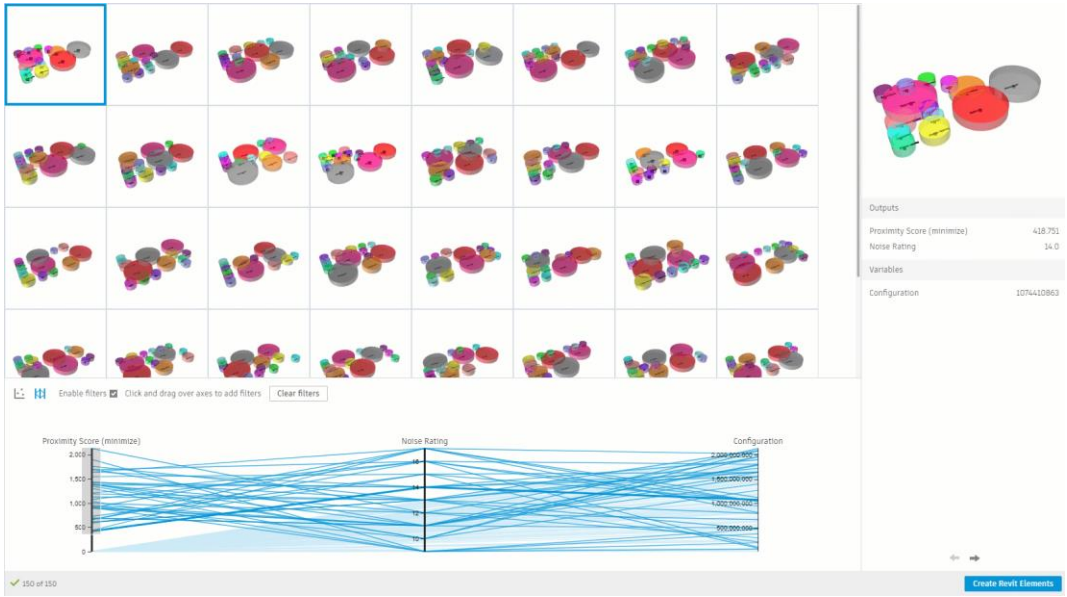
Generative Design in Revit

Building massing studies based on various parameters related to occupancy and site.

Generative Design in Revit

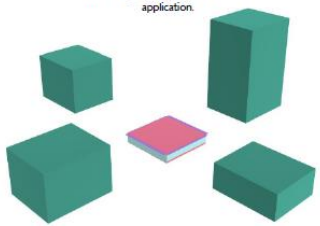
Workplace Space Planning





DAY LITE

DayLite responds to the issues with daylight analysis tools, which require an investment in time and training. DayLite is a tool related to Machine Learning supervised predictions for quick and easy daylighting design. The designs can be evaluated and the selected design can be generated in 3D modeling software and a web application.



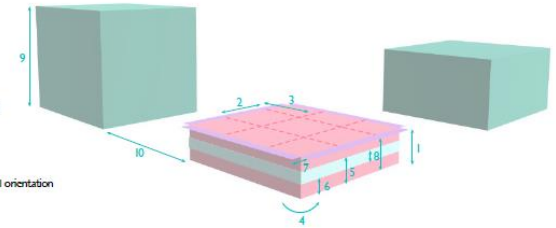
Skills: Rhinoceros . Grasshopper . HTML . CSS . JavaScript . Python . Data Visualization . Machine Learning
Individual Work
Faculty: Angelos Chronis

HYPOTHESIS

Variable Inputs

1. Floor Height
2. Room Width
3. Room Height
4. Room Orientation
5. Window Height*
6. Window Sill Height*
7. Shading Depth*
8. Glazing Ratio*
9. Context Height*
10. Context Offset*

* repeated for each cardinal orientation

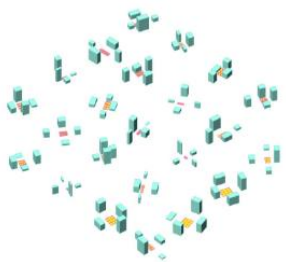


Outputs

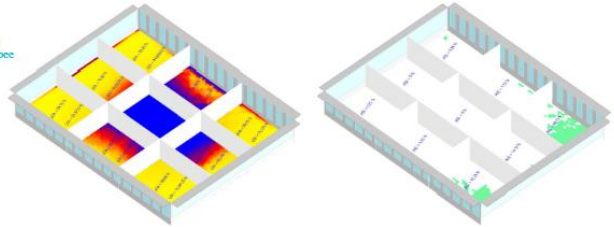
1. sDA
2. UDI
3. ASE

METHODOLOGY

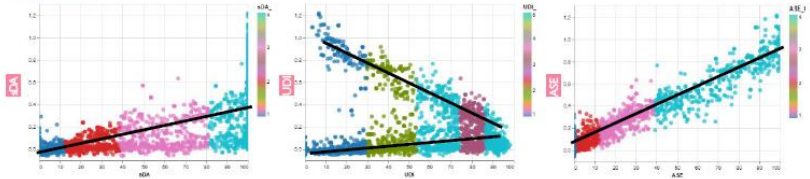
Room Generator
Wallacei



Daylight Analysis
Ladybug and Honeybee



Machine Learning
Linear Regression



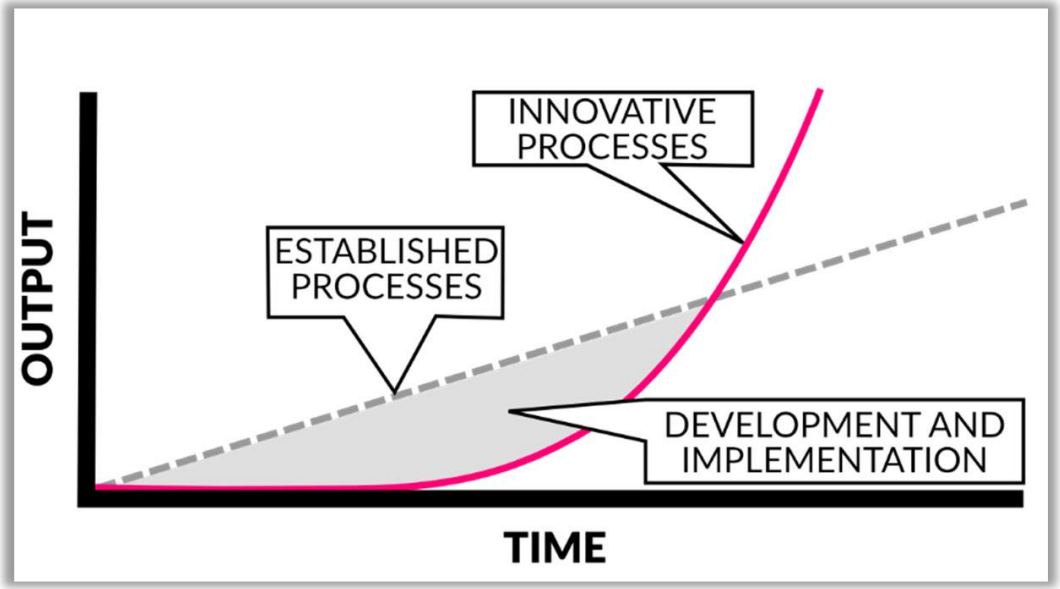
Grasshopper Hops
Validation

Test	Predicted Daylight	Honeybee Daylight	Error	% Error
1 - room 9	sDA = 26.55 UDI = 48.30 ASE = 7.19	sDA = 24.57 UDI = 46.01 ASE = 7.76	sDA = 1.98 UDI = 2.29 ASE = -0.55	sDA = 8.07% UDI = 4.98% ASE = -7.08%
2 - room 9	sDA = 13.98 UDI = 53.58 ASE = 3.23	sDA = 28.13 UDI = 69.75 ASE = 8.72	sDA = -1415 UDI = -16.17 ASE = -5.49	sDA = -50.30% UDI = -23.18% ASE = -62.95%
3 - room 9	sDA = 79.72 UDI = 80.88 ASE = 33.52	sDA = 57 UDI = 74 ASE = 22	sDA = 22.72 UDI = 6.88 ASE = 11.51	sDA = 39.86% UDI = 9.30% ASE = 52.34%
4 - room 9	sDA = 76.20 UDI = 80.73 ASE = 34.74	sDA = 75 UDI = 78 ASE = 28	sDA = 1.20 UDI = 2.73 ASE = 6.74	sDA = 1.60% UDI = 3.50% ASE = 24.08%

Research and Innovation at the Forefront

"Architects are increasingly using their design technology initiatives as a mechanism to promote research and innovation. Digital design is framed as a long-term investment (rather than an expense) affecting top- and bottom-line business considerations. Furthermore, the marketability of capability is also essential – digital design culture is readily apparent in public narratives in many practices today."

Nate Miller | proving ground
Architectural Digital Design Roadmap



Conceptual graph showing the opportunity to leverage research and development to drive innovation over established processes.

Source: Architectural Digital Design Roadmap | proving ground

Goals

- Short-term goal: Quickly generate Data Center plans.
- Long-term goal: Make the tools easily available for the project teams.

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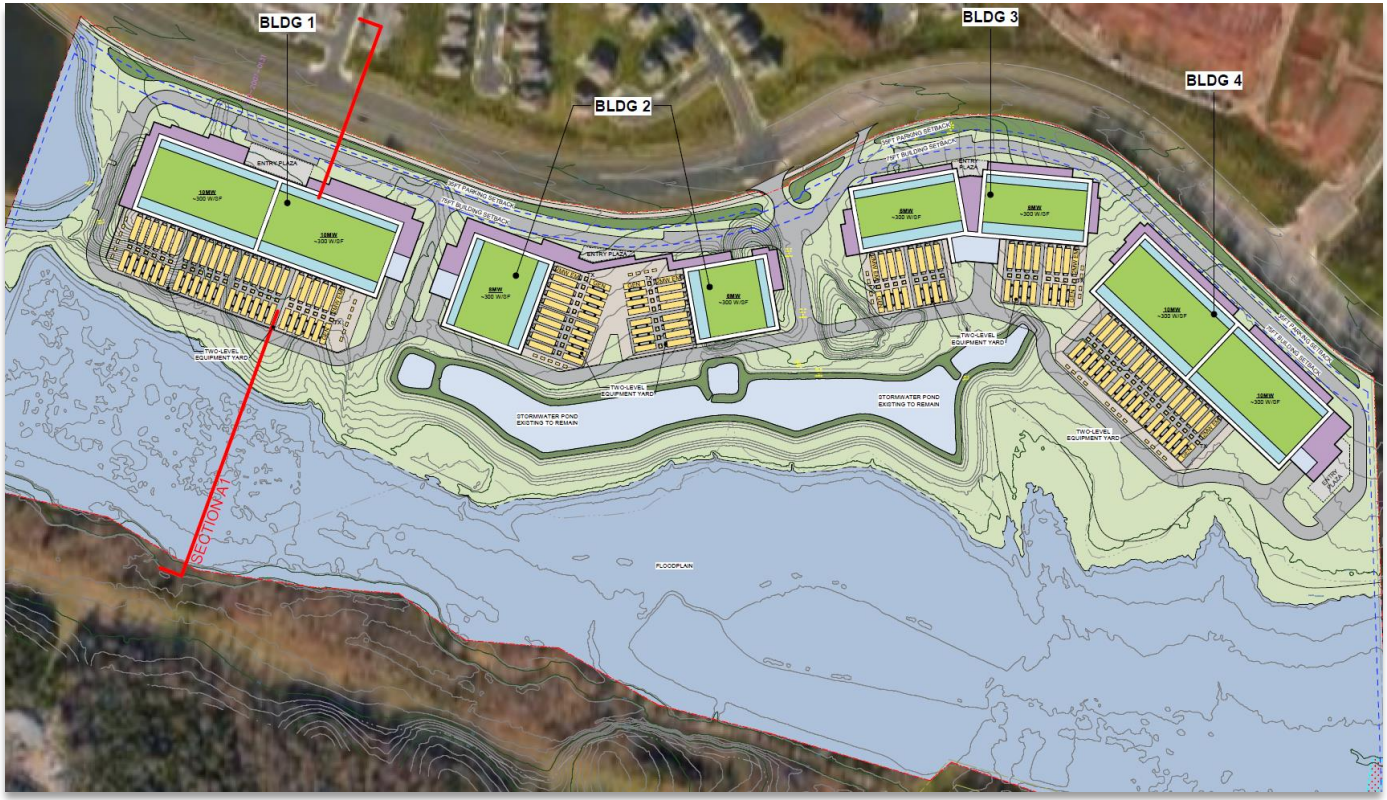
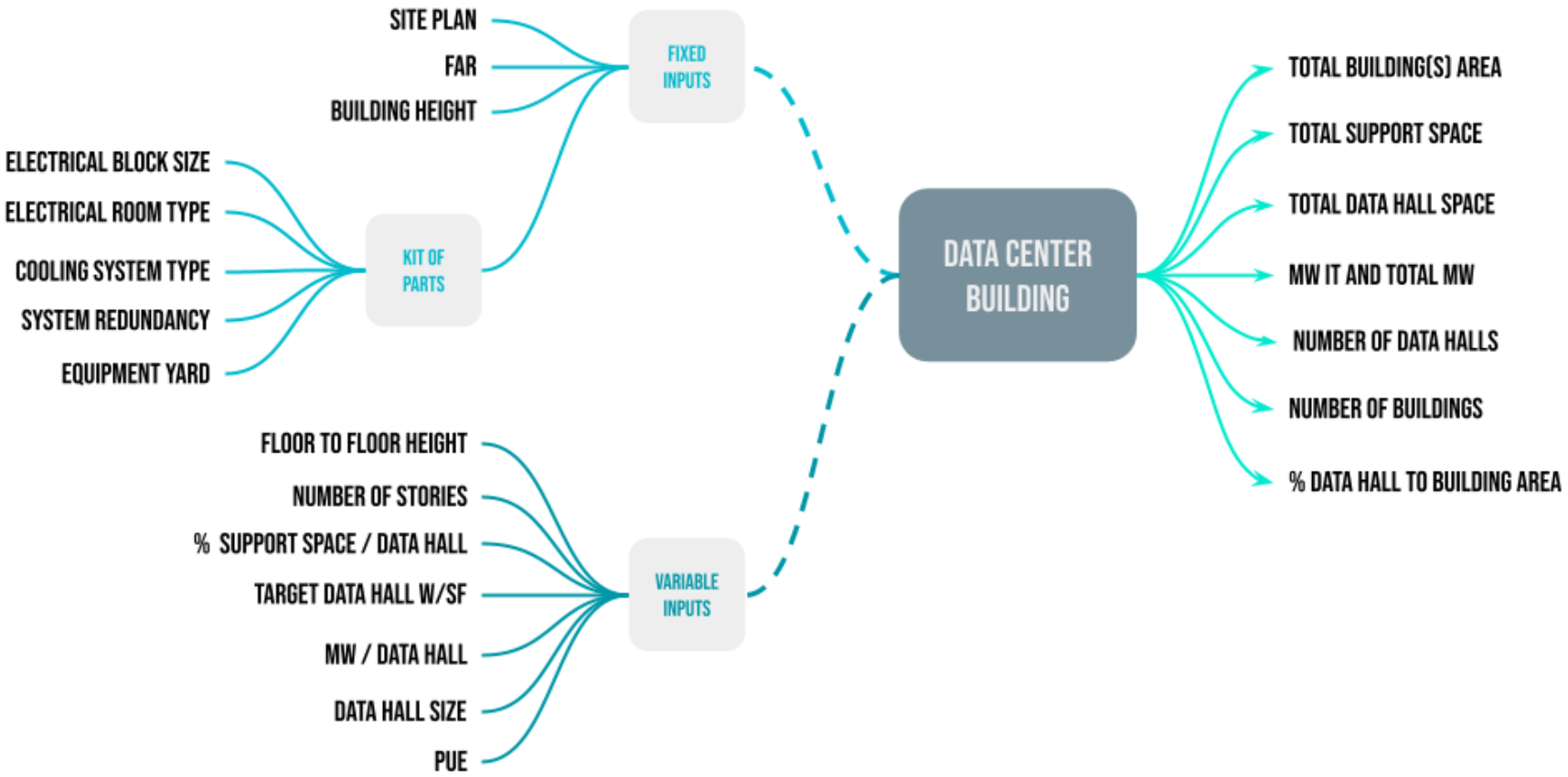
Data Center Campus Planning



CONCEPT DIAGRAM

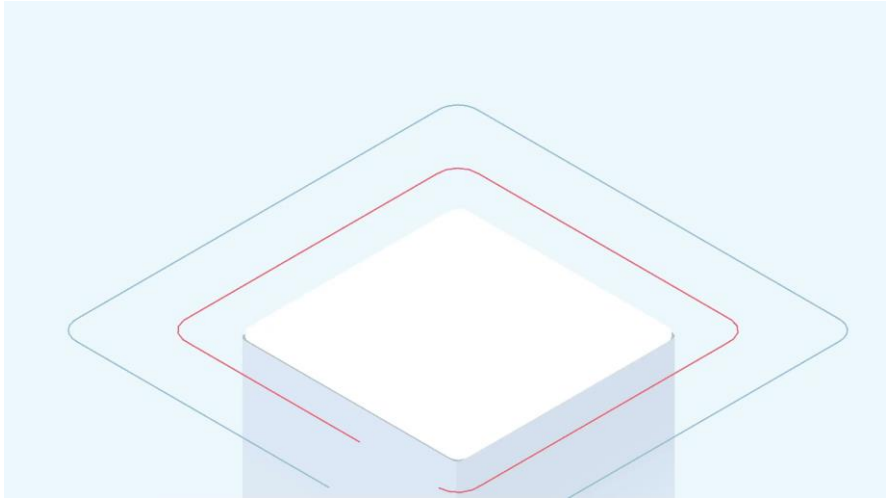


HED

About Hypar

- Hypar is a web-based software that enables designers to rapidly create and optimize complex building designs.

- Generate models using a simple and intuitive graphical interface.



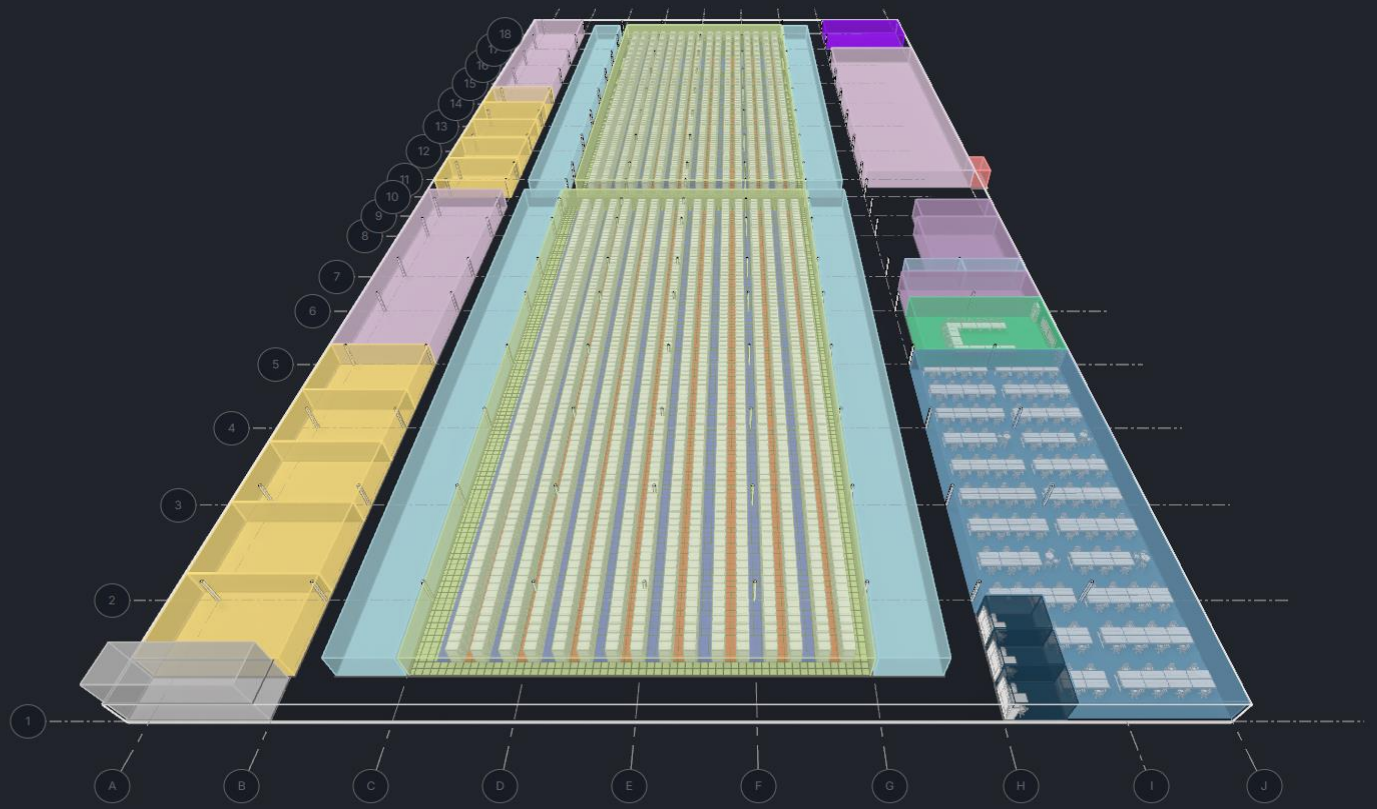
Source: hypar.io

Hypar Space Planning

- Fast
- Smart
- Fits into your workflows

DATA CENTER

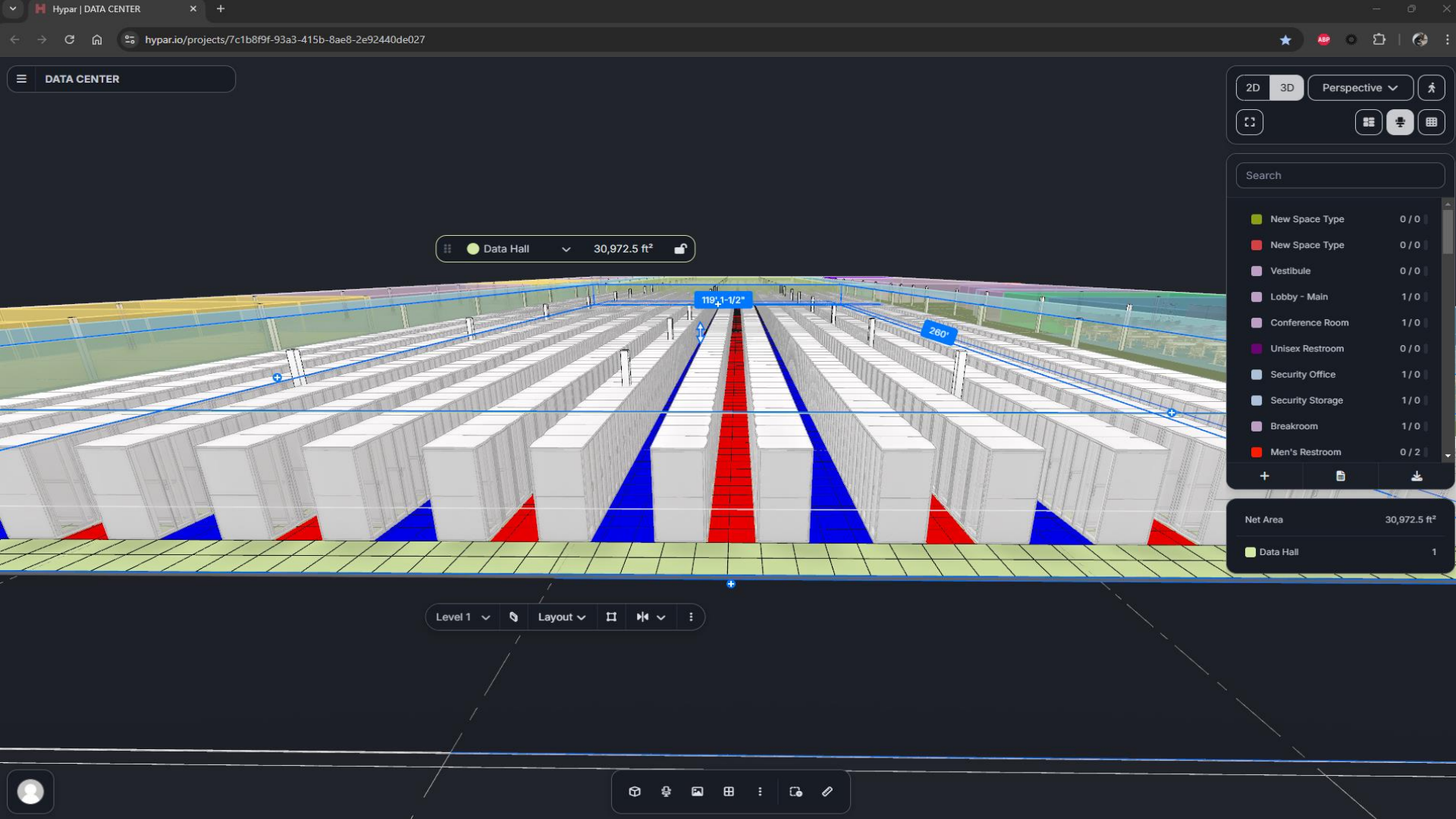
2D 3D Perspective



Search

New Space Type	0 / 0
New Space Type	0 / 0
Vestibule	0 / 0
Lobby - Main	1 / 0
Conference Room	1 / 0
Unisex Restroom	0 / 0
Security Office	1 / 0
Security Storage	1 / 0
Breakroom	1 / 0
Men's Restroom	0 / 2

Gross Floor Area	152,017.8 ft²
Net Area in Building	124,698.9 ft²
Building Gross-up Factor	1.22


Hypar | DATA CENTER
hypar.io/projects/7c1b8f9f-93a3-415b-8ae8-2e92440de027
DATA CENTER
2D
3D
Perspective
Search
Data Hall
30,972.5 ft²
New Space Type 0 / 0
New Space Type 0 / 0
Vestibule 0 / 0
Lobby - Main 1 / 0
Conference Room 1 / 0
Unisex Restroom 0 / 0
Security Office 1 / 0
Security Storage 1 / 0
Breakroom 1 / 0
Men's Restroom 0 / 2
Net Area 30,972.5 ft²
Data Hall 1
Level 1
Layout

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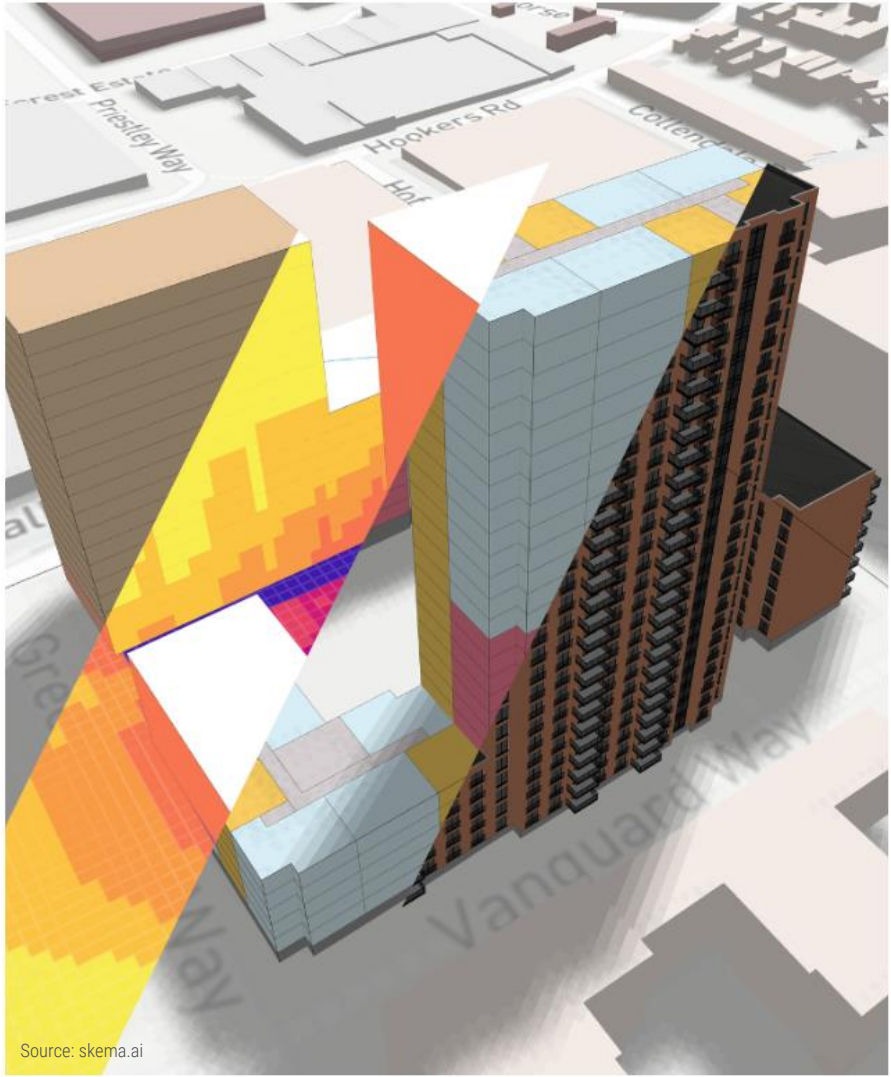
About Skema

- AI-powered conceptual design tool that generates Revit models using your previous designs to create a "Skema Design Catalog."

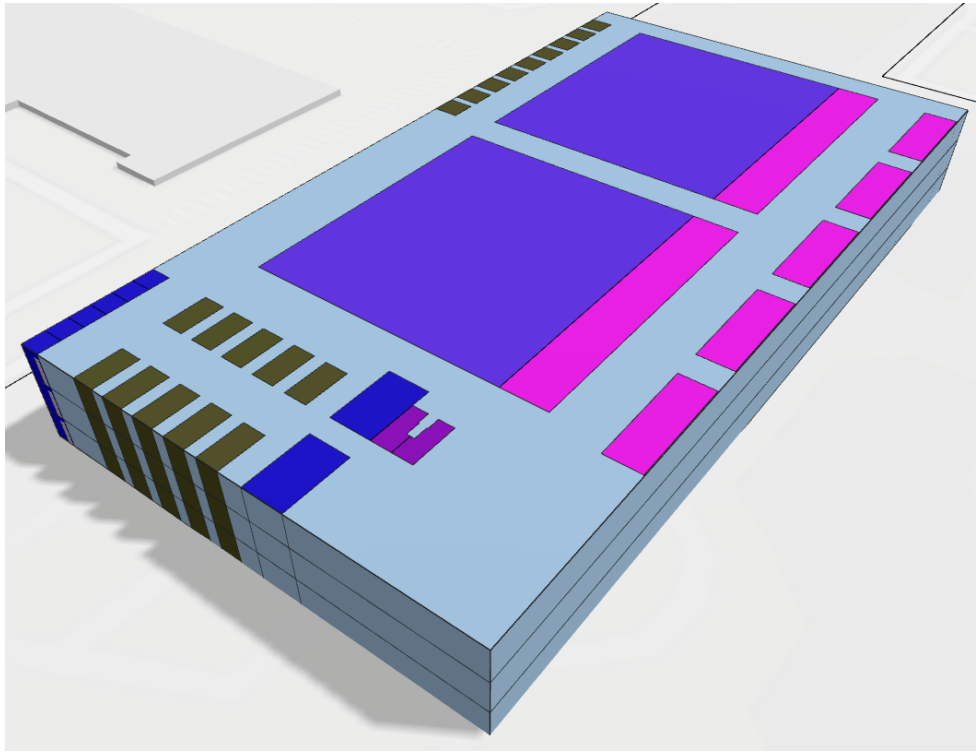


Source: skema.ai


SKEMA

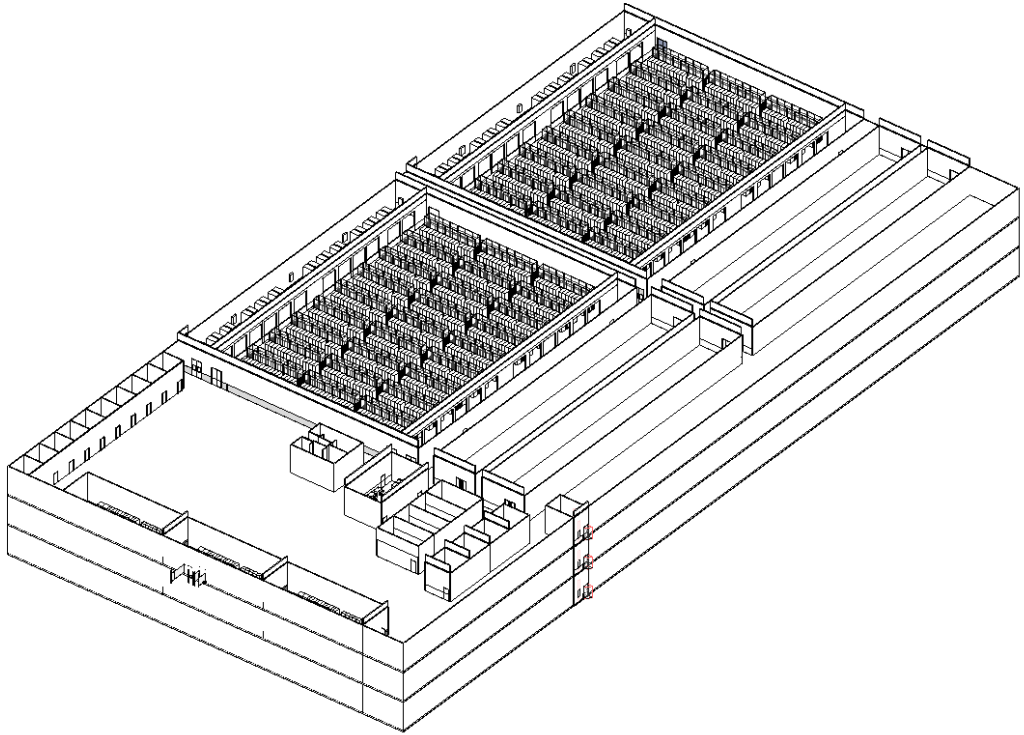
Skema Web-App

- Context and Massing for Concept Design.
- Simulation and Analysis for Climatic Design.
- Design Catalogs for Schematic Design.
- Integrated Metrics for Financial Analysis.



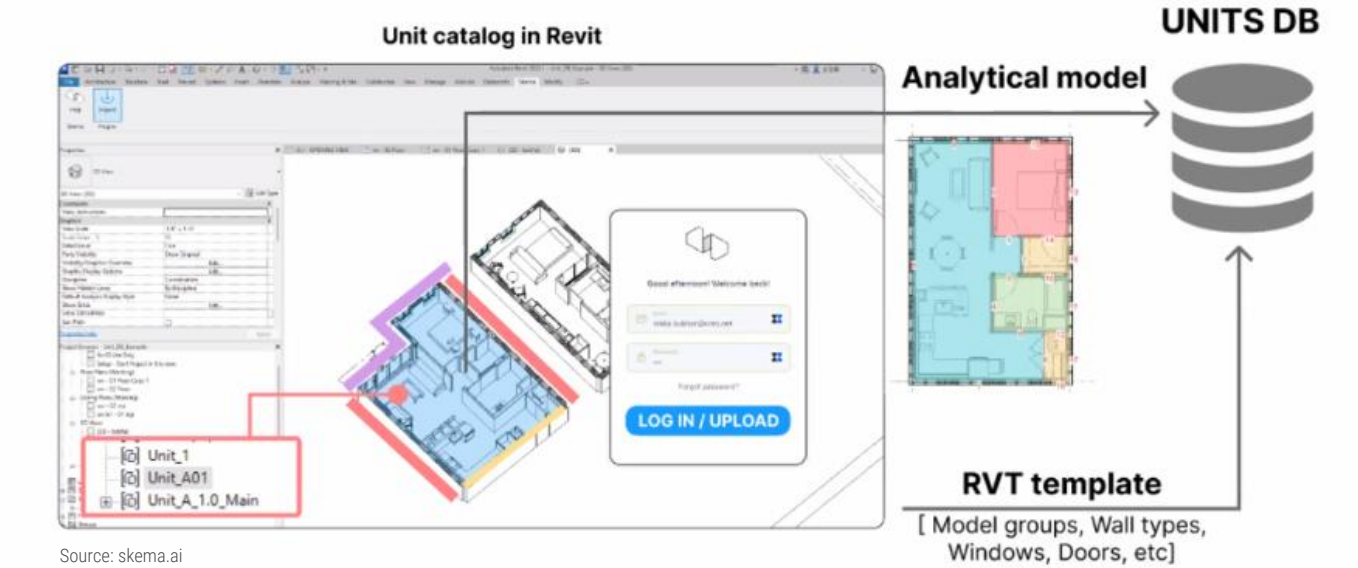
Revit Integration

- LOD350 detail level.
- Catalog units preserved as groups in BIM.
- Adherence to a firm's BIM standards and families.
- Accelerated construction deliverables.



Data

- BIM designs remain your intellectual property.
- Skema does not train their AI on your data.
- Design Catalogs are exclusive to your firm.



Source: skema.ai

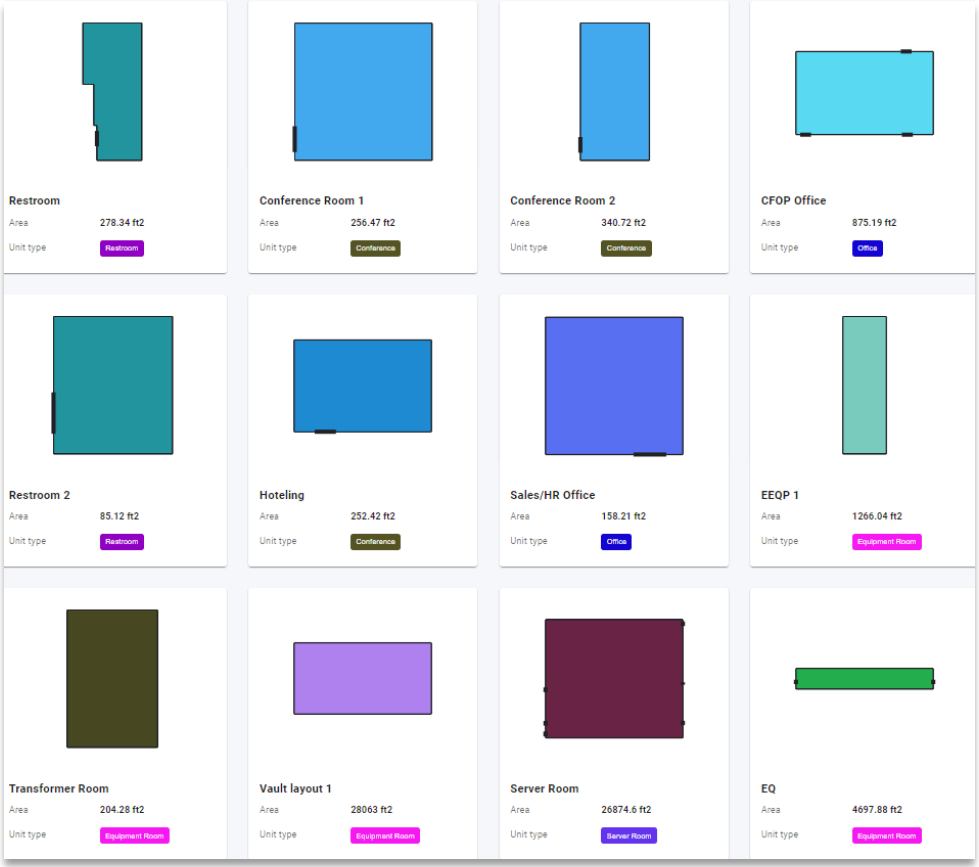
Workshop Checklist

- Revit files containing repeatable elements
  - Standard Data Center spaces
- Project brief
  - Project Address
  - Area
  - Number of stories
  - Equipment
  - Program

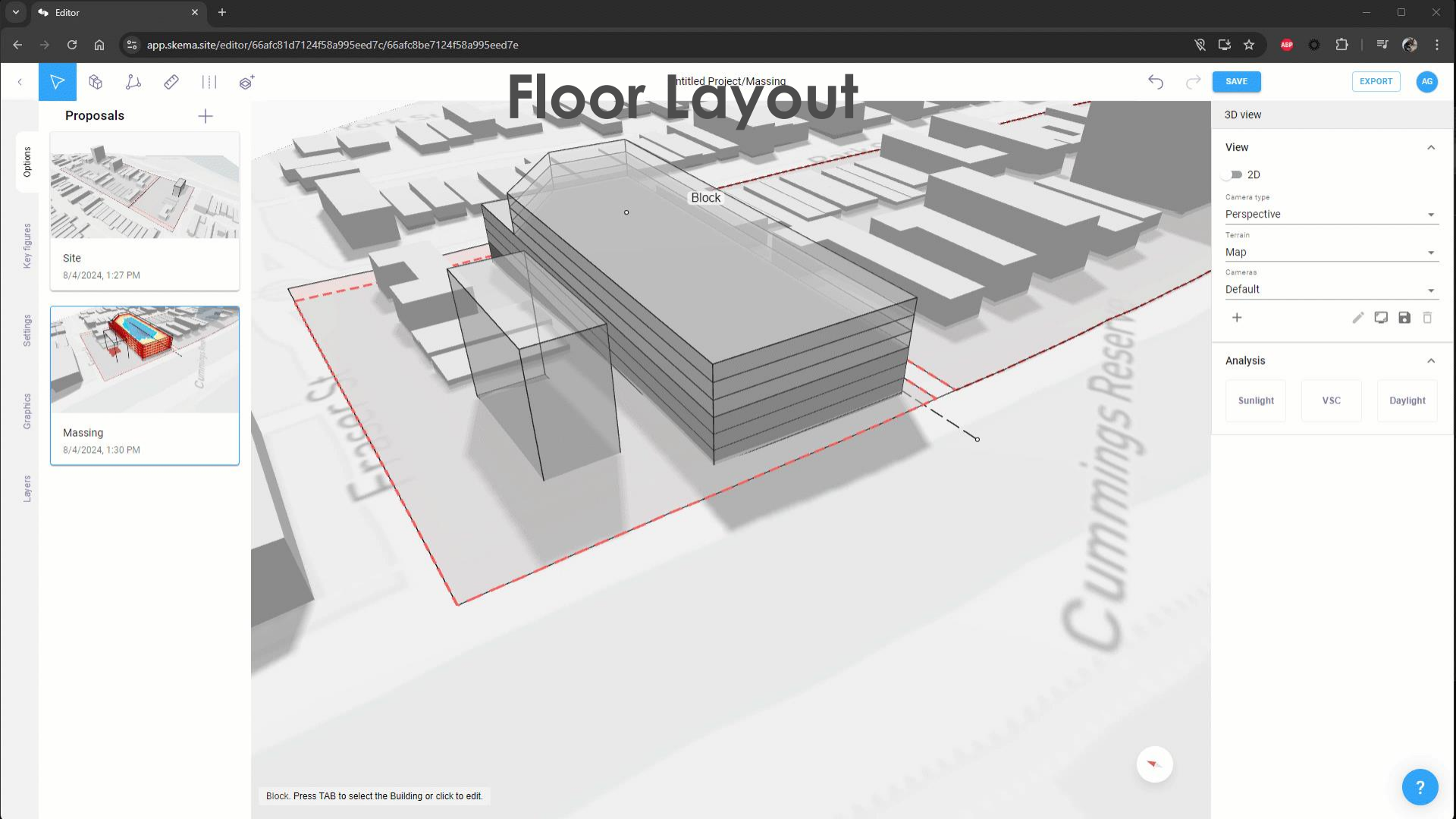
Data Center Catalog

HED Data Center Catalog

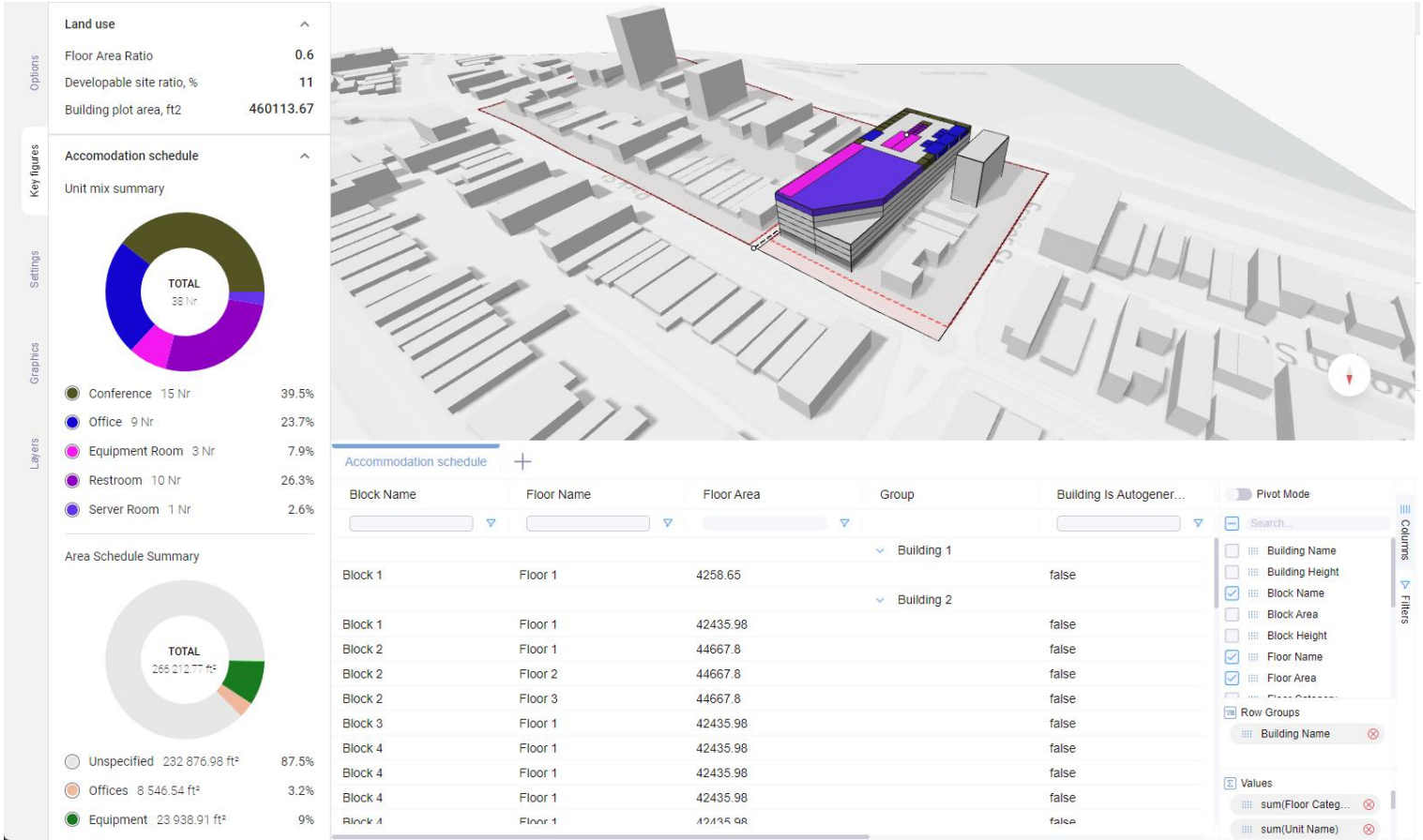
Unit count	12
Revit version	2023



Floor Layout



Key Figures


Options
Key figures
Settings
Graphics
Layers
Land use
Floor Area Ratio 0.6
Developable site ratio, % 11
Building plot area, ft2 460113.67
Accomodation schedule
Unit mix summary
TOTAL
38 Nr
Conference 15 Nr 39.5%
Office 9 Nr 23.7%
Equipment Room 3 Nr 7.9%
Restroom 10 Nr 26.3%
Server Room 1 Nr 2.6%
Area Schedule Summary
TOTAL
Unspecified 232 876.98 ft² 87.5%
Offices 8 546.54 ft² 3.2%
Equipment 23 938.91 ft² 9%
Accommodation schedule
Block Name
Floor Name
Floor Area
Group
Building Is Autogener...
Pivot Mode
Building 1
Block 1 Floor 1 4258.65 false
Building 2
Block 1 Floor 1 42435.98 false
Block 2 Floor 1 44667.8 false
Block 2 Floor 2 44667.8 false
Block 2 Floor 3 44667.8 false
Block 3 Floor 1 42435.98 false
Block 4 Floor 1 42435.98 false
Block 4 Floor 1 42435.98 false
Block 4 Floor 1 42435.98 false
Columns
Filters
Building Name
Building Height
Block Name
Block Area
Block Height
Floor Name
Floor Area
Row Groups
Building Name
Values
sum(Floor Categ...
sum(Unit Name)


Autodesk Revit 2023.1 - Home
agioia_HED
File
Architecture
Structure
Steel
Precast
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Revizto 5
Enscape™
Datasmith
Data Exchanges
HEDTools
Ideate Software
pyRevit
Revolution Design
Rhino.Inside
Skema
TestFit
Toolbox
V-Ray
Help
Skema
Import Project
Upload Unit Catalog
Plugins
Revit Export
Ready

Introduction

The Power of Computational Tools

Implementing the Workflow

Hypar

Skema

TestFit

Comparison of Computational Tools

Integration and Future Potential

HED

Solves Schemes Sites Data

Site A
- Pond
- Sub Station - Sm
- Sub Station - Lar
- Data Centers - Large Single Load No Offset
- Data Centers

Unsaved Deal

TestFit

Site A

Setbacks
- Ignore roads
- Default 10'0"
- Front 10'0"
- Side 10'0"
- Rear 10'0"
- Balcony overhang 0'0"
- Tolerance 1'0"
- Slope step 20'0"
- Global setback
- Label default
- Trailing clamp

apply to all edges | reset all setbacks

Zoning

Pro Forma

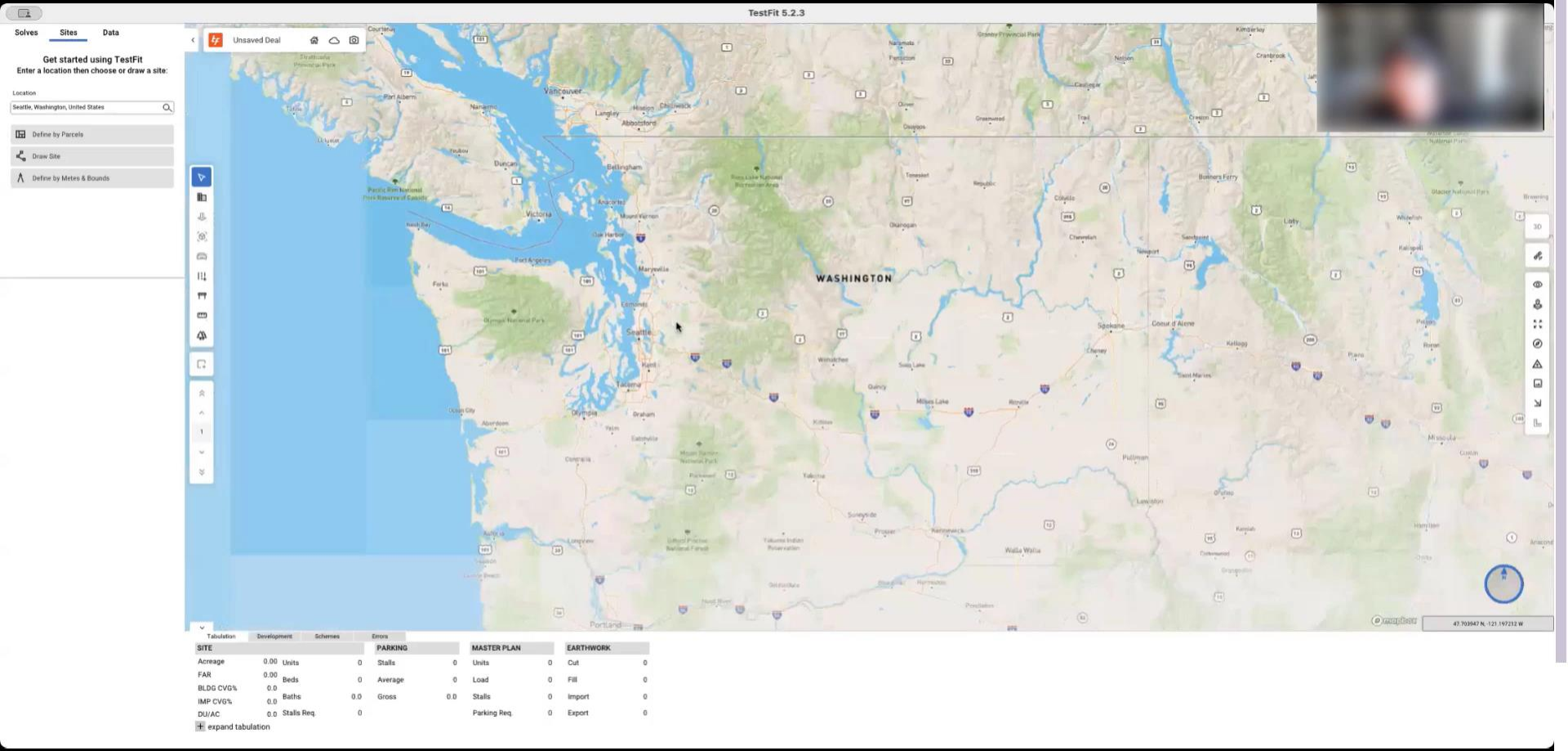
Earthwork

<name> save locally

Tabulation | Development | Schemes | Errors

SITE		DATA CENTER BLDG		DATA CENTER PWR		YARD		CAR PARKING		PARKING		MASTER PLAN		EARTHWORK	
Acreage	144.02	Bldg	4,698,000.0	Area	3,758,399.8	Area	1,613,966	Area	0	Stalls	0	Stalls	0	Cut	2,467,576
FAR	0.75			IT Power	676.5									Fill	2,723,325
BLDG CVG%	41.3	Bays	120	Non-IT Power	169.1	Stalls Prov.	0	Stalls Prov.	0	Average	0			Import	255,750
IMP CVG%	67.0			Critical Power	845.6										
Green	2,206,266	Height	72.0	Elec. Dist.	900.0	Stalls Req.	0	Stalls Req.	0	Ratio (Units)	0.00	Ratio (Units)	0.00	Export	0
				Elec. Avail.	PASS							Parking Req.	0		

expand tabulation

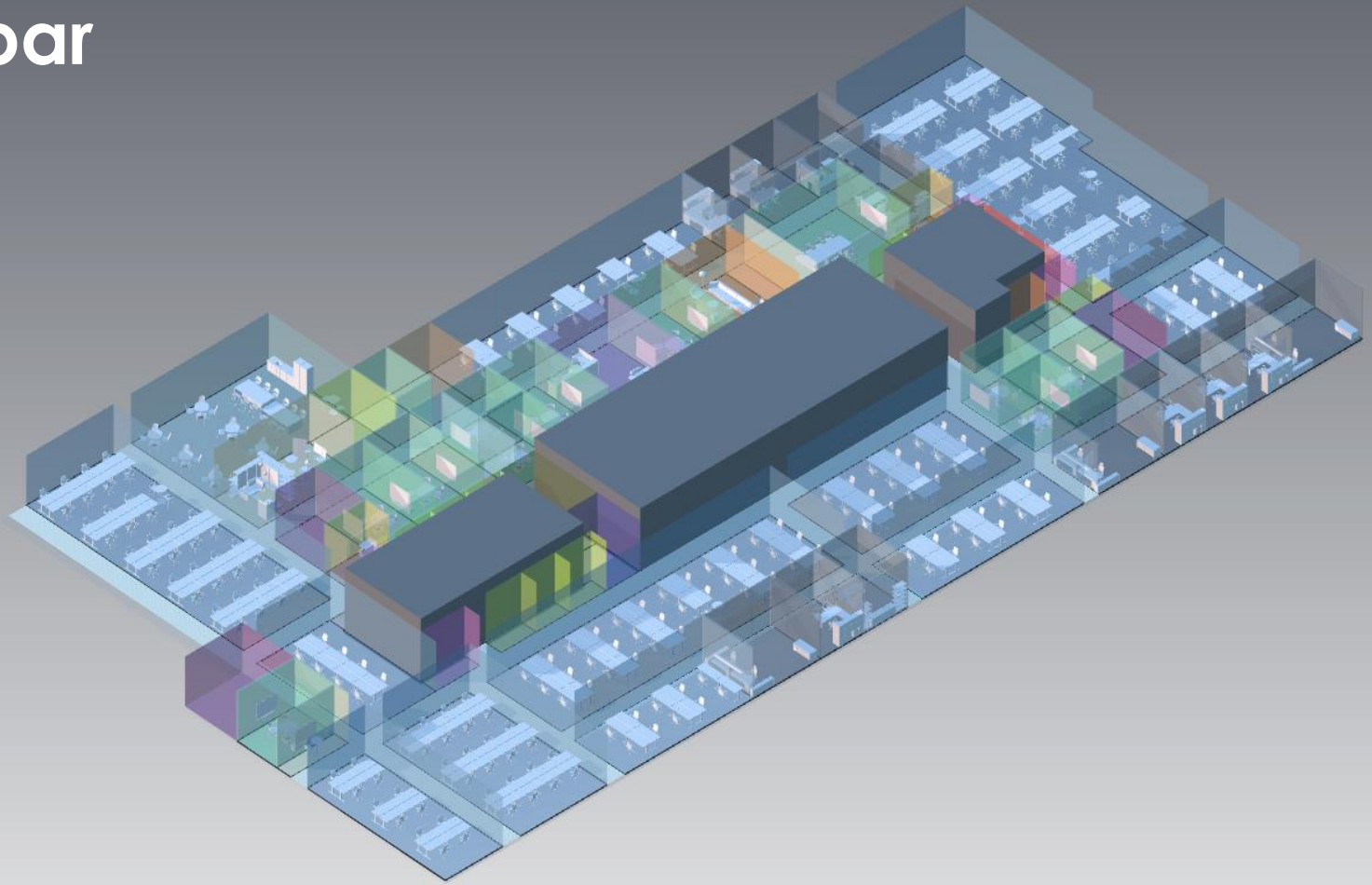

TestFit 5.2.3
Solves
Sites
Data
Get started using TestFit
Enter a location then choose or draw a site:
Location
Seattle, Washington, United States
Define by Parcels
Draw Site
Define by Metes & Bounds
Unsaved Deal
WASHINGTON
Vancouver
Victoria
Seattle
Portland
Spokane
Tabulation
Development
Schemes
Errors
SITE
Acreage 0.00
FAR 0.00
BLDG CVG% 0.0
IMP CVG% 0.0
DU/AC 0.0
Units 0
Beds 0
Baths 0.0
Stalls Req. 0
PARKING
Stalls 0
Average 0
Gross 0.0
MASTER PLAN
Units 0
Load 0
Stalls 0
Parking Req. 0
EARTHWORK
Cut 0
Fill 0
Import 0
Export 0
expand tabulation

HED

Comparison of Tools in the Industry

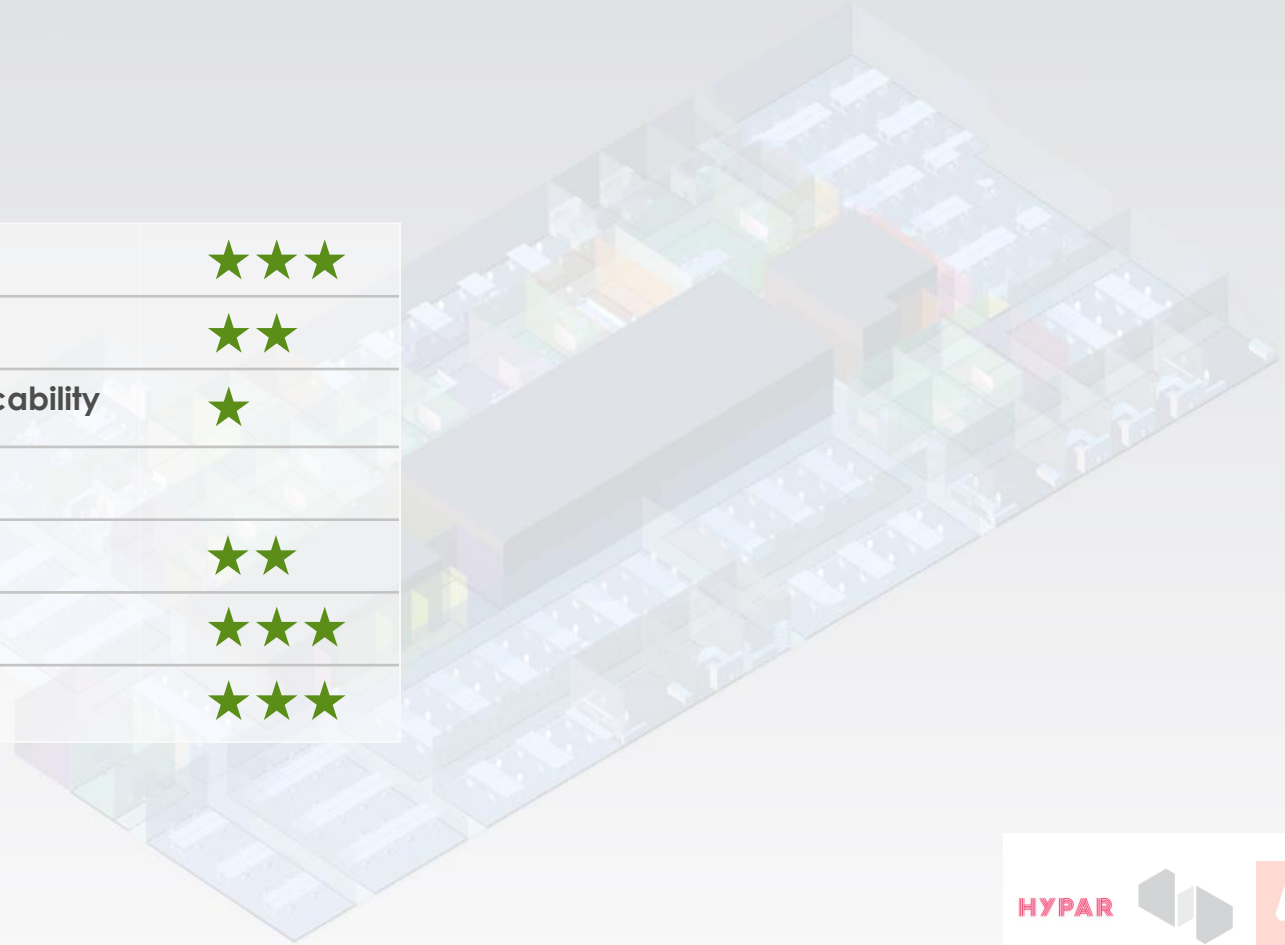
	HYPAR			
Getting Started				
Value				
Data Center Applicability				
Customization				
BIM Integration				
Support				
Low Cost				

Hypar

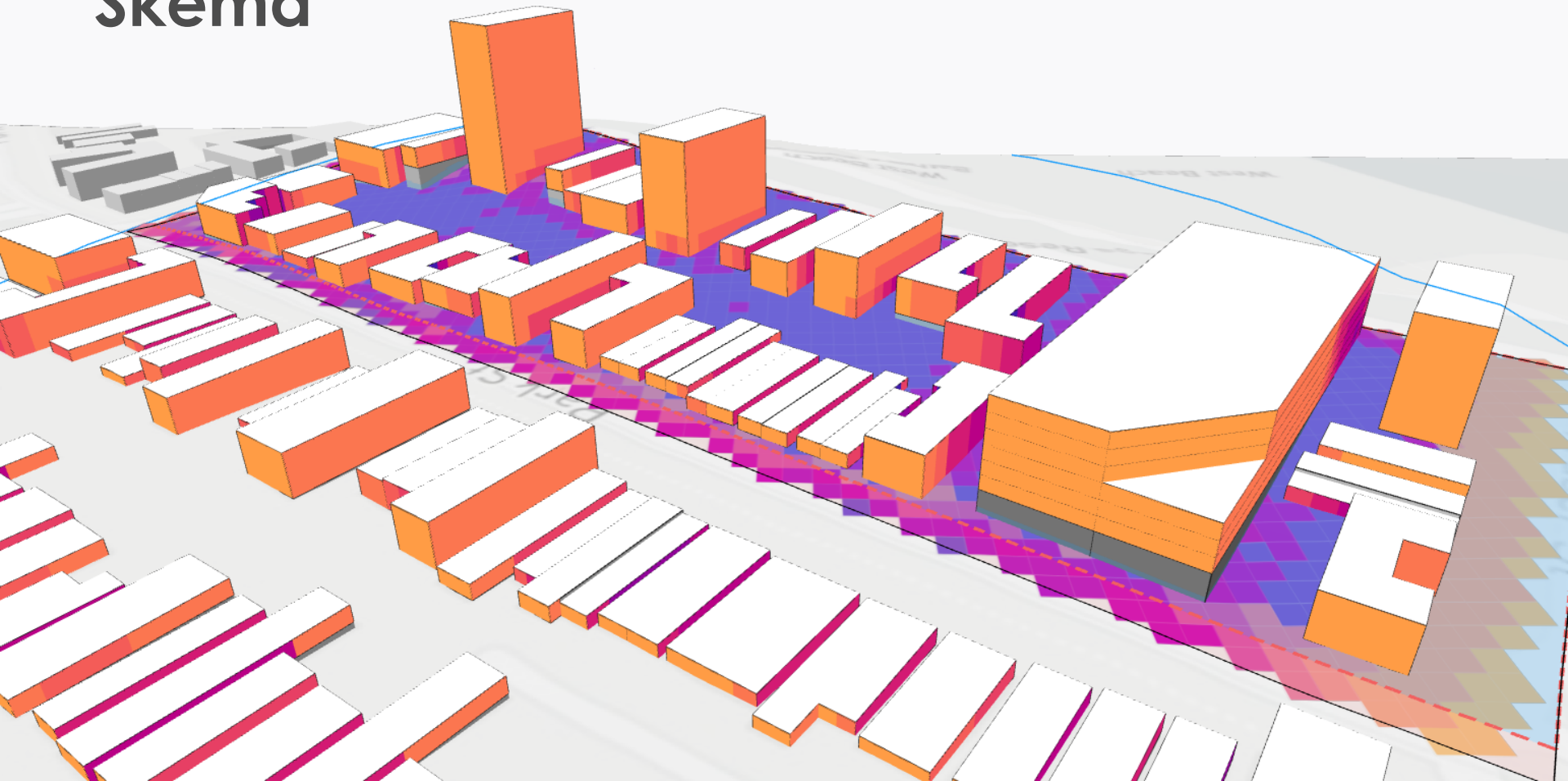


Hypar

Getting Started	★★★
Value	★★
Data Center Applicability	★
Customization	
BIM Integration	★★
Support	★★★
Low Cost	★★★



Skema



Skema

Getting Started	★★
Value	★★
Data Center Applicability	★★
Customization	★★
BIM Integration	★★★
Support	★★★
Low Cost	★

Solves Schemes Sites Data

Unsaved Deal

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  - Sub Station - Small
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  - Data Centers

TestFit

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Side	10'0"
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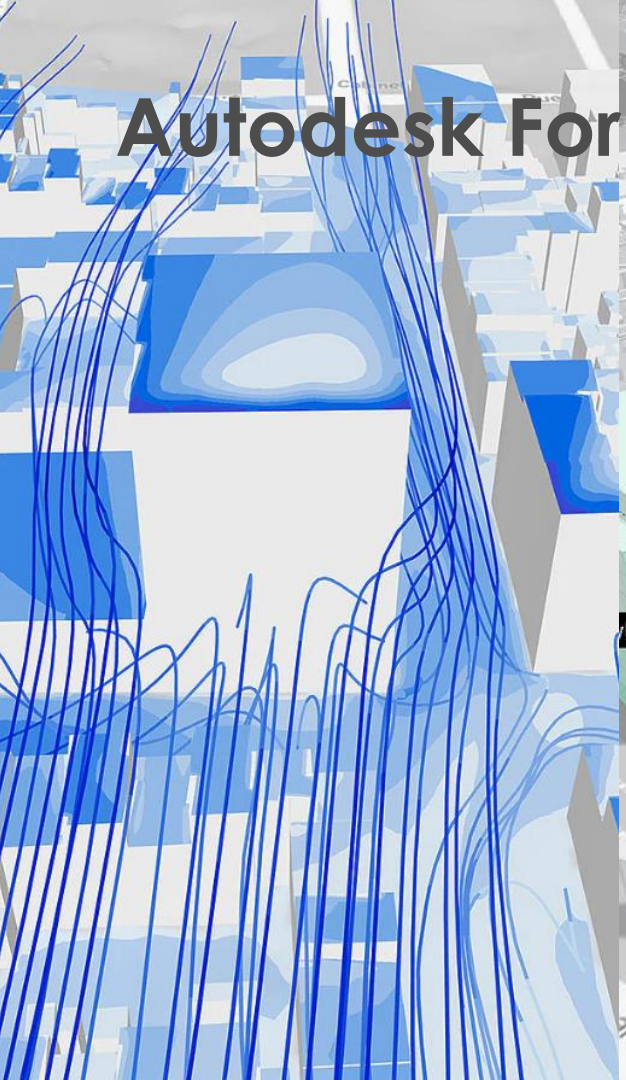
Green	2,206,266	Height	72.0	Elec. Dist.	900.0	Stalls Req.	0	Stalls Req.	0	Ratio (Units)	0.00			Export	0
				Elec. Avail.	PASS							Parking Req.	0		

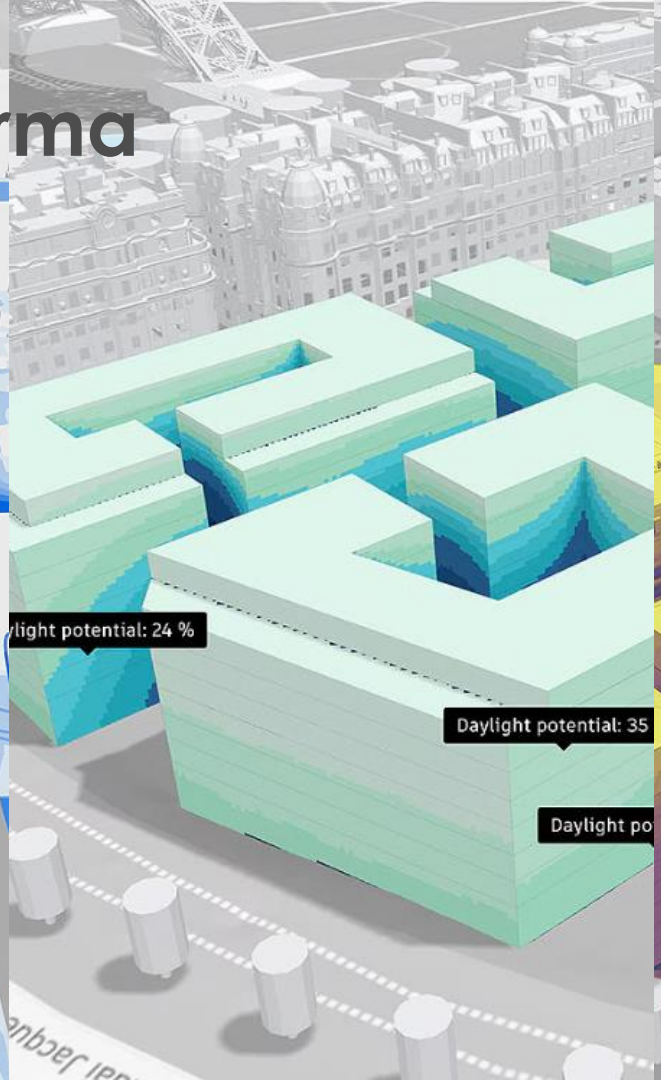
expand tabulation

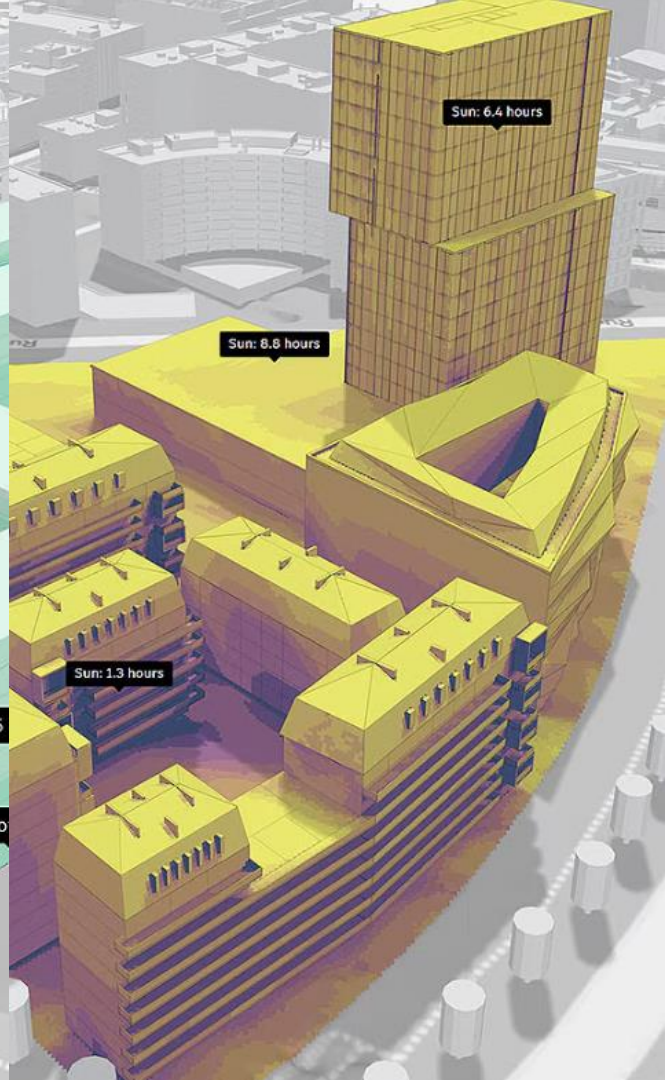
TestFit

Getting Started	★★
Value	★★
Data Center Applicability	★★★
Customization	★
BIM Integration	★
Support	★★
Low Cost	★

Autodesk Forma

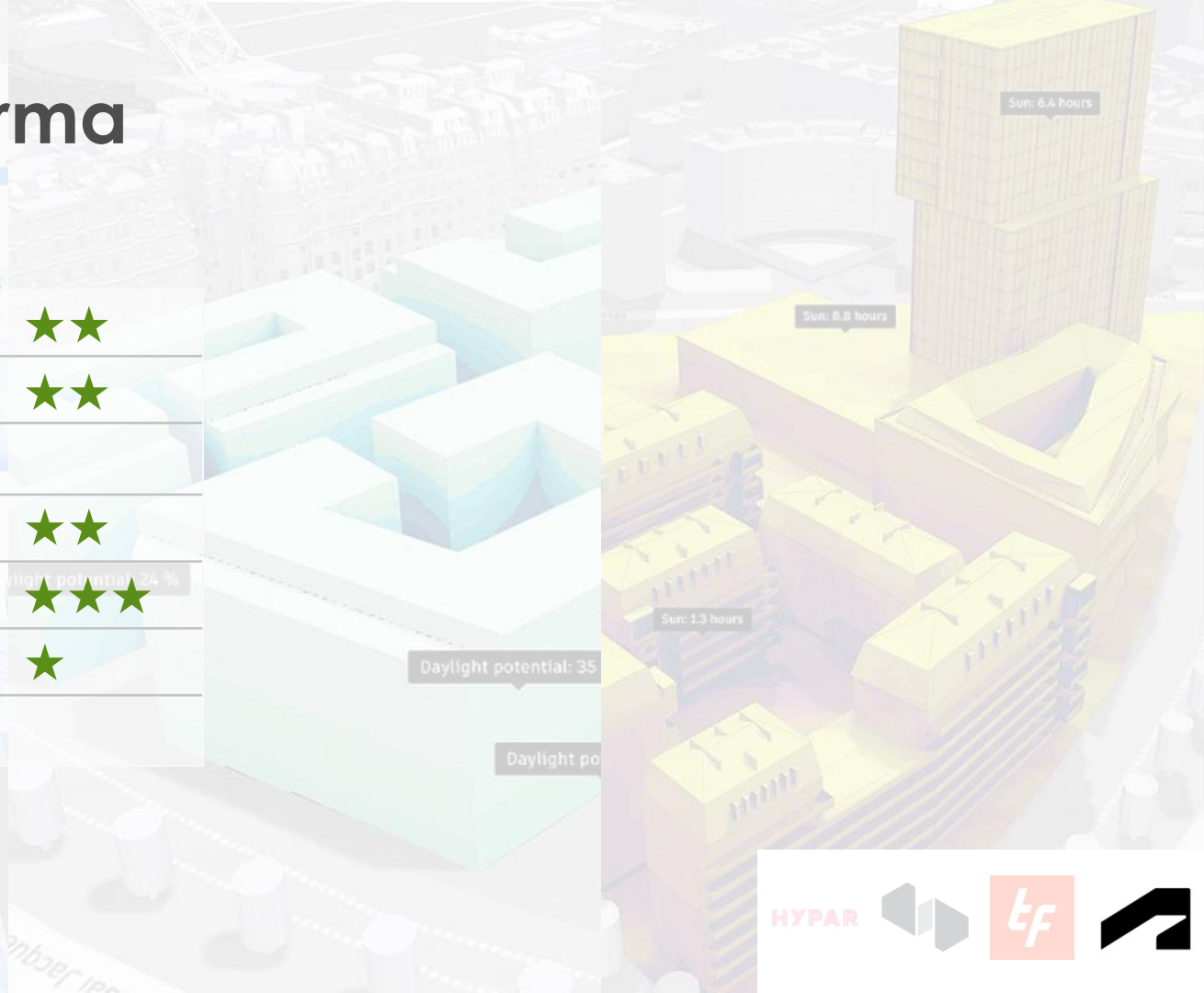






Autodesk Forma

Getting Started	★★
Value	★★
Data Center Applicability	
Customization	★★
BIM Integration	★★★
Support	★
Low Cost	



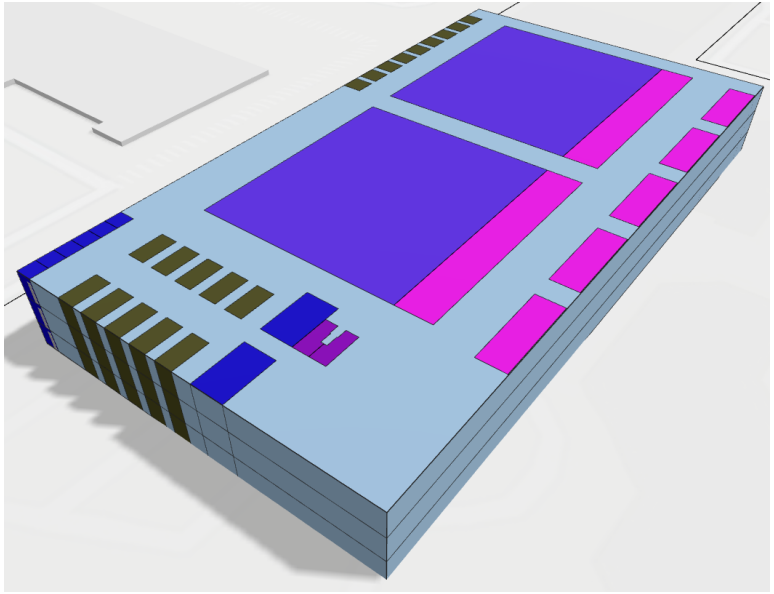
Summary

	HYPAR			
Getting Started	★★★	★★	★★	★★
Value	★★	★★	★★	★★
Data Center Applicability	★	★★	★★★	
Customization		★★	★	★★
BIM Integration	★★	★★★	★	★★★
Support	★★★	★★★	★★	★
Low Cost	★★★	★	★	

HED

The Integration and Impact of Computational Tools at HED

- The exploration began with the hope that designers would show interest and potentially implement the workflows.

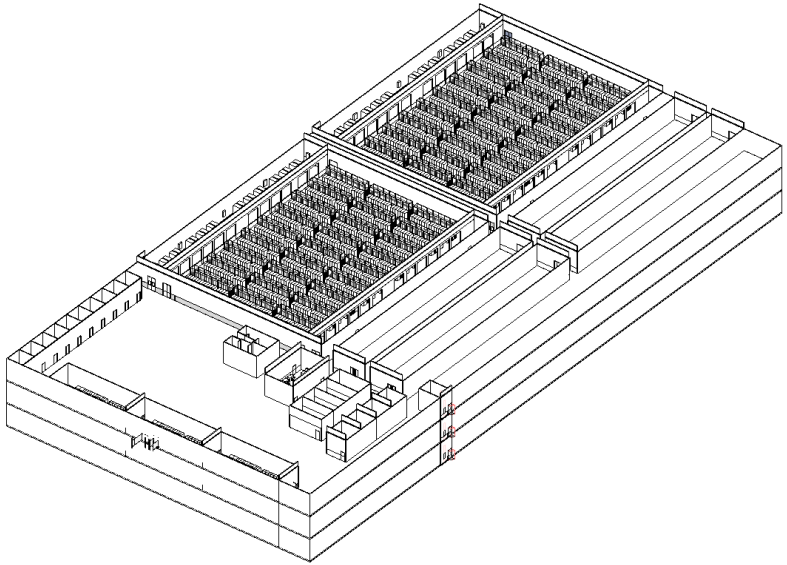


HED

The Integration and Impact of Computational Tools at HED

- The exploration began with the hope that designers would show interest and potentially implement the workflows.

- Despite our efforts, the team is still completing projects using their established tools and methods in Revit.

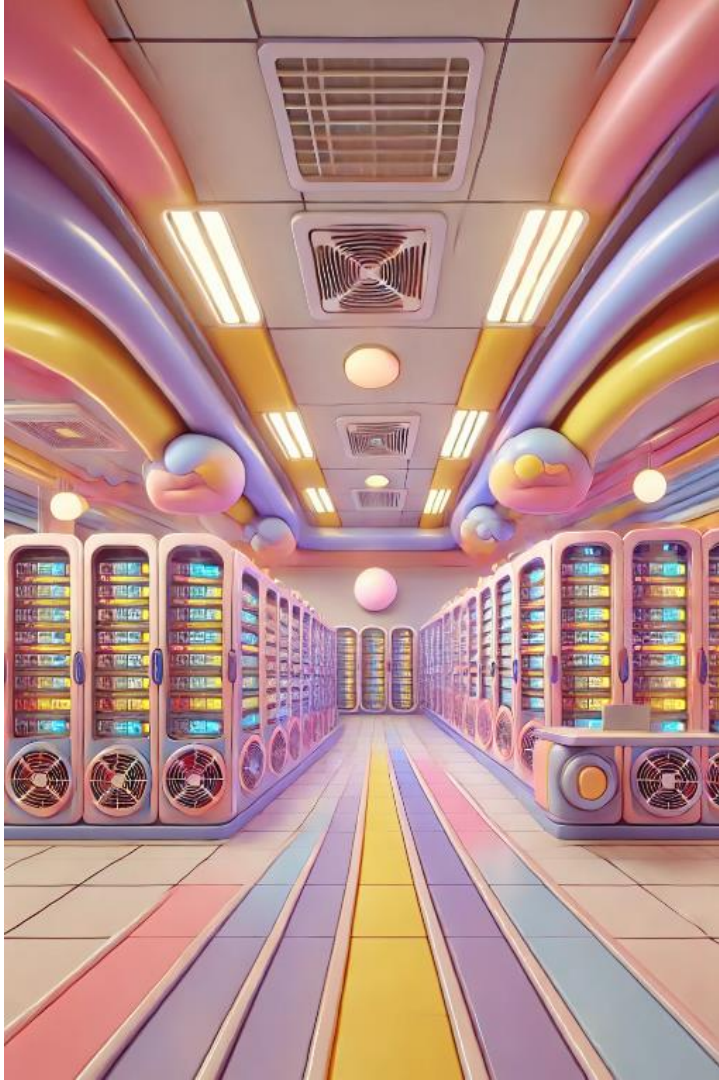


HED

The Challenge of Introducing New Workflows

- Introducing new and innovative workflows can be a challenging and slow process that requires exposure and persuasion.

- HED is actively seeking ways to address obstacles to encourage the adoption of innovative workflows.



Obstacles to Adoption

People

- Leadership disconnects from modern design and technology processes.
- Staff exclusion from decision-making.

Process

- Limited awareness of R&D initiatives.
- Focus on production over innovation.

Technology

- Inconsistent production standards.
- Technology viewed as an expense rather than an investment.

Plan for Encouraging Adoption

- Identify needs and design metrics.
- Position Digital Design as an investment in innovation.
- Research and select appropriate tools.
- Empower staff in software acquisition.
- Engage project managers and leaders.
- Assess impact and benefits.
- Iterate and refine.

Future Opportunities

- Data Center design automation has tremendous potential and can be applied to many other design scenarios.
- Continuously exploring new tools and opportunities to enhance the design process.
- 2024-2026 Strategic Plan goals, centered around AI are driving faster adoption.

Conclusion

- HED is dedicated to fostering a culture of innovation and efficiency in design.
- Look forward to exchanging ideas and learning from others' experiences in improving the industry's approach to design.

Streamlining Data Center Design with Advanced Computational Tools

Amanda Gioia

HED

Technology in Architectural Practice (TAP) +
Professional Practice Committees

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