



North Hall | American University | Washington D.C.

Penn State Architectural Engineering Senior Thesis Project

Brandon Tezak | Construction Management

Dr. Anumba | Facility Advisor

Presentation Outline

- I. Project Background
- II. Analysis 1: Modularization of Suite Bathrooms
- III. Analysis 2: GPS Tracking of Precast Panel
- IV. Analysis 3: Solar Panel Upgrade
 - I. Electrical Breadth
- V. Analysis 4: Traditional Reinforced Concrete Slab
 - I. Structural Breadth
- VI. Summary of Conclusions & Acknowledgements



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- 8 Story New Dormitory
 - 358 Beds
 - Suite Style Rooms
- \$29 Million
- 122,200 SF
- May 15, 2012 - August 9, 2013
- LEED Gold
- Concrete Structure



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Problem Identification

- Compressed Schedule
- Small Site

Goals

- Generate Cost Savings if Possible
- Generate Schedule Savings
- Reduce Congestion Onsite

Background

- 94 Total Suites
- 64 With Typical Bathroom Layout
 - Shower Room
 - Toilet Room
 - Vanity Area

Presentation Outline

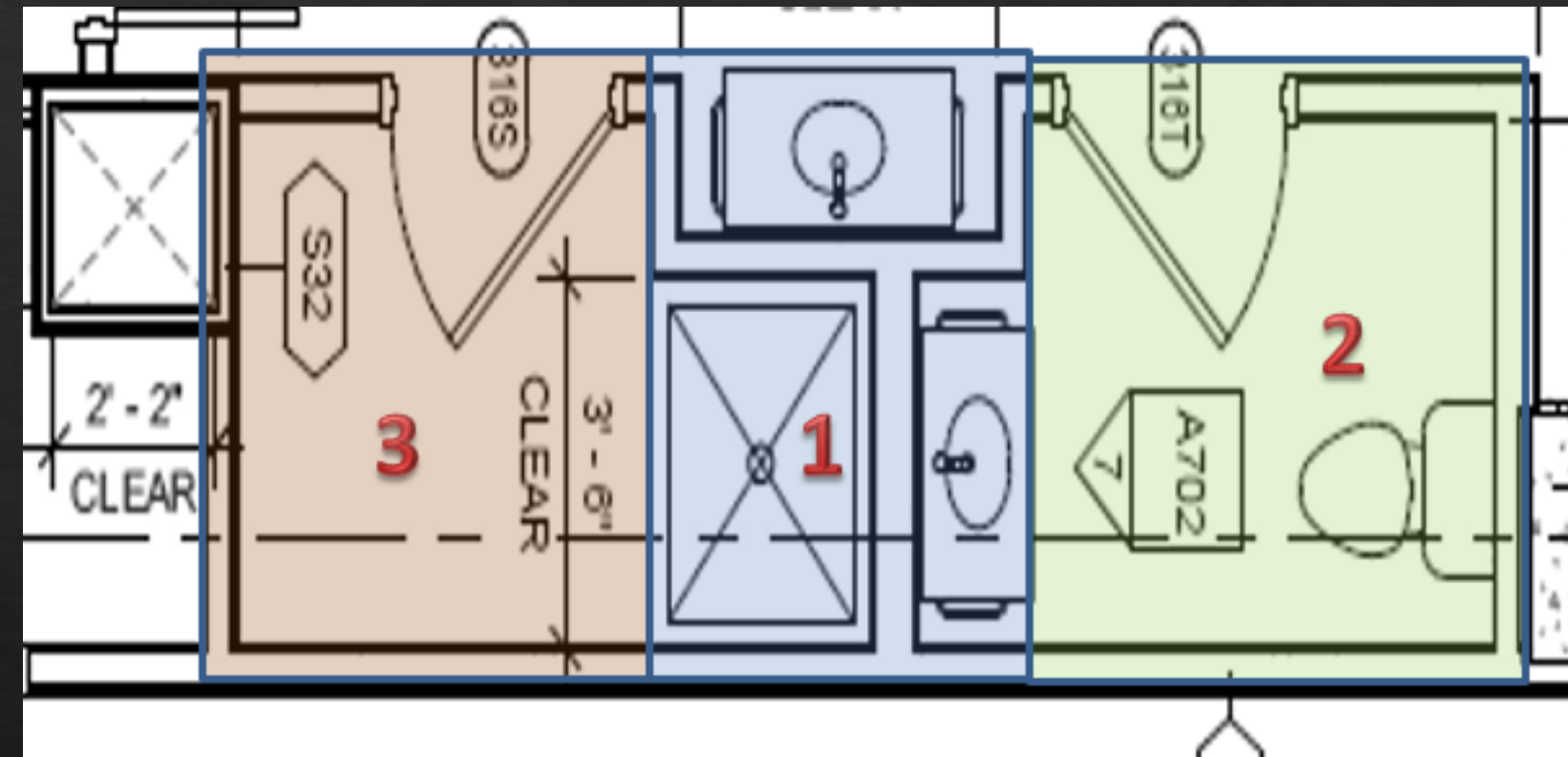
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Module Constraints

- Fit on Truck
- Fit Through Unfinished Corridors
- Handled & Moved Easily

Constructability

- Interface with Stick Built Construction



3 Modules

Logistics

- Production Warehouse
 - 7.5 Miles away (25 Minute Drive)
 - ~9,000 SF
- Transported by Truck
- Lifted by Material Hoist

Presentation Outline

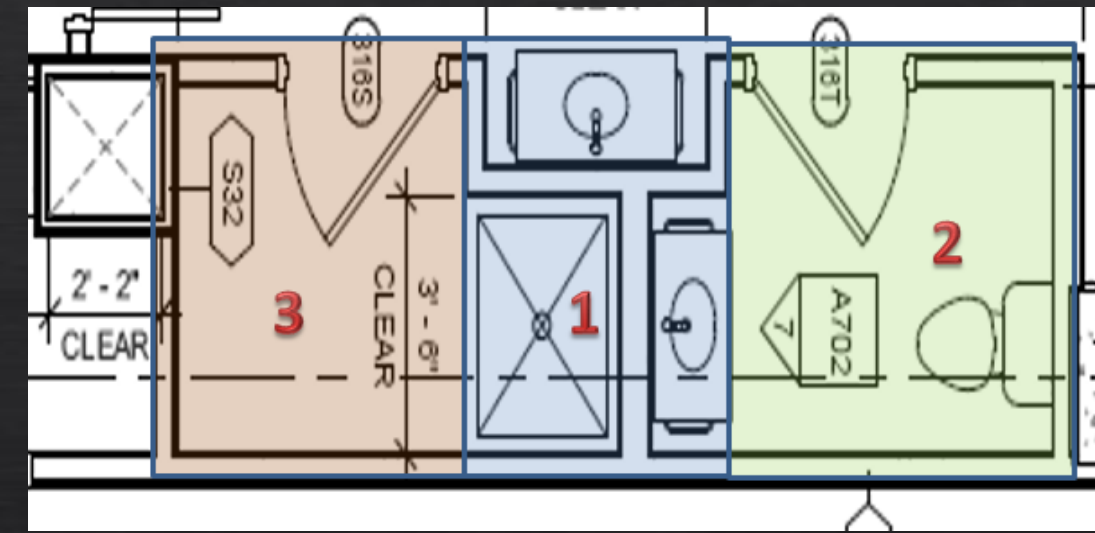
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Assumptions:

- Modules Built Concurrently
- New Bathroom Started Every Two Days for Stick Built

Schedule

- Module 1 – 4.27 Days
- Module 2 – 3.94 Days
- Module 3 – 1.85 Days
- Transportation/Installation – 2 Days



	Single Suite		Full Building (64 suites)	
	Modularized	Stick Built	Modularized	Stick Built
Duration (days)	6.27	10.18	70.31	136.18
Savings (days)		3.91		65.87

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Costs

Modular Construction

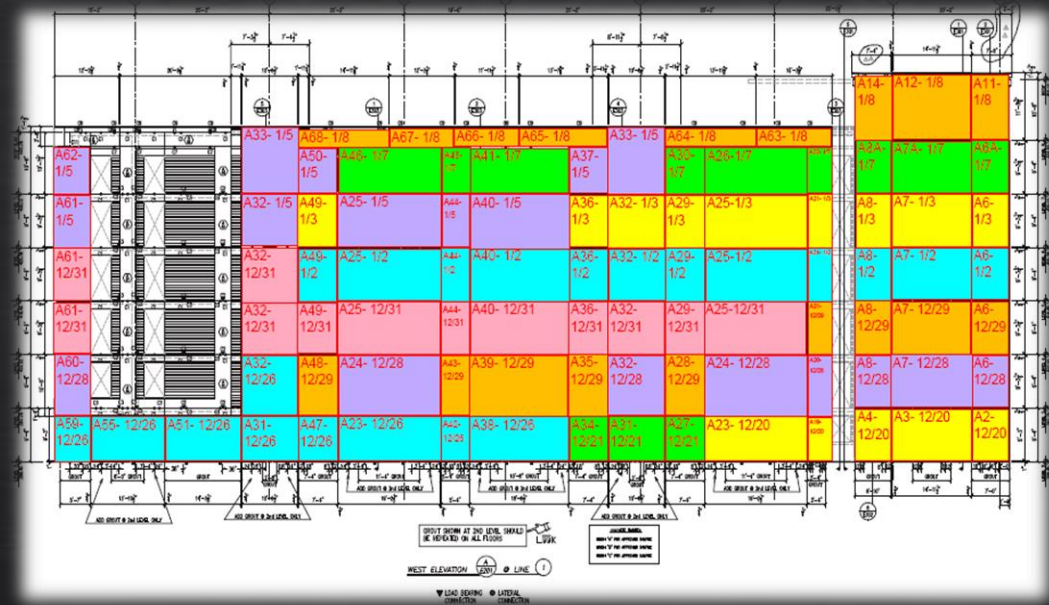
	Single Suite	Full Building (64 Suites)
Module 1	\$6,617.83	\$423,541.12
Module 2	\$5,637.25	\$360,784
Module 3	\$2,577.38	\$164,952.32
Shipping	\$150	\$9,600
Warehouse	\$270	\$17,280
TOTAL	\$15,252.46	\$976,157.44

Modular vs. Stick Built

	Single Suite	Full Building (64 Suites)
Modular	\$15,525.46	\$976,157.44
Stick Built	\$13,810.03	\$883,841.92
Difference	\$1,715.43	\$92,315.52

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Problem Identification

- Limited Crane Usage
- Compressed Project Schedule
- Small Site Entrance

Goals

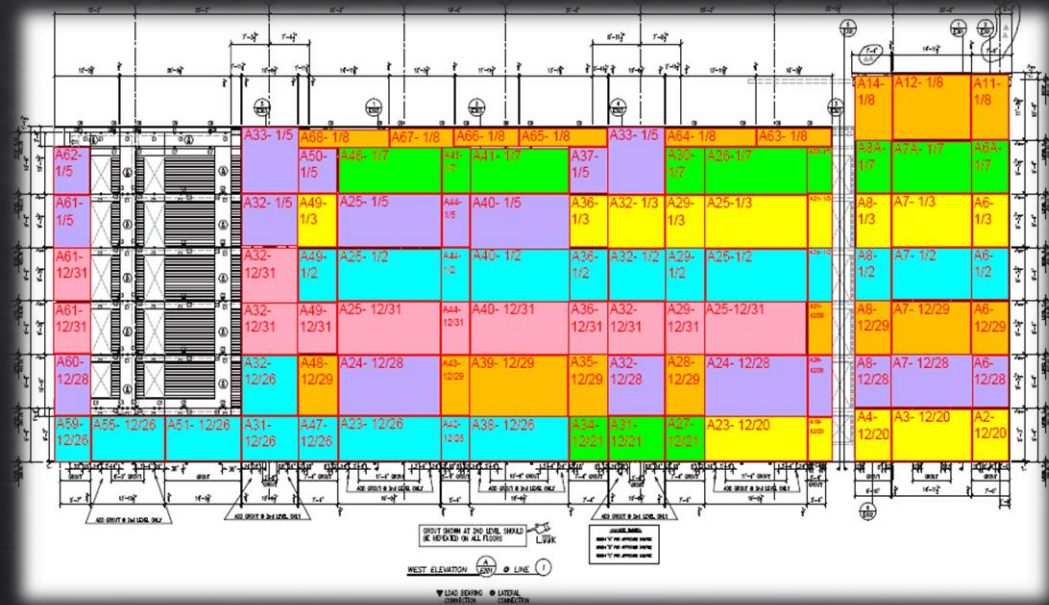
- Keep Erection On Schedule
- Keep Site Entrance Unblocked
- Track Panel Testing

Background

- 8 Week Schedule
- 409 Panels
- Testing of Welds & Bolted Connections
- Manufactured in Oxford, NC

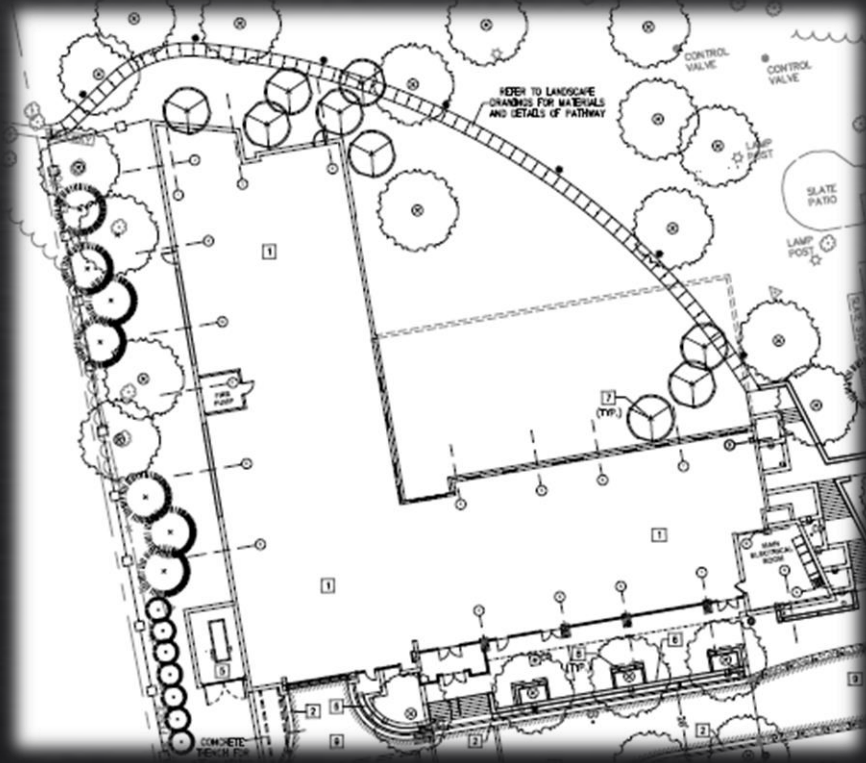
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Sequence

- West Façade - Clockwise
- Second Floor



Erection Problems

- Not Enough Panels
- Site Congestion
- New Crane
- Weather
 - Snow / Ice
 - High Winds



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System Needs

- Real Time Location
- Durable
- Track Testing

Intelliwave Technology – SiteSense

- Web-Based Software
- Designed to Military Specs
- 7 Year Battery Life
- Real Time Location
- Electronic Document Tracking



Best Choice

GPS Insight – FT-1000

- Web-Based Software
- Will Work Inside Buildings
- Real Time Location
- Accelerometer
- Small Size



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Intelliwave Technology – SiteSense



Cost

- 309 Tags
 - Reuse First 100
- Tag Cost: \$108,150
 - \$350 per tag
- Service Fee: \$4,635
 - \$15 per Device per Month
 - 2 Month Activation
- Total Cost: \$112,785
- Eliminate Rental of New Crane
 - Approx. \$3,150

Schedule Benefits

- No New Crane
- Minimize Project Delays
- Keep Erection On Track



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Problem Identification

- Limited Capabilities of Current Design
- Increasing Energy Costs

Goals

- Increase Capability of System
- Provide Energy Savings
- Effectively Use Generated Electricity

Background

- Current Design
 - Solar Hot Water
- Two Groupings of Panels
 - 7th Floor Roof
 - 8th Floor Roof

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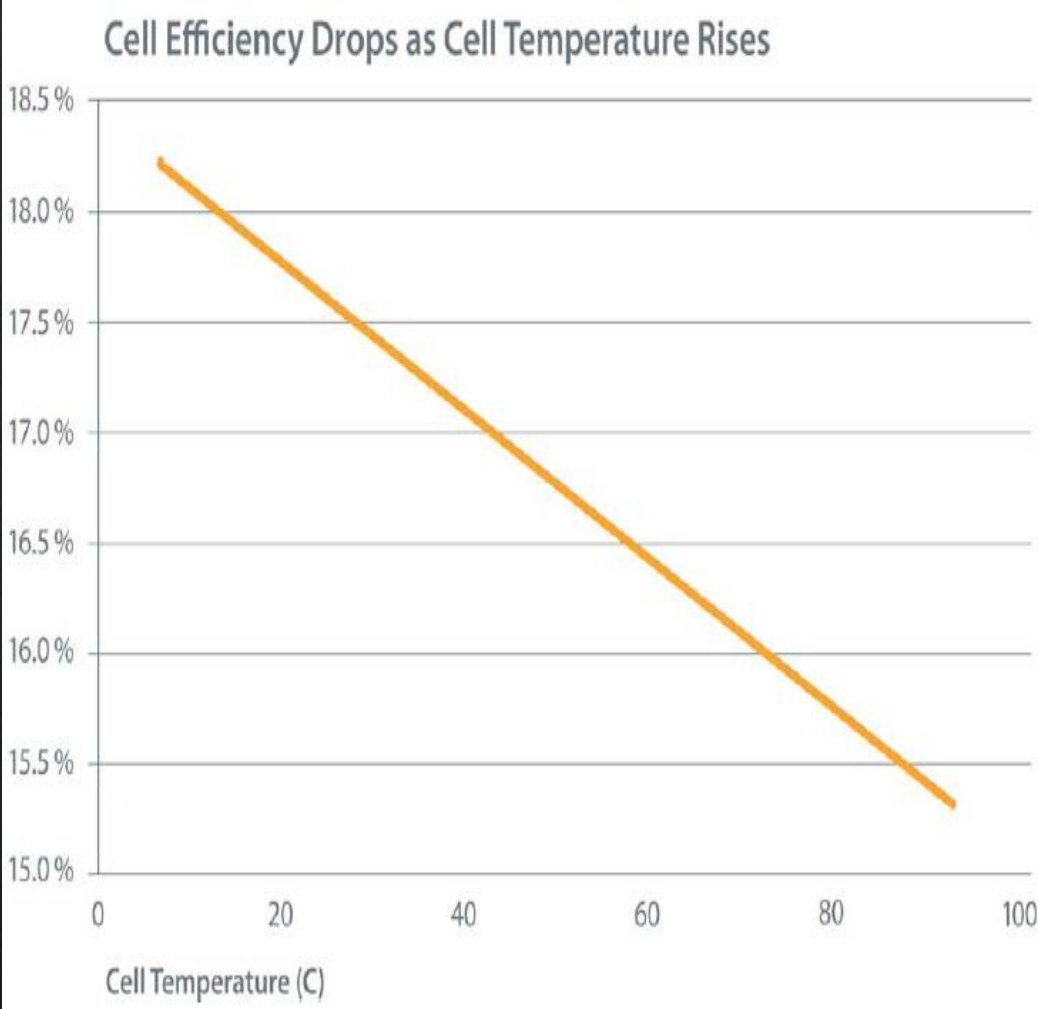


Image Source www.cogenera.com

Cogeneration Panel

- Solar Hot Water & Electrical Generation
- Silicone Cell
- Up to 75% Efficient
- Sun Tracking
- 35% Increase in Energy Panel Sees

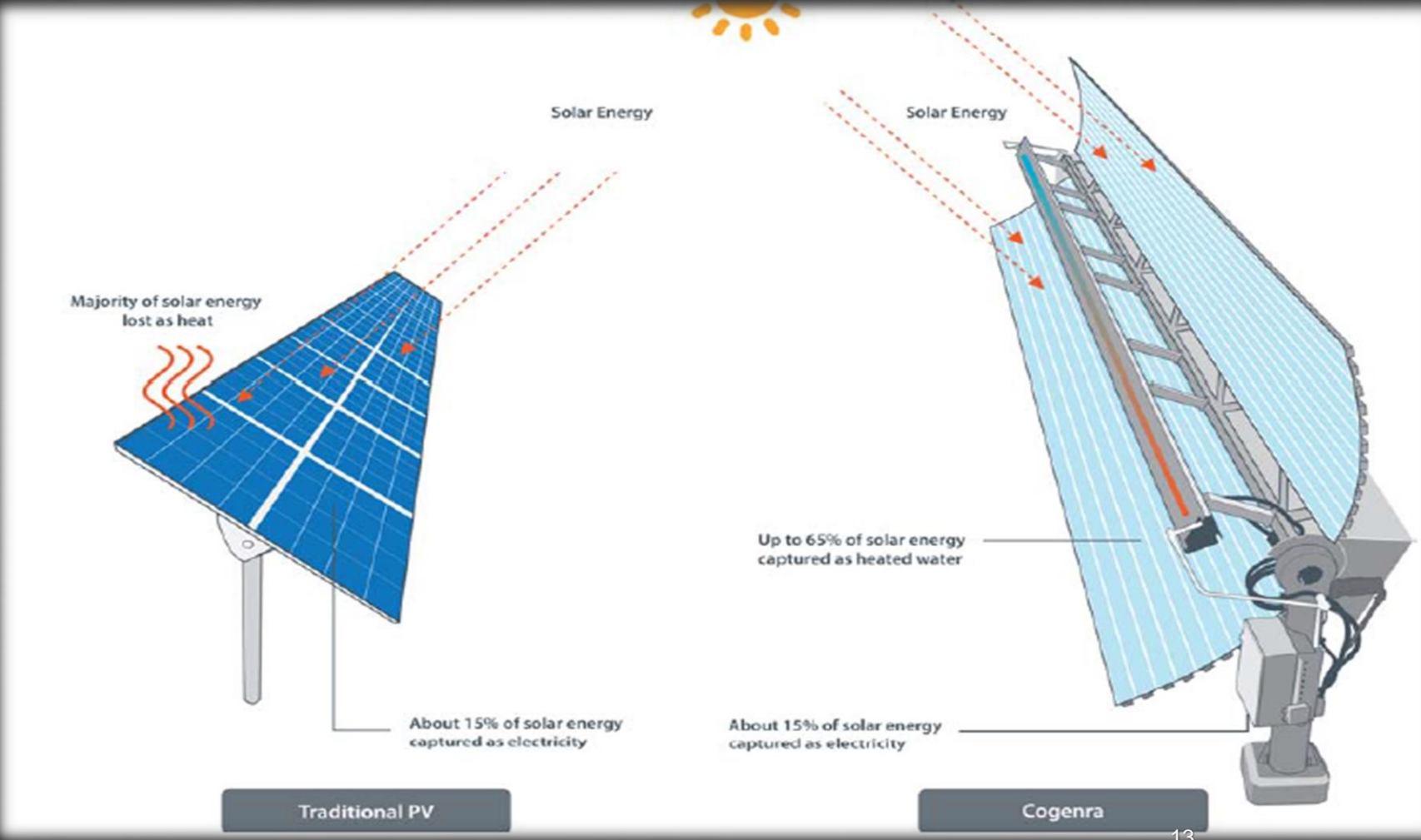


Image From www.cogenera.com

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North Hall Average Solar Radiation

- 6.04 kWh/m²/day



Image Source www.guntherportfolio.com

Cogeneration Panel Estimated Output

- 15 Modules
- 227 Kilowatts
- Displacement
 - 53,411 Kilowatt Hours per Year
 - 10,431 Therms of Natural Gas per Year

Energy Costs

- \$.122 per Kilowatt-Hour
- \$ 1.112 per Therm of Natural Gas

North Hall Savings Per Year

- \$ 6,516 – Electrical
- \$ 11,600 –Natural Gas
- \$ 18,116 – Total

Solar Panel Upgrade

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Cogeneration Panel Cost

- Original Design ~ \$ 125,000
- Cogeneration Panel ~ \$200,000
- Payback Approx. 11 Years

Solar Panel Upgrade

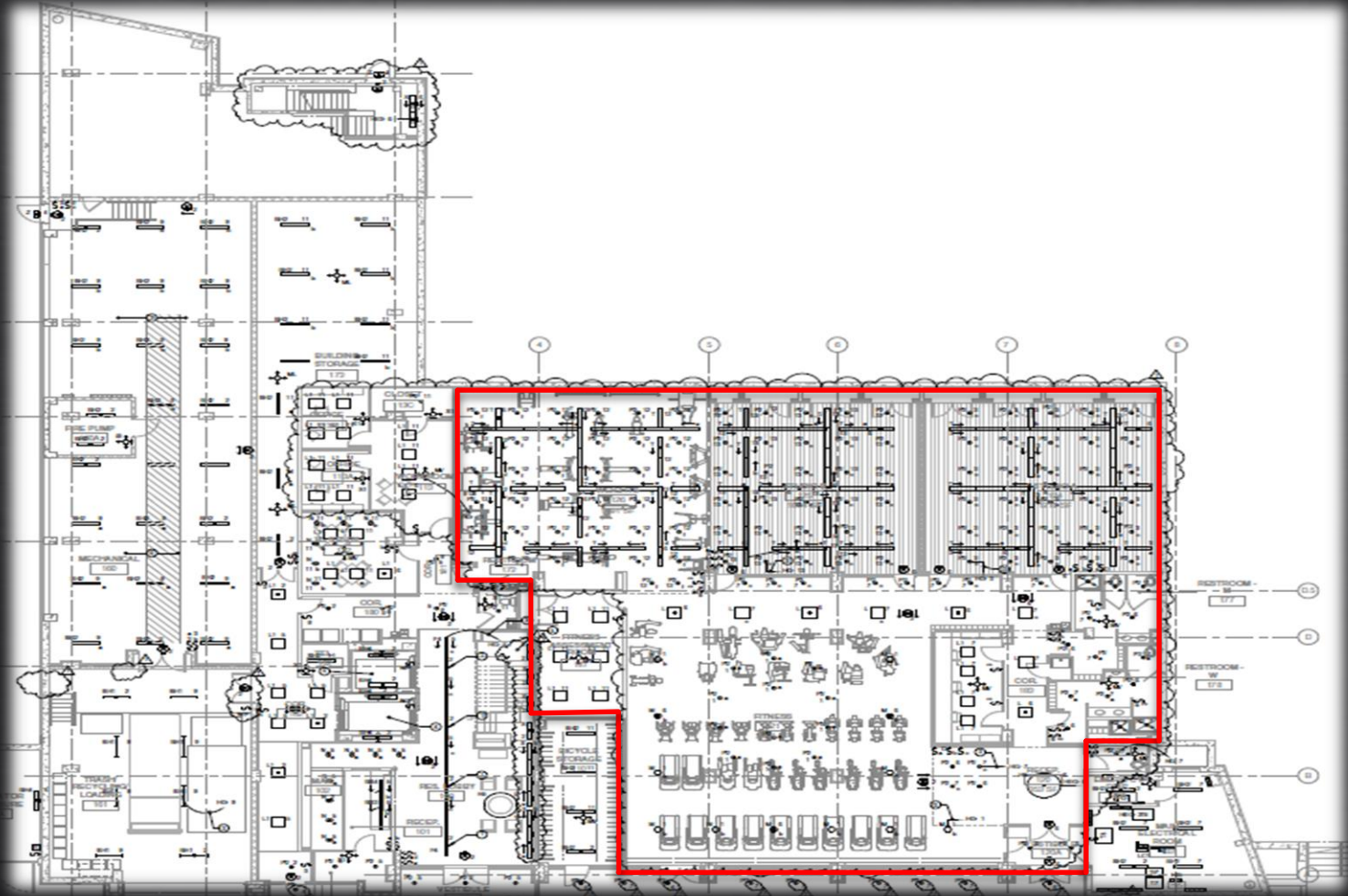
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Fitness Center Lighting

- Used 16 Hours a Day
- Used Every Day
- Requires 49,628 kWh per year
- Available 53,411 kWh per year

North Hall Fitness Center



Fixture Description	Quantity	Input Watts	Total Watts
K2- 6" Recessed Shower Downlight	3	36	108
L-2'x2' Recessed Indirect/ Direct	8	19	152
L2-2'x2' Recessed Indirect/ Direct	10	30	300
M- Pendant 3" Diameter Decorative	12	50	600
P2- 6" Recessed CLF	132	36	4,752
T-1'x4' Recessed Fluorescent	108	32	3,456
Total	273		8,498

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Analysis 1 – Modularization of Suite Bathrooms

- Cost Savings: Increase of \$92,315.52
- Schedule Savings: 66 Days (13.2 Weeks)
- **Recommended**

Analysis 2 – GPS Tracking of Precast Panels

- Cost Savings: Increase of \$112,785
- Schedule Savings: 5 Days (1 Week)
- **NOT Recommended**

Analysis 3 – Solar Panel Upgrade

- Cost Savings: Initial Cost of \$200,000, Payback in 11 Years
- Schedule Savings: None
- **Recommended**

Analysis 4 – Traditional Reinforced Concrete Slab

- Cost Savings: Increase of \$168,647
- Schedule Savings: None
- **NOT Recommended**

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Questions?



Acknowledgments

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