

RETHINKING THERMAL ENCLOSURES

ALTERNATIVE STUDIES IN MASS AND MATERIAL

PERFORMANCE BASED COMPUTATIONAL DESIGN

ARCH632_003

NOAH MEDLINSKY + ADAM SCHROTH



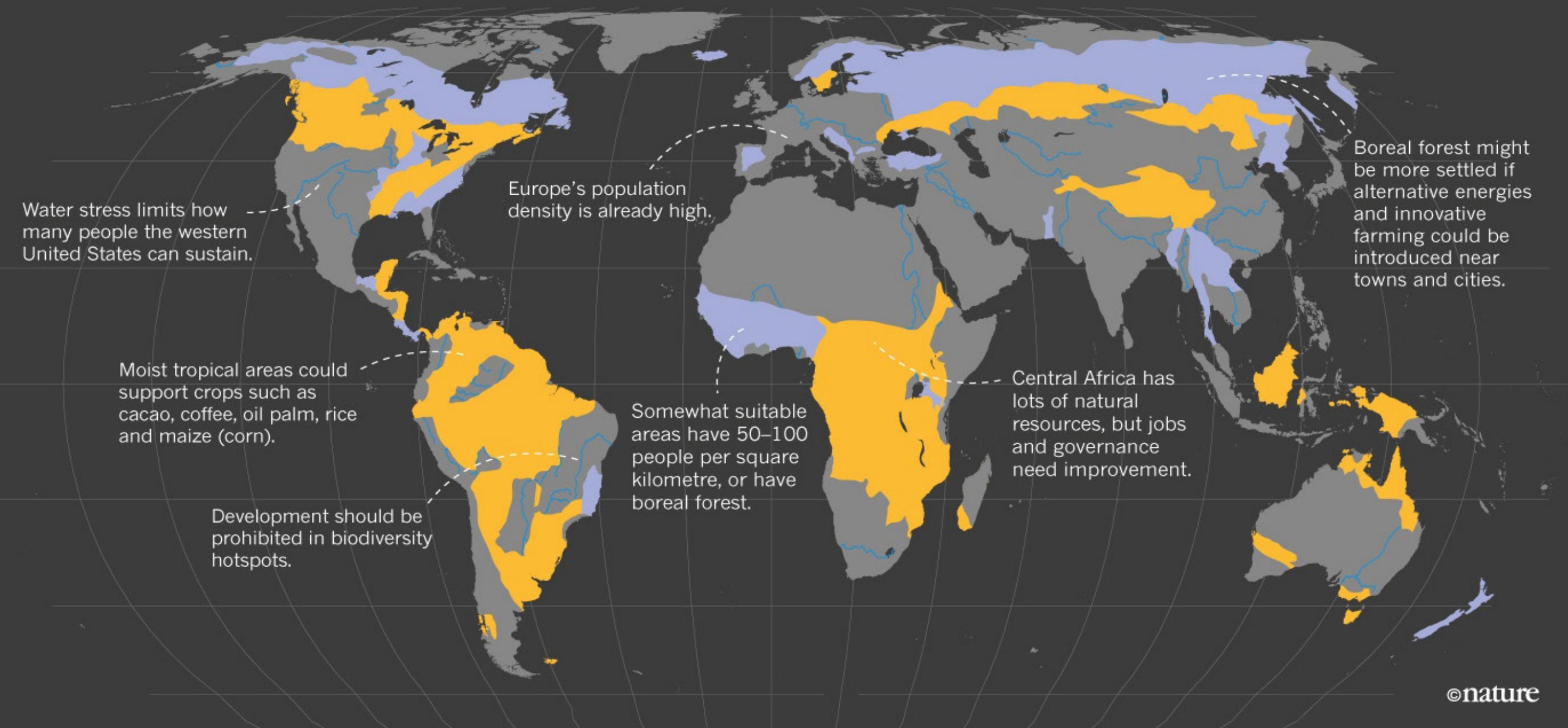
THICK NATURAL THERMAL ENCLOSURE



HABITABLE ZONES

Places with warm and moist climates amenable to growing crops, such as grassy and forested lands in temperate and tropical regions, could in theory sustainably accommodate more people. These include large areas of the Americas, central Africa and Asia as well as pockets of Oceania and Australia, but not populous or water-stressed regions or biodiversity hotspots.

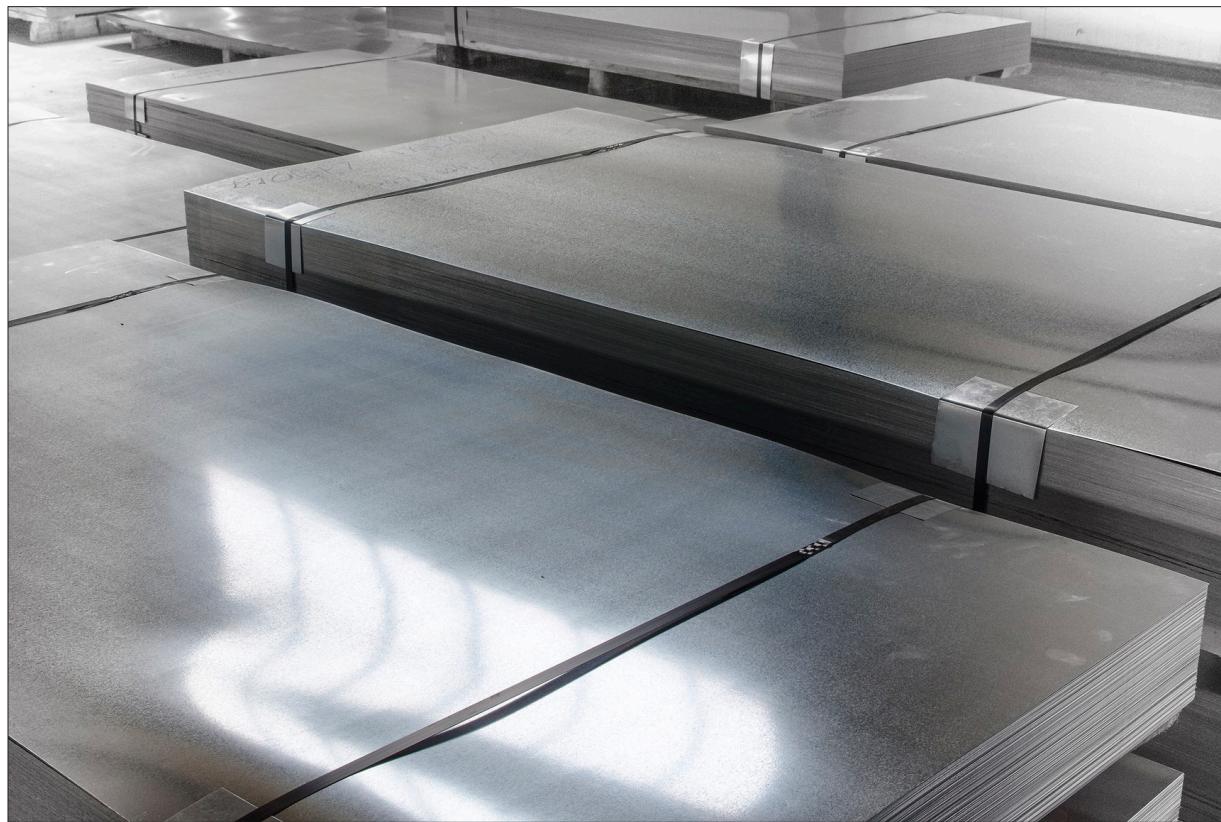
■ Suitable ■ Somewhat suitable ■ Unsuitable



©nature



01 _ CONCRETE



02 _ STEEL PLATE



03 _ MYCELIUM



04 _ FIBER COMPOSITE



01 _ HY-FI (MoMA PS1)



02 _ COMPOSITE SWARM (PROTO-TYPE)

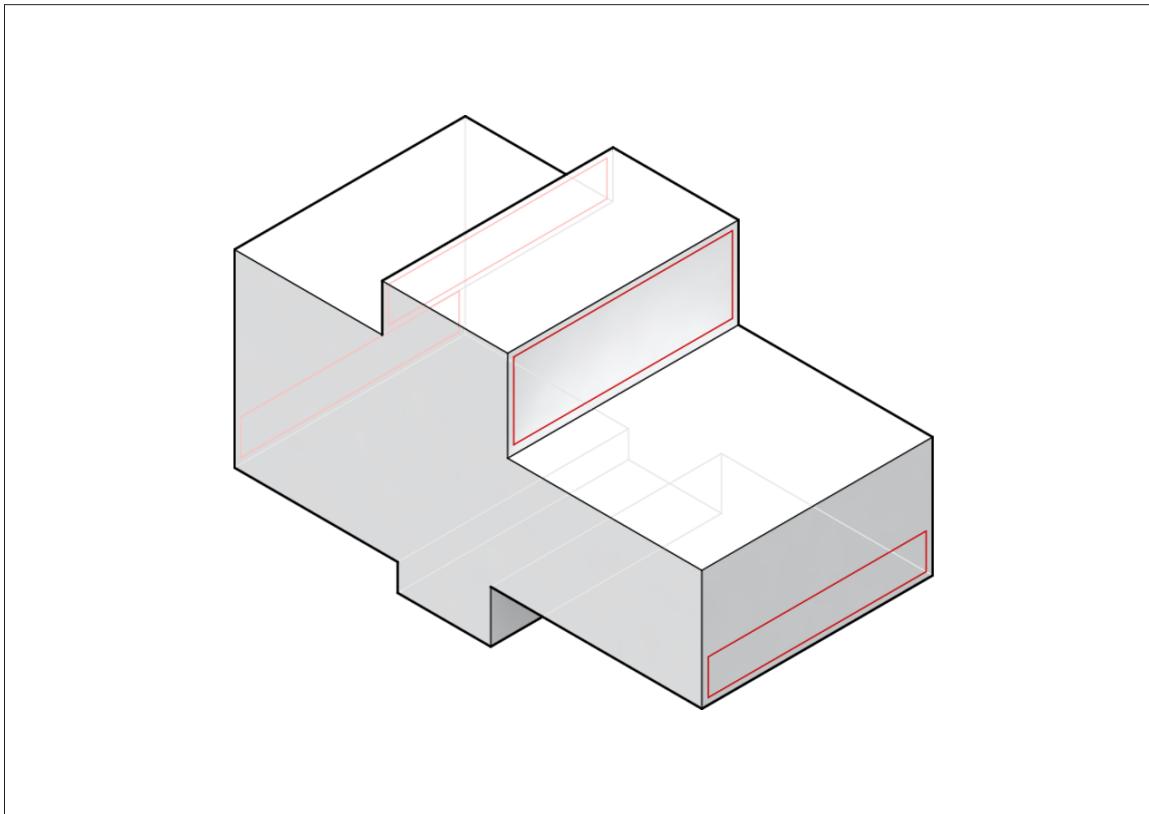


03 _ MYCELIUM BRICK CONSTRUCTION



04 _ FIBER COMPOSITE CONSTRUCTION

INITIAL ASSEMBLY TESTS



01 _ TEST MASSING 01 (THERMAL ENVELOPE SIMULATION) 58,587 m³

LOCATION : NEW YORK, NEW YORK (WARM - TEMPERATE)

MATERIAL 01_ FIBER COMPOSITE SKIN

ROUGHNESS: MEDIUM ROUGH

THICKNESS: .02 - .1M

CONDUCTIVITY: .04 Wm-K

DENSITY: 90 kg/m³

SPECIFIC HEAT: 1800 J/ kg-K

MATERIAL 02_ STEEL PLATE

ROUGHNESS: MEDIUM SMOOTH

THICKNESS: .1 - 1M

CONDUCTIVITY: 16 Wm-K

DENSITY: 8050 kg/m³

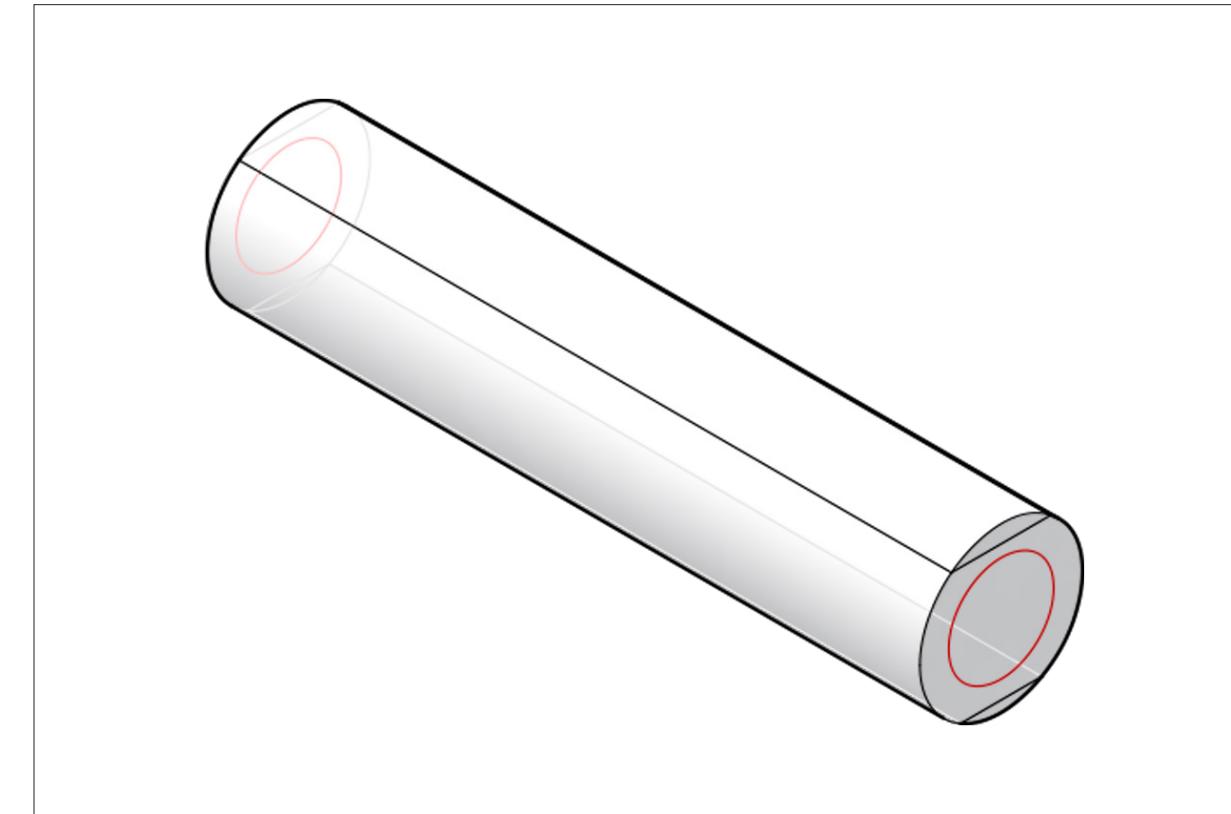
SPECIFIC HEAT: 490 J/ kg-K

CONFIGURATIONS / LAYERING:

01_ FIBER COMPOSITE - STEEL - FIBER COMPOSITE

02_ FIBER COMPOSITE - STEEL

03_ STEEL - FIBER COMPOSITE



02 _ TEST MASSING 02 (THERMAL ENVELOPE SIMULATION) 12,812 m³

LOCATION : NEW YORK, NEW YORK (WARM - TEMPERATE)

MATERIAL 01_ MYCELIUM

ROUGHNESS: MEDIUM ROUGH

THICKNESS: .4 - 1M

CONDUCTIVITY: .04 Wm-K

DENSITY: 121.74 kg/m³

SPECIFIC HEAT: 2000 J/kg-K

MATERIAL 02_ CONCRETE

ROUGHNESS: ROUGH

THICKNESS: .4 - 1M

CONDUCTIVITY: 1.4 Wm-K

DENSITY: 2400 kg/m³

SPECIFIC HEAT: 850 J/kg-K

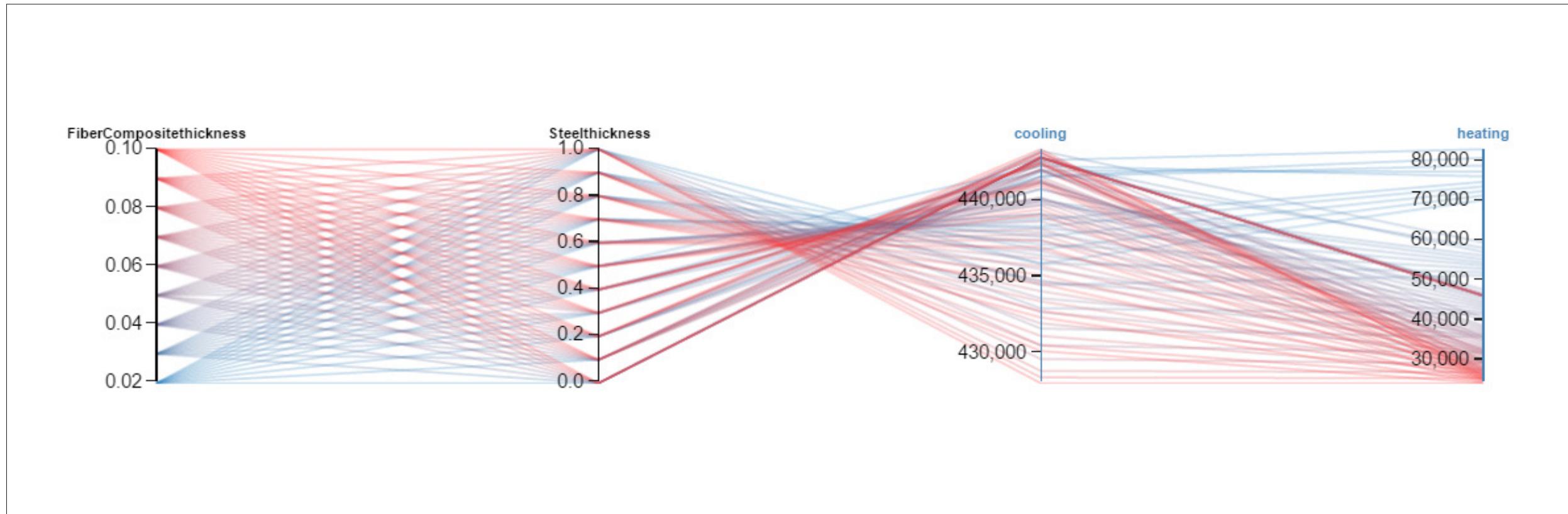
CONFIGURATIONS / LAYERING:

01_ CONCRETE - MYCELIUM - CONCRETE

02_ MYCELIUM - CONCRETE - MYCELIUM

03_ CONCRETE - MYCELIUM

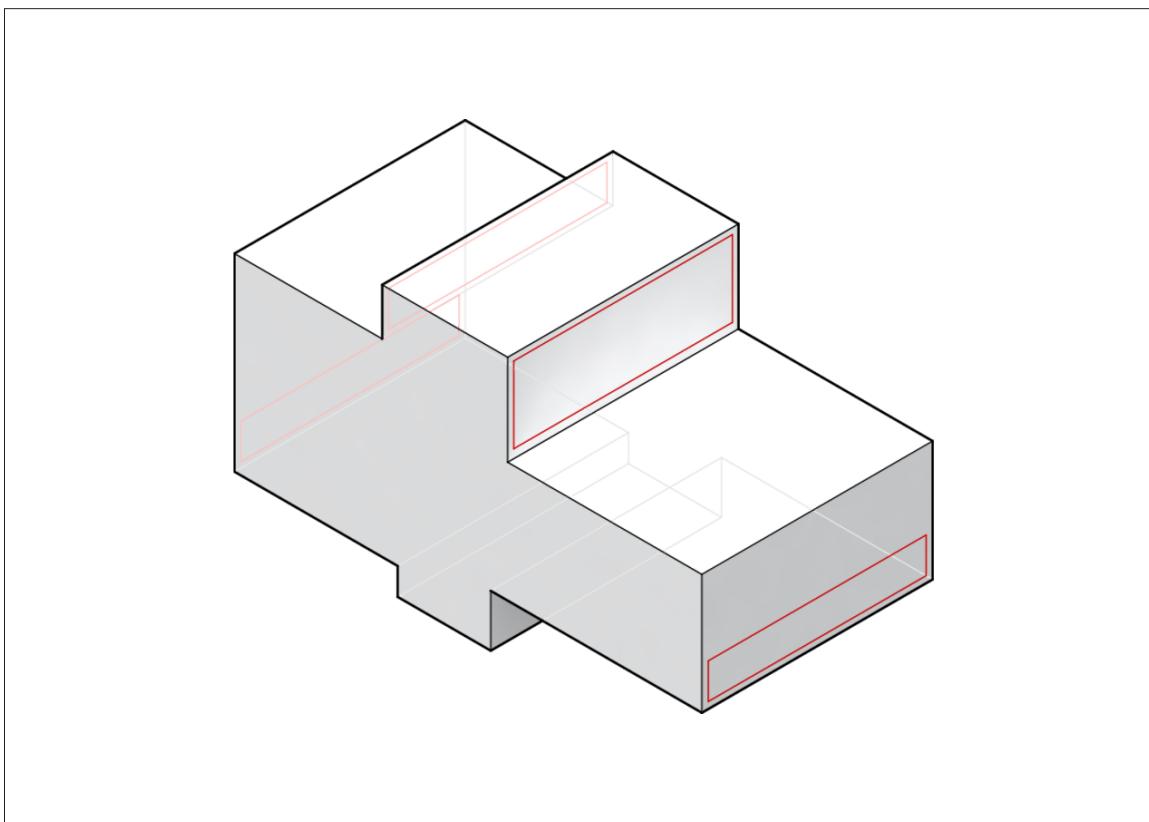
****INITIAL ASSEMBLY TESTS**



01 _ MASSING 01 (FIBER COMPOSITE/STEEL CONSTRUCTION)

HEATING + COOLING DATA MATRIX

INITIAL ASSEMBLY TESTS



LOCATION : NEW YORK, NEW YORK (WARM - TEMPERATE)

MATERIAL 01_ FIBER COMPOSITE SKIN

ROUGHNESS: MEDIUM ROUGH

THICKNESS: .02 - .1M

CONDUCTIVITY: .04 Wm-K

DENSITY: 90 kg/m³

SPECIFIC HEAT: 1800 J/ kg-K

MATERIAL 02_ STEEL PLATE

ROUGHNESS: MEDIUM SMOOTH

THICKNESS: .1 - 1M

CONDUCTIVITY: 16 Wm-K

DENSITY: 8050 kg/m³

SPECIFIC HEAT: 490 J/ kg-K

CONFIGURATIONS / LAYERING:

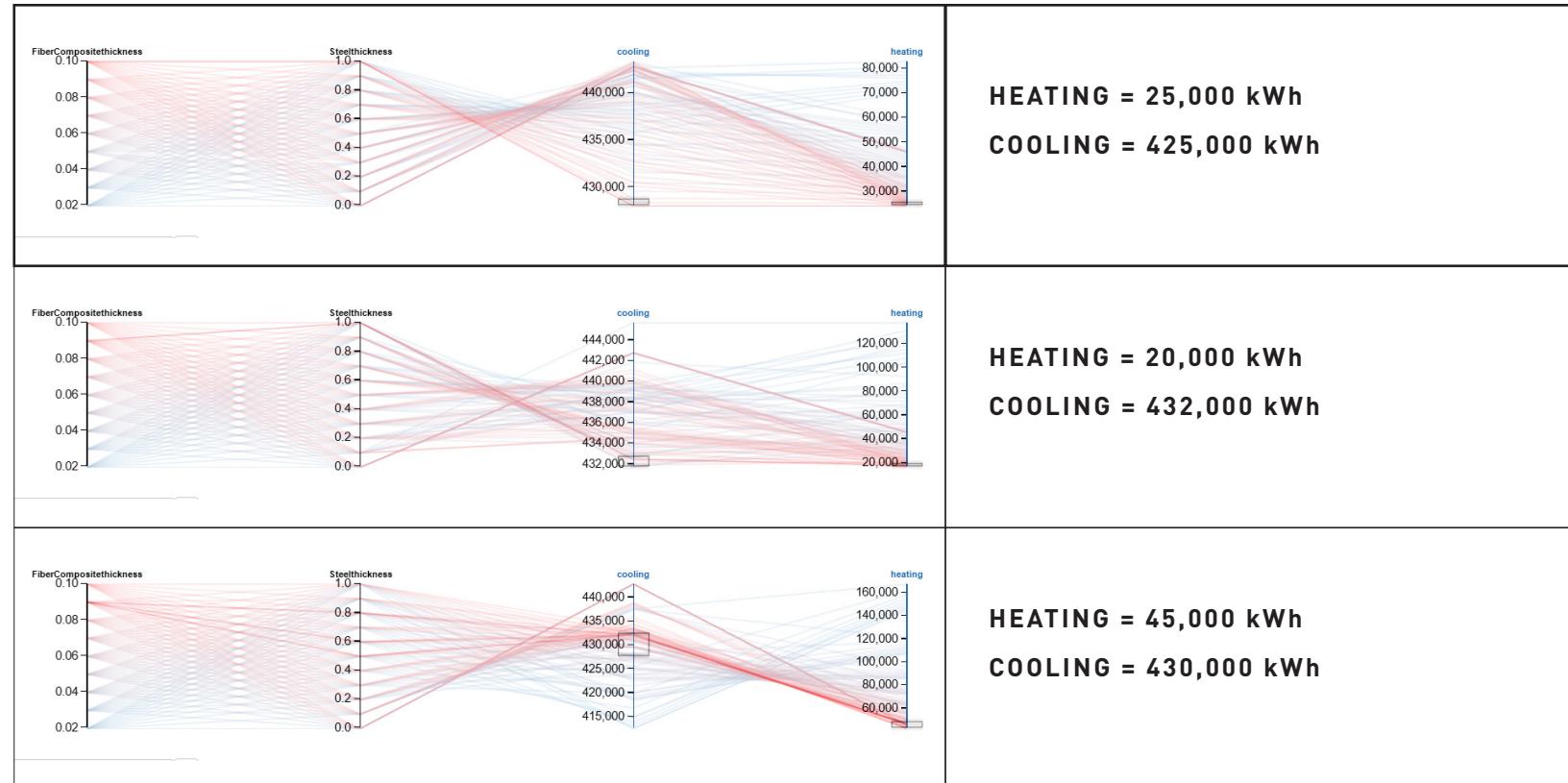
01_ FIBER COMPOSITE - STEEL - FIBER COMPOSITE

02_ FIBER COMPOSITE - STEEL

03_ STEEL - FIBER COMPOSITE

01 _ WALL TYPE 01

FIBER COMPOSITE - STEEL - FIBER COMPOSITE



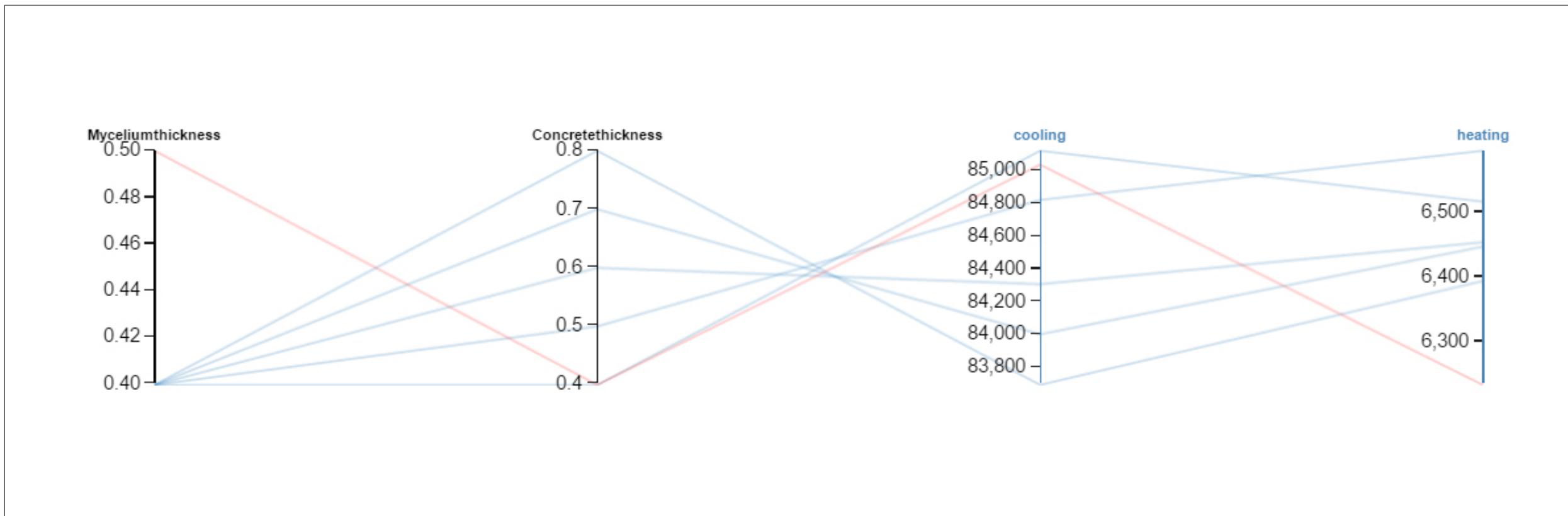
02 _ WALL TYPE 02

FIBER COMPOSITE - STEEL

03 _ WALL TYPE 03

STEEL - FIBER COMPOSITE

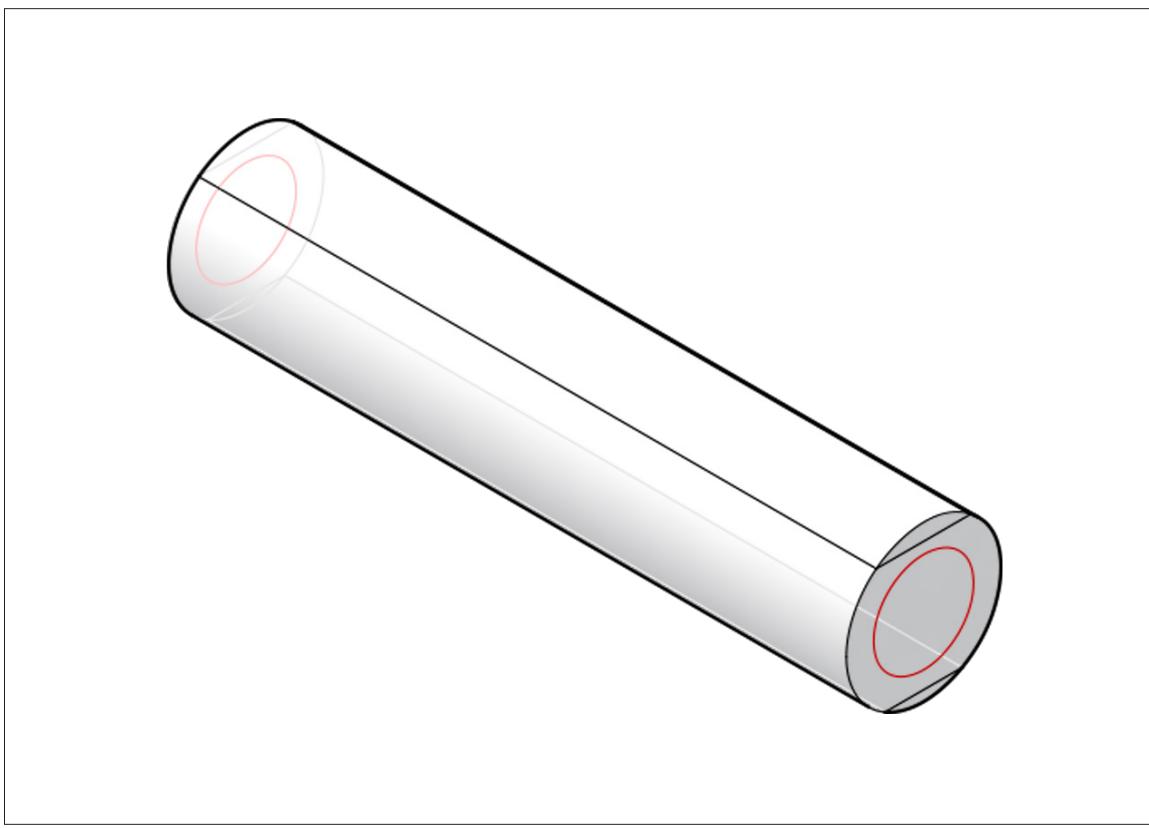
****INITIAL ASSEMBLY TESTS**



03 _ MASSING 02 (MYCELIUM/CONCRETE CONSTRUCTION)

HEATING + COOLING DATA MATRIX

INITIAL ASSEMBLY TESTS



02 _ TEST MASSING 02 (THERMAL ENVELOPE SIMULATION)

12,812 m³

LOCATION : NEW YORK, NEW YORK (WARM - TEMPERATE)

MATERIAL 01_ MYCELIUM

ROUGHNESS: MEDIUM ROUGH

THICKNESS: .4 - 1M

CONDUCTIVITY: .04 Wm-K

DENSITY: 121.74 kg/m³

SPECIFIC HEAT: 2000 J/kg-K

MATERIAL 02_ CONCRETE

ROUGHNESS: ROUGH

THICKNESS: .4 - 1M

CONDUCTIVITY: 1.4 Wm-K

DENSITY: 2400 kg/m³

SPECIFIC HEAT: 850 J/kg-K

CONFIGURATIONS / LAYERING:

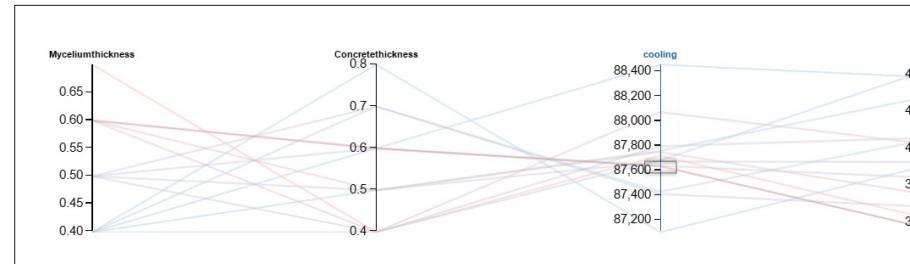
01_ CONCRETE - MYCELIUM - CONCRETE

02_ MYCELIUM - CONCRETE - MYCELIUM

03_ CONCRETE - MYCELIUM

01_ WALL TYPE 01

CONCRETE - MYCELIUM - CONCRETE

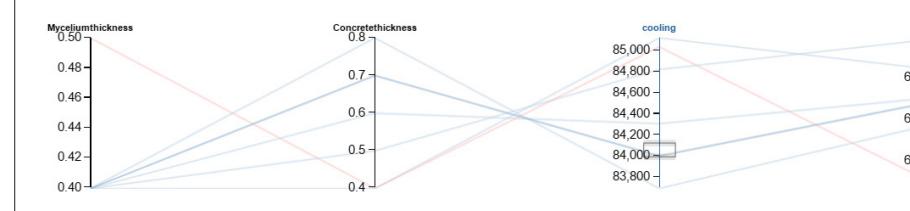


HEATING = 3,600 kWh

COOLING = 87,600 kWh

02_ WALL TYPE 02

MYCELIUM - CONCRETE - MYCELIUM

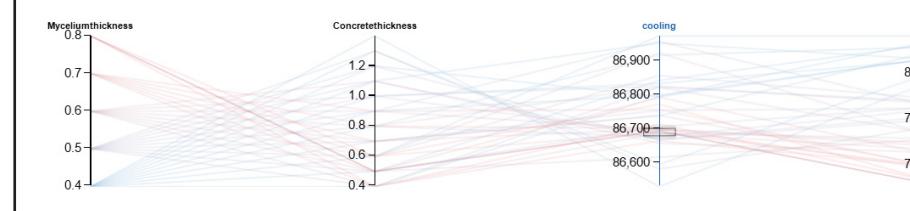


HEATING = 6,300 kWh

COOLING = 84,100 kWh

03_ WALL TYPE 03

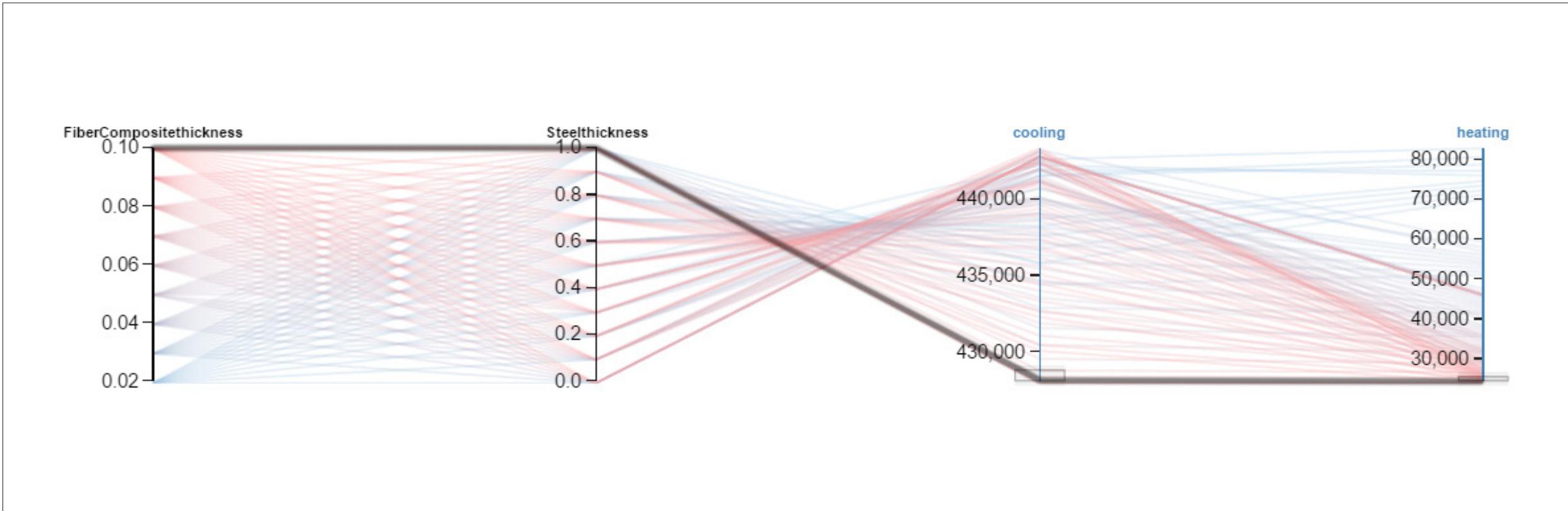
CONCRETE - MYCELIUM



HEATING = 6,750 kWh

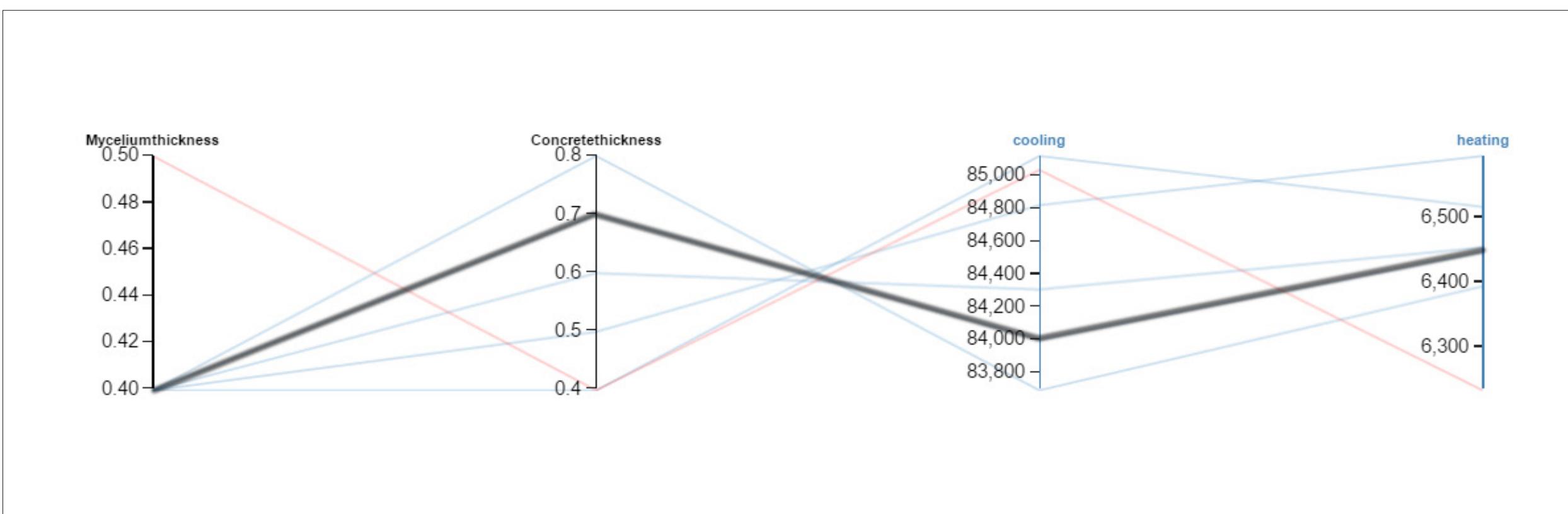
COOLING = 86,700 kWh

INITIAL ASSEMBLY TESTS (BEST OPTIONS)



01 _ MASSING 01 (FIBER COMPOSITE/STEEL CONSTRUCTION)

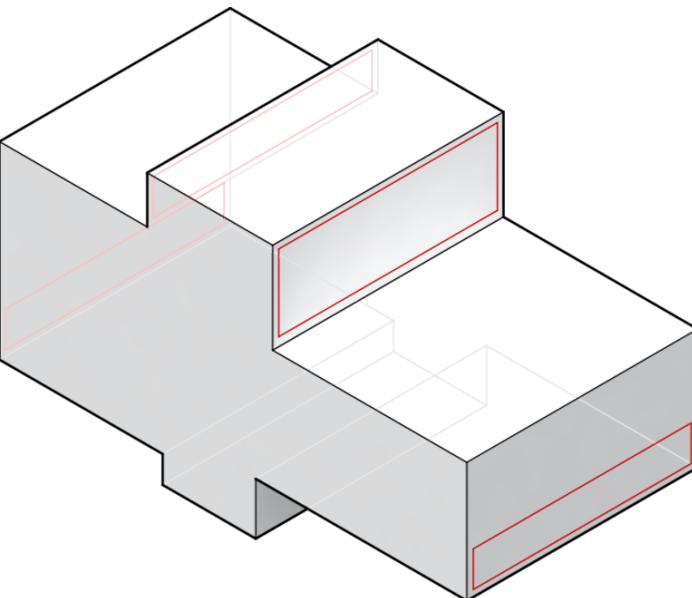
HEATING = 25,000 kWh
COOLING = 425,000 kWh



03 _ MASSING 02 (MYCELIUM/CONCRETE CONSTRUCTION)

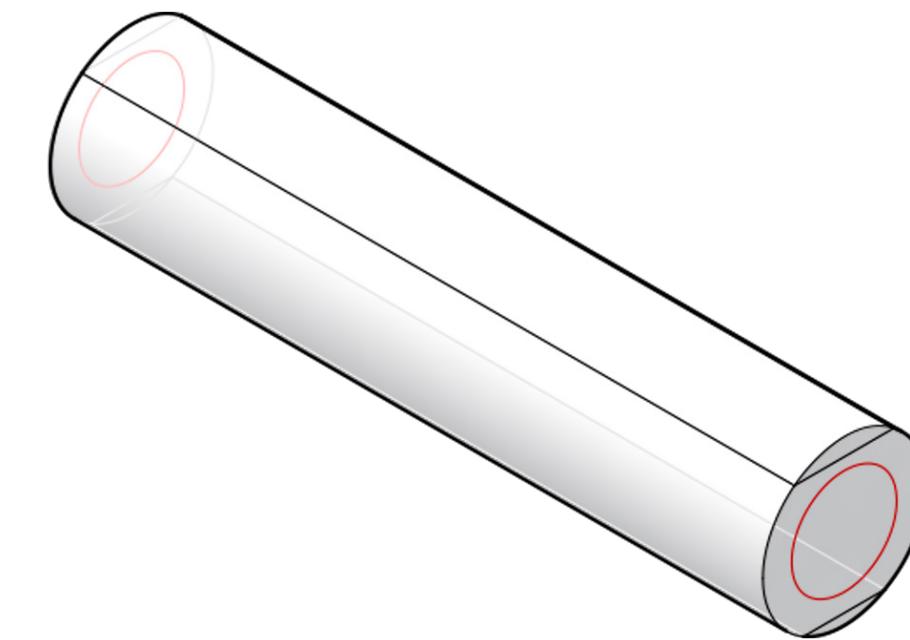
HEATING = 6,300 kWh
COOLING = 84,100 kWh

****RECALIBRATION + UPDATED ASSEMBLIES**



01 _ TEST MASSING 01 (THERMAL ENVELOPE SIMULATION)

58,587 m³



02 _ TEST MASSING 02 (THERMAL ENVELOPE SIMULATION)

12,812 m³

****RECALIBRATION**

**** TAKING WALL CONFIGURATION 01 (FIBER COMPOSITE - STEEL - FIBER COMPOSITE) AS THE BEST CASE OF THE SELECTION, THE ENVELOPE SIMULATION INDICATES THAT WHILE THE STEEL PLATE MASS IS HIGHLY THERMALLY CONDUCTIVE, THE FIBER COMPOSITE SKIN WOULD NEED ADDITIONAL LAYERS OR THICKNESS IN ORDER TO MEET DESIRED HEATING AND COOLING LOADS.**

CONFIGURATIONS / LAYERING:

- 01_ FIBER COMPOSITE - STEEL - FIBER COMPOSITE**
- 02_ FIBER COMPOSITE - STEEL**
- 03_ STEEL - FIBER COMPOSITE**

PARAMETER ADJUSTMENT: FIBER COMPOSITE MASS INCREASED TO BEYOND SKIN APPLICATION AND INTO ELEMENT WITH THICKNESS IN EXCESS OF 2" FOR FURTHER THERMAL PERFORMANCE. ADDITIONALLY, AN AUTONOMOUS LAYER OF FIBER COMPOSITE WAS CREATED IN ORDER TO TEST VARIABLE THICKNESS BETWEEN THE TWO LAYERS IN THE ASSEMBLY.

****RECALIBRATION**

**** TAKING WALL CONFIGURATION 02 (MYCELIUM- CONCRETE - MYCELIUM) AS THE BEST CASE OF THE SELECTION, THE ENVELOPE SIMULATION INDICATES A RELATIVELY HIGH PERFORMANCE STANDARD FOR HEATING AND COOLING LOADS. THE TESTING WILL BE RECALIBRATED WITH A WIDER RANGE OF THICKNESS VALUES.**

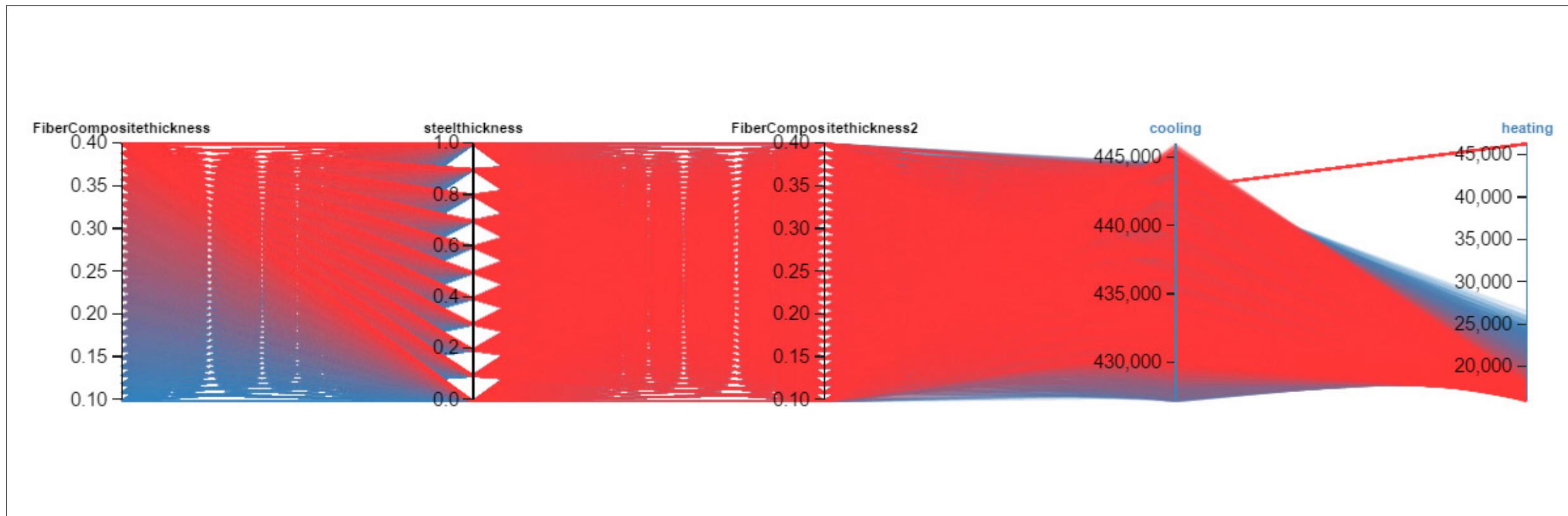
CONFIGURATIONS / LAYERING:

- 01_ CONCRETE - MYCELIUM - CONCRETE**
- 02_ MYCELIUM - CONCRETE - MYCELIUM**
- 03_ CONCRETE - MYCELIUM**

PARAMETER ADJUSTMENT:

AN AUTONOMOUS LAYER OF MYCELIUM WAS CREATED IN ORDER TO TEST VARIABLE THICKNESS BETWEEN THE TWO LAYERS IN THE ASSEMBLY.

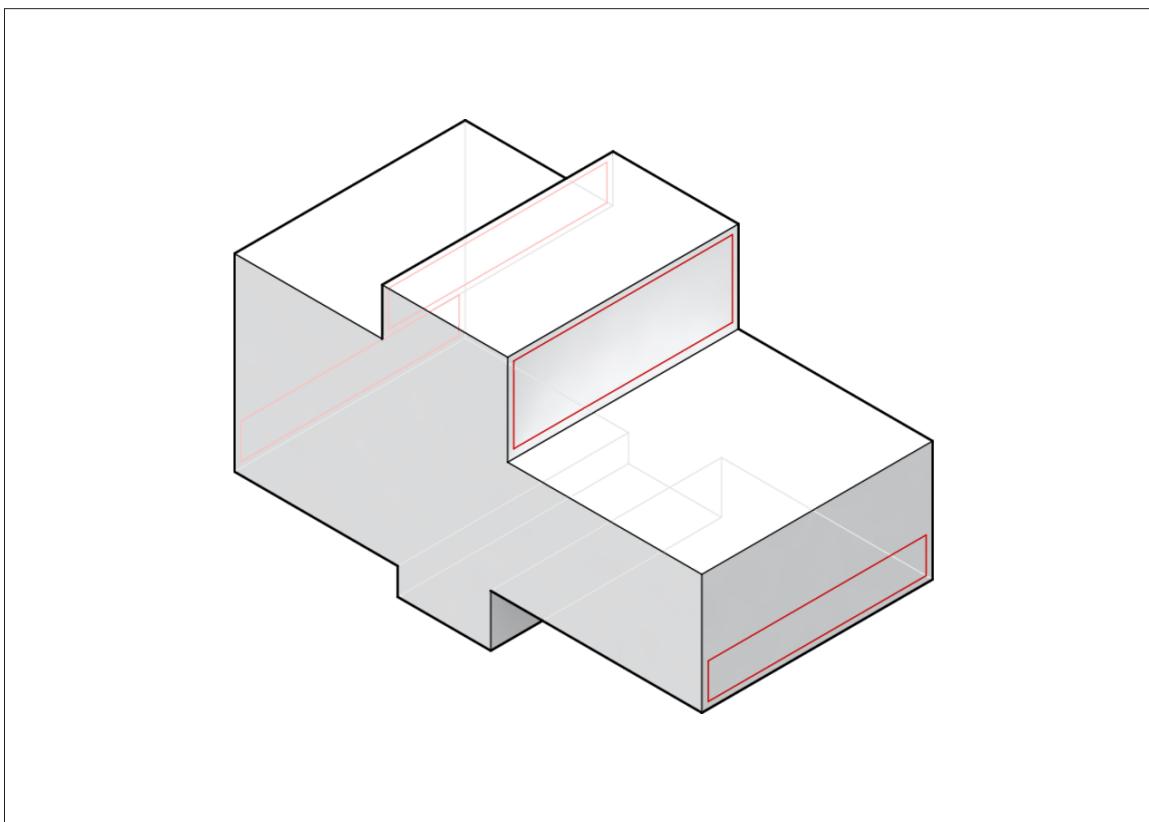
****RECALIBRATION + UPDATED ASSEMBLIES**



01 _ MASSING 01 (FIBER COMPOSITE/STEEL CONSTRUCTION) **UPDATED**

HEATING + COOLING DATA MATRIX

****RECALIBRATION + UPDATED ASSEMBLIES**



01 _ TEST MASSING 01 (THERMAL ENVELOPE SIMULATION)

58,587 m³

LOCATION : NEW YORK, NEW YORK (WARM - TEMPERATE)

MATERIAL 01_ FIBER COMPOSITE SKIN

ROUGHNESS: MEDIUM ROUGH

THICKNESS: .1 - .4M (2 AUTONOMOUS LAYERS)

CONDUCTIVITY: .04 Wm-K

DENSITY: 90 kg/m³

SPECIFIC HEAT: 1800 J/ kg-K

MATERIAL 02_ STEEL PLATE

ROUGHNESS: MEDIUM SMOOTH

THICKNESS: .1 - 1M

CONDUCTIVITY: 16 Wm-K

DENSITY: 8050 kg/m³

SPECIFIC HEAT: 490 J/ kg-K

CONFIGURATIONS / LAYERING:

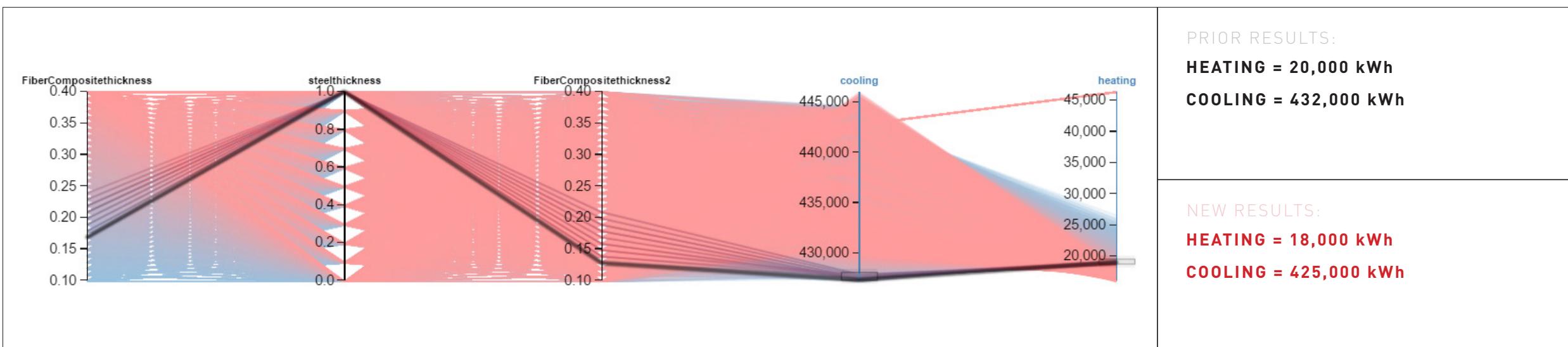
01_ FIBER COMPOSITE - STEEL - FIBER COMPOSITE

02_ FIBER COMPOSITE - STEEL

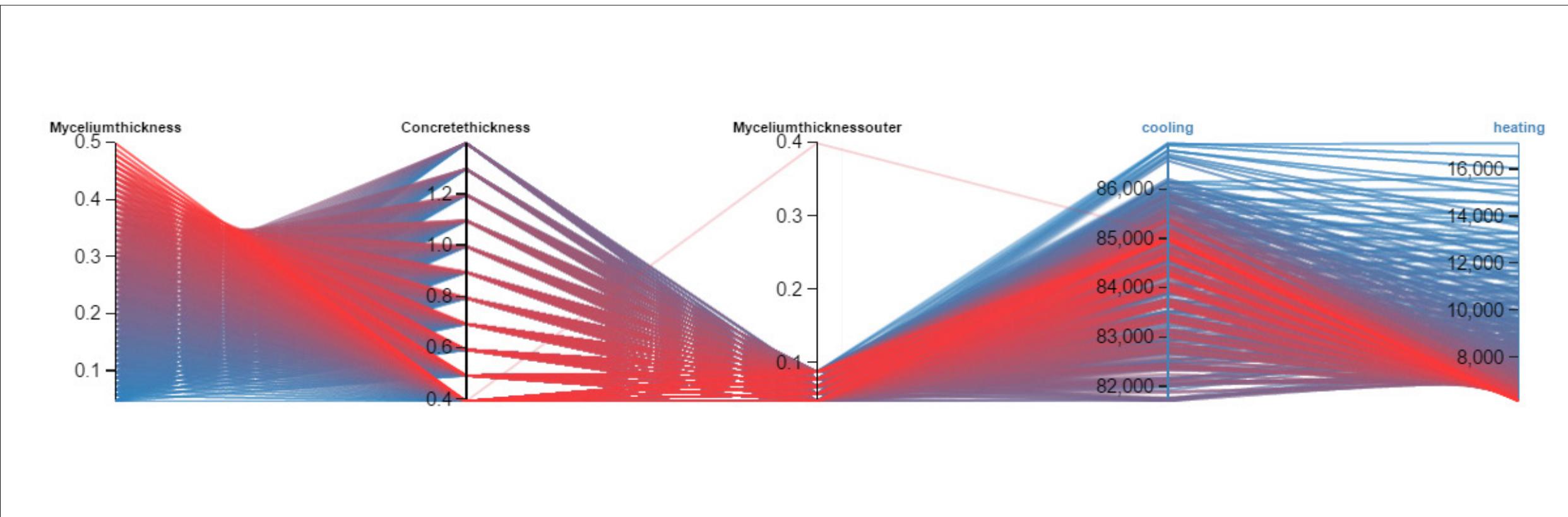
03_ STEEL - FIBER COMPOSITE

01 _ WALL TYPE UPDATE

FIBER COMPOSITE - STEEL - FIBER COMPOSITE



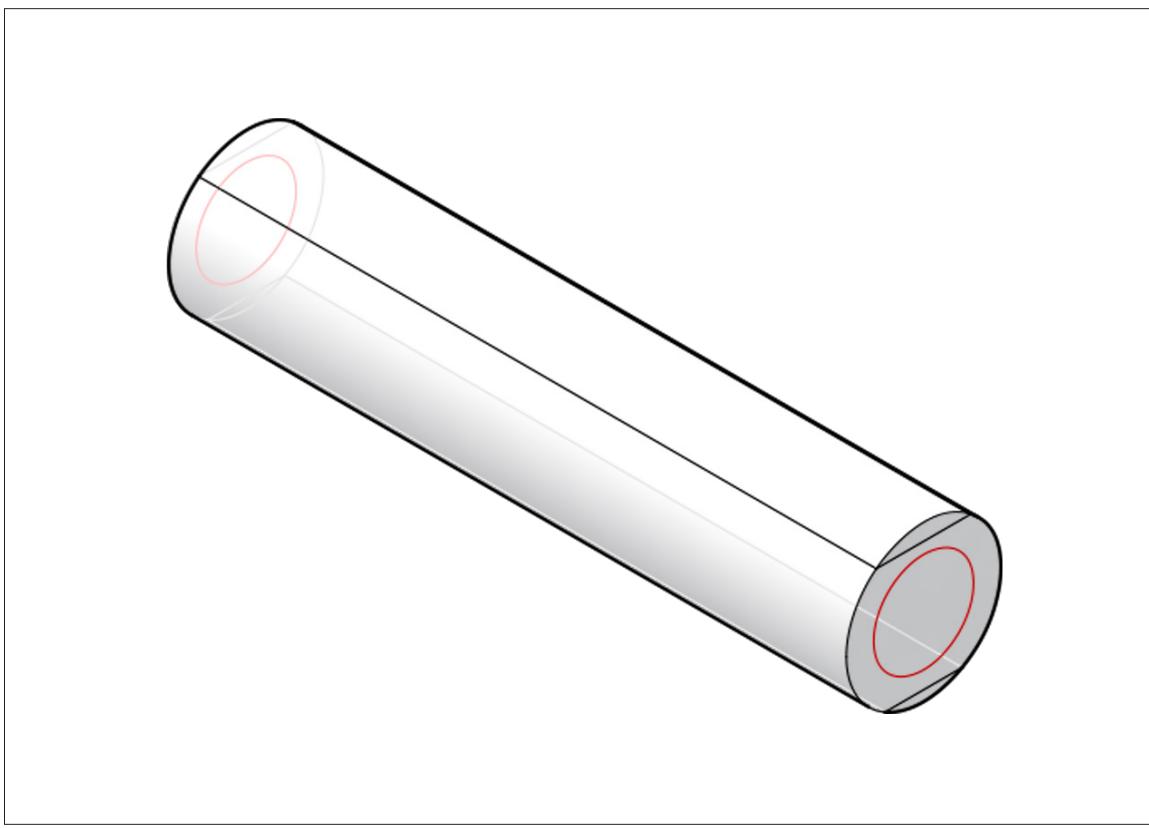
****RECALIBRATION + UPDATED ASSEMBLIES**



03 _ MASSING 02 (MYCELIUM/CONCRETE CONSTRUCTION) **UPDATED**

HEATING + COOLING DATA MATRIX

****RECALIBRATION + UPDATED ASSEMBLIES**



02 _ TEST MASSING 02 (THERMAL ENVELOPE SIMULATION)

12,812 m³

LOCATION : NEW YORK, NEW YORK (WARM - TEMPERATE)

MATERIAL 01_ MYCELIUM

ROUGHNESS: MEDIUM ROUGH

THICKNESS: .1 - 1M (2 AUTONOMOUS LAYERS)

CONDUCTIVITY: .04 Wm-K

DENSITY: 121.74 kg/m³

SPECIFIC HEAT: 2000 J/kg-K

MATERIAL 02_ CONCRETE

ROUGHNESS: ROUGH

THICKNESS: .4 - 1M

CONDUCTIVITY: 1.4 Wm-K

DENSITY: 2400 kg/m³

SPECIFIC HEAT: 850 J/kg-K

CONFIGURATIONS / LAYERING:

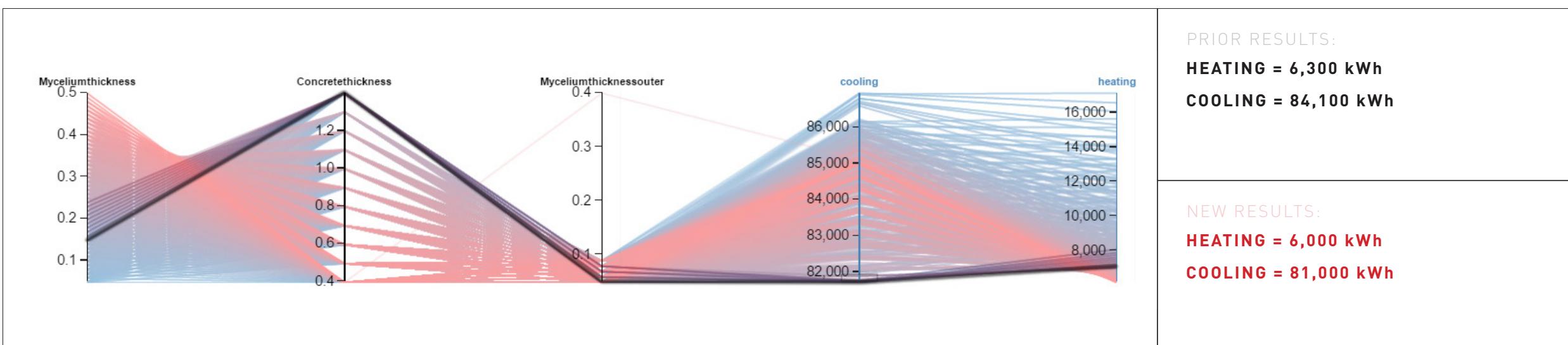
01_ CONCRETE - MYCELIUM - CONCRETE

02_ MYCELIUM - CONCRETE - MYCELIUM

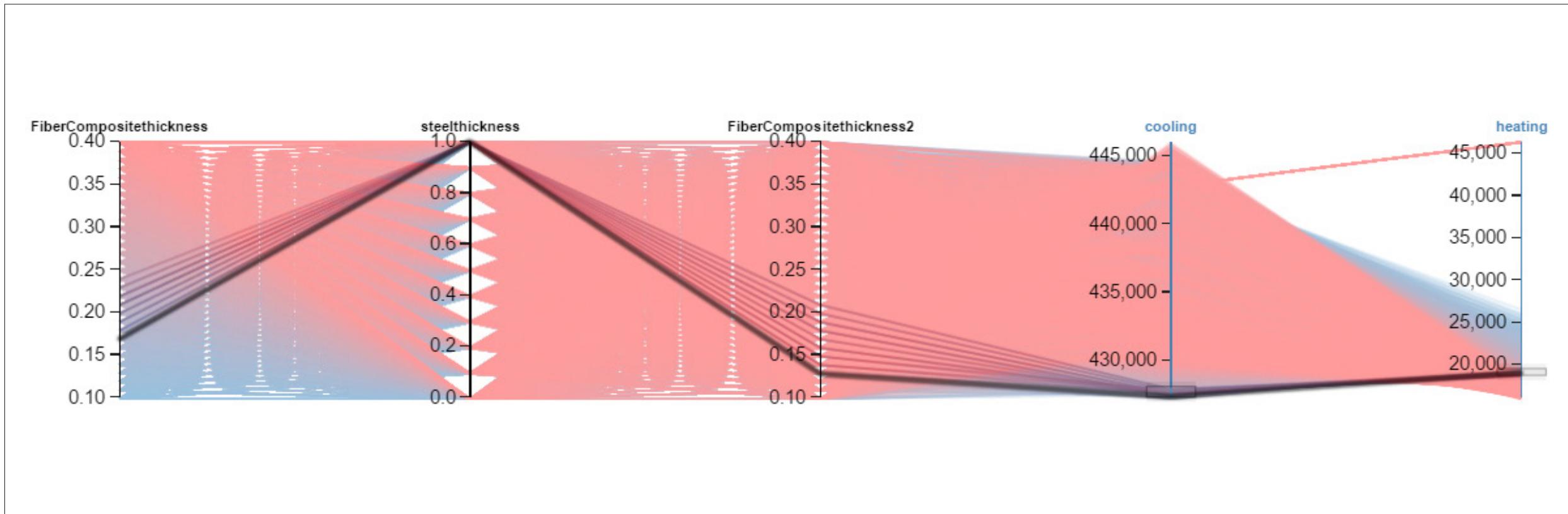
03_ CONCRETE - MYCELIUM

02 _ WALL TYPE UPDATE

MYCELIUM - CONCRETE - MYCELIUM



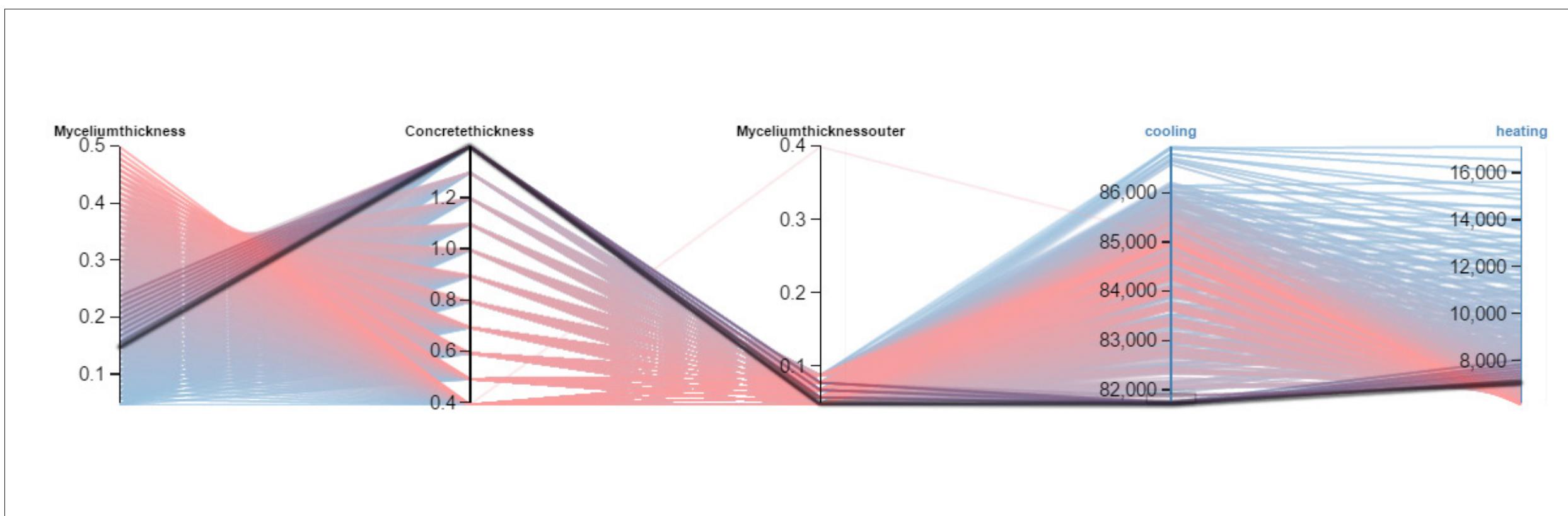
****RECALIBRATION + UPDATED ASSEMBLIES (BEST OPTIONS)**



01 _ MASSING 01 (FIBER COMPOSITE/STEEL CONSTRUCTION) **UPDATED**

HEATING = 18,000 kWh

COOLING = 425,000 kWh



03 _ MASSING 02 (MYCELIUM/CONCRETE CONSTRUCTION) **UPDATED**

HEATING = 6,000 kWh

COOLING = 81,000 kWh

HEATING = 13,200 kWh
COOLING = 653,800 kWh

VOLUME = 50,000 m³

HEATING = 18,000 kWh
COOLING = 425,600 kWh

VOLUME = 58,587 m³

HEATING = 6,000 kWh
COOLING = 81,000 kWh

VOLUME = 12,812 m³

HIGHEST QUALITY ASSEMBLY DETERMINED BY
HEATING / COOLING LOAD PER VOLUME

01 _ TYP. COMMERCIAL COMPARISON
STUCCO/ CONCRETE/ MASS INSULATION

02 _ TEST MASSING 01
(FIBER COMPOSITE/STEEL CONSTRUCTION) **UPDATED**

03 _ TEST MASSING 02
(MYCELIUM/CONCRETE CONSTRUCTION) **UPDATED**

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