Vertical Farming

Energie- und ressourceneffiziente Lebensmittelproduktion in dicht verbauten Gebieten

FFG
Forschung wirkt.

THEMENWORKSHOP

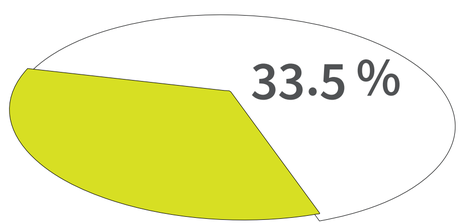
vertical farm institute

Daniel Podmirseg
Wien, am 01.10.2018

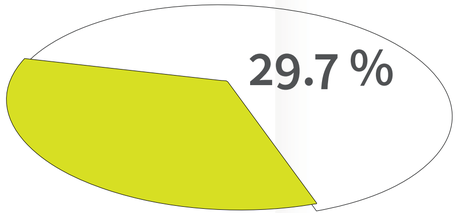
01 BETRACHTUNGSWINKEL


7,627,000,000

50,000,000 km²

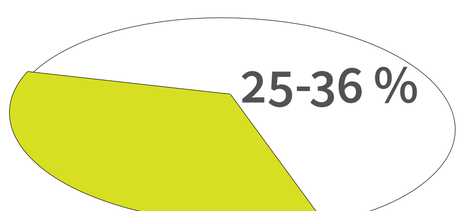


faostat.org

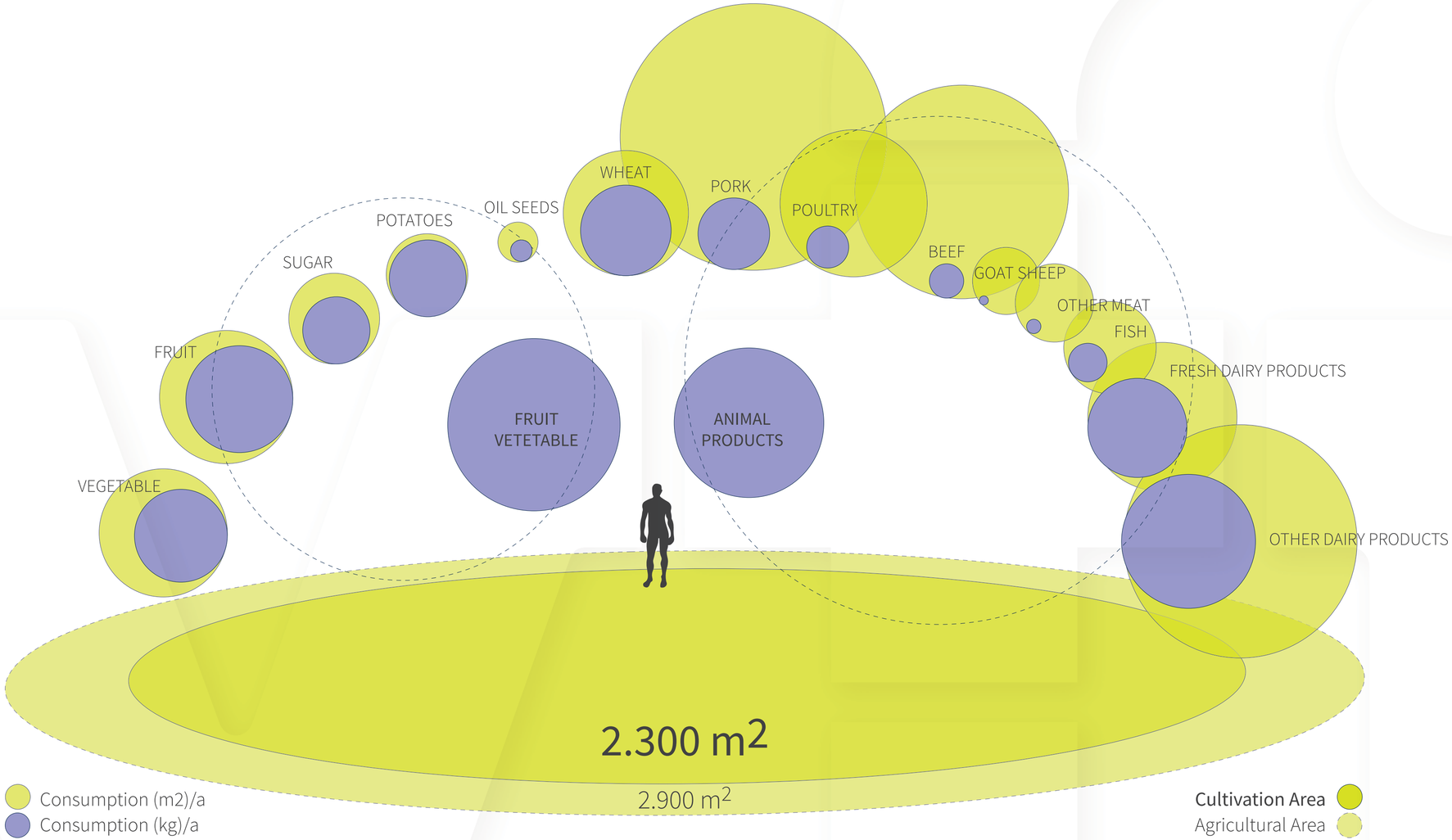


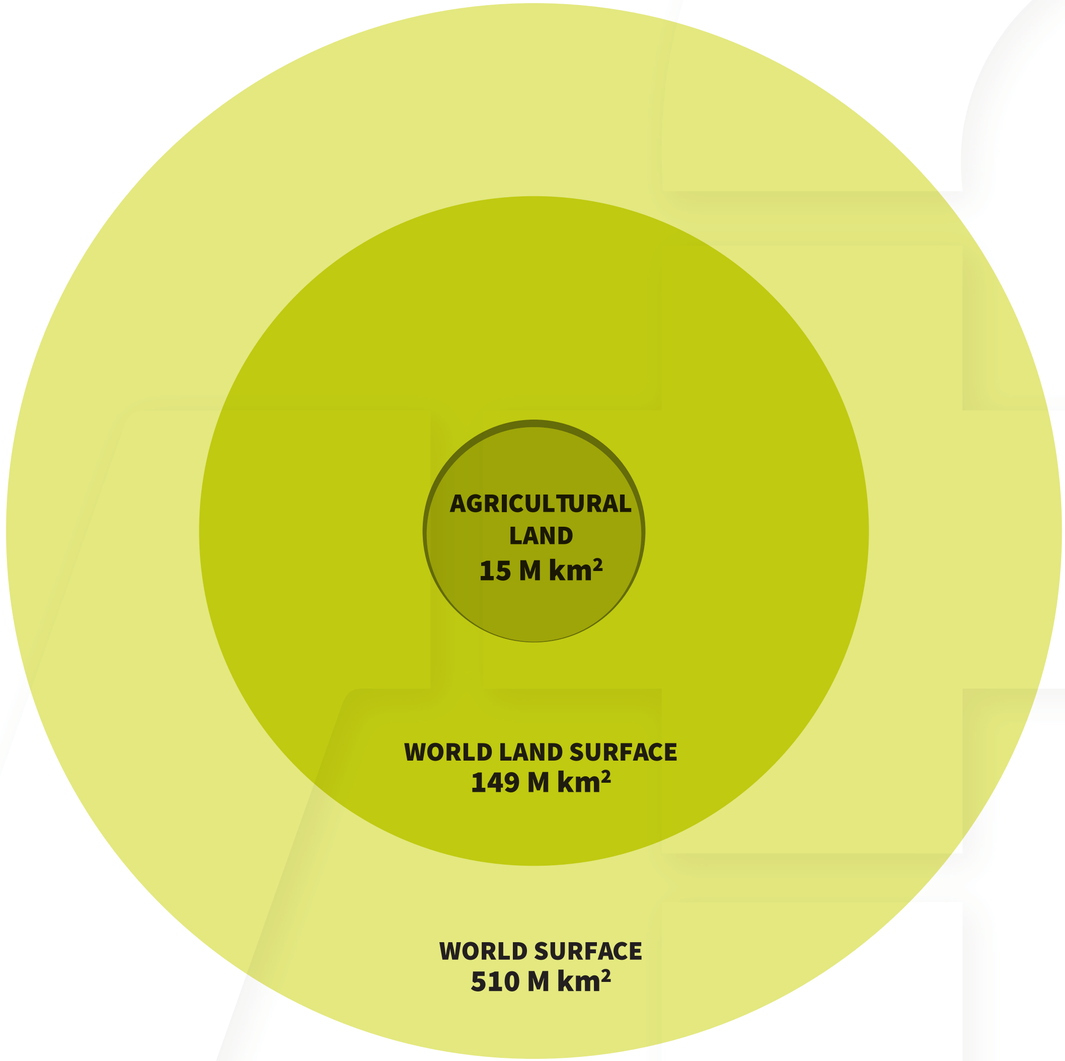
2015, Podmirseg D. „up! Contribution of Vertical Farms to increase the overall Energy Efficiency of Cities.“

15,9 Gt CO_{2eq}



greenpeace.org/austria/Global/austria/marktcheck/uploads/media/Cool_Farming_Report_Summary_Final_web_01.pdf
data.worldbank.org
2015, Podmirseg D. „up! Contribution of Vertical Farms to increase the overall Energy Efficiency of Cities.“





02 VORBEREITUNG AUF DEN BEDARF

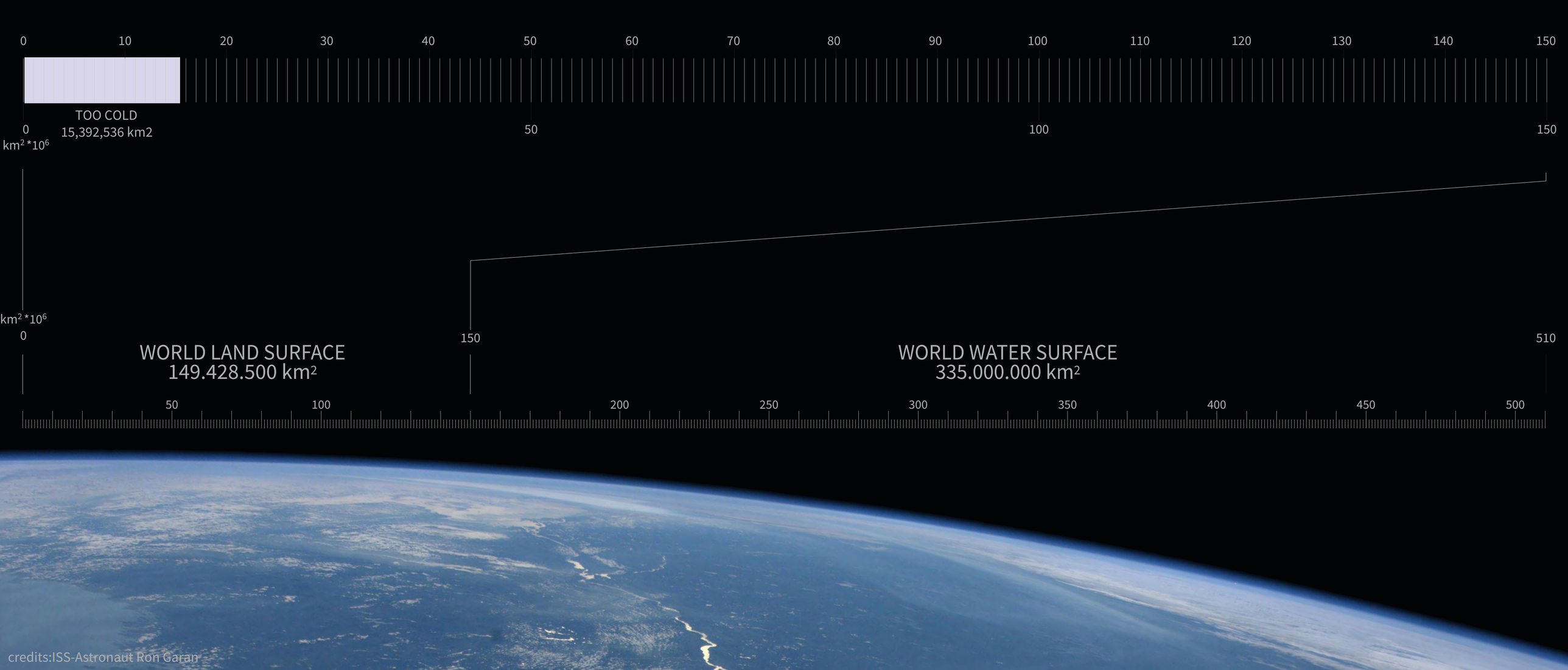
2015

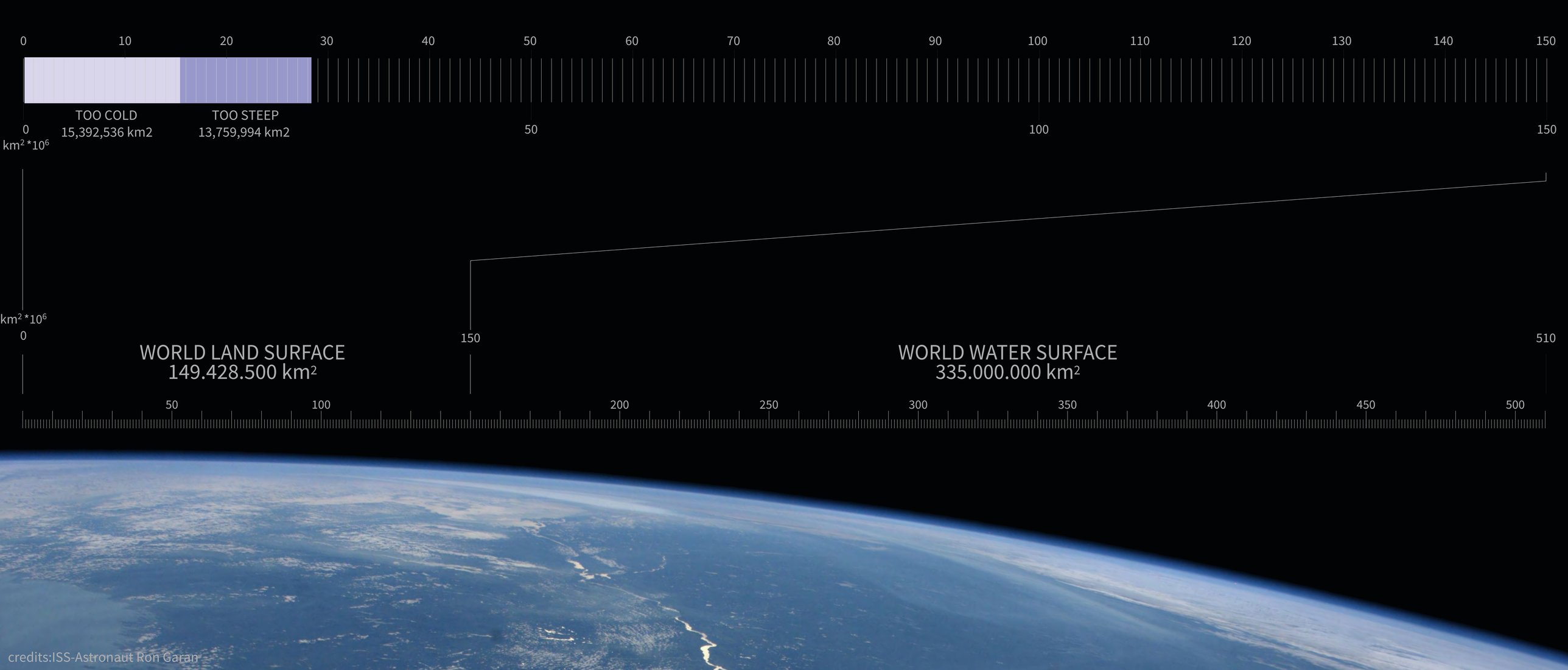
AGRICULTURAL LAND
15 M km²

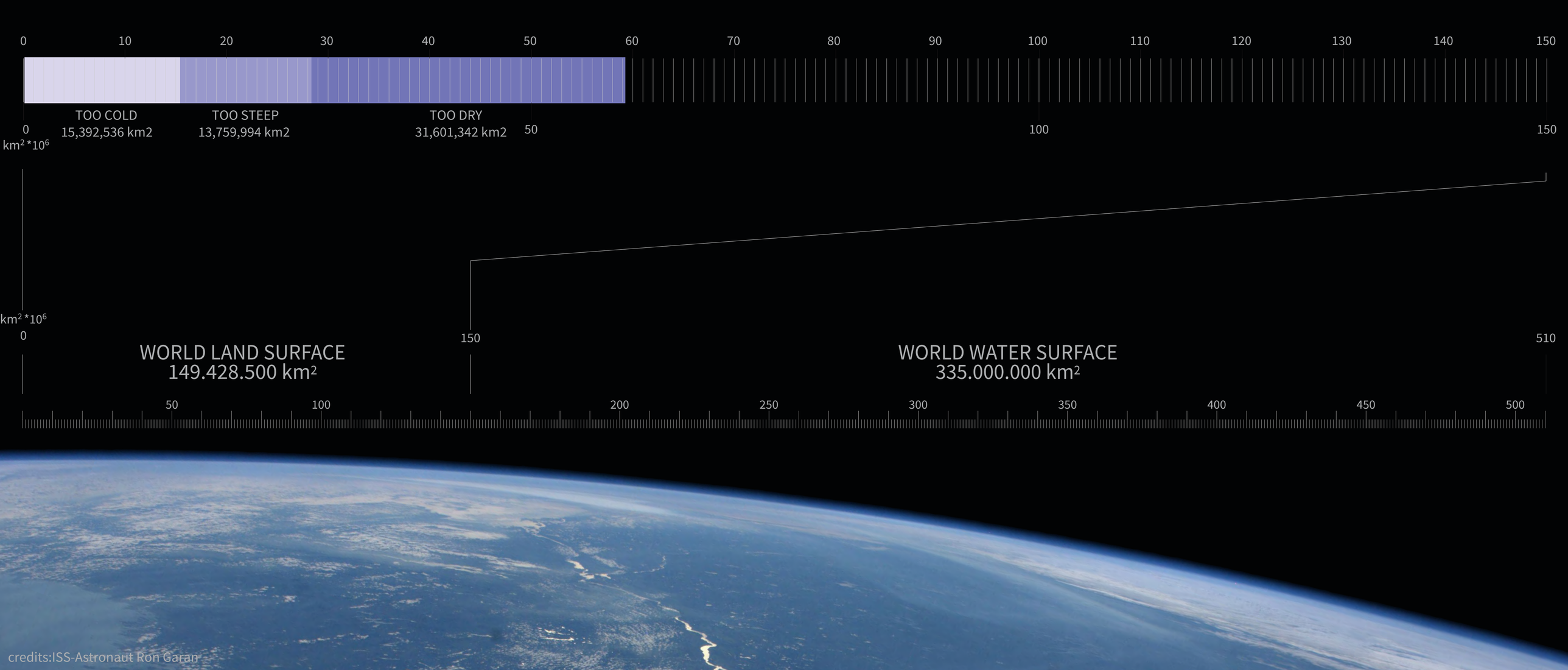
WORLD LAND SURFACE
149 M km²

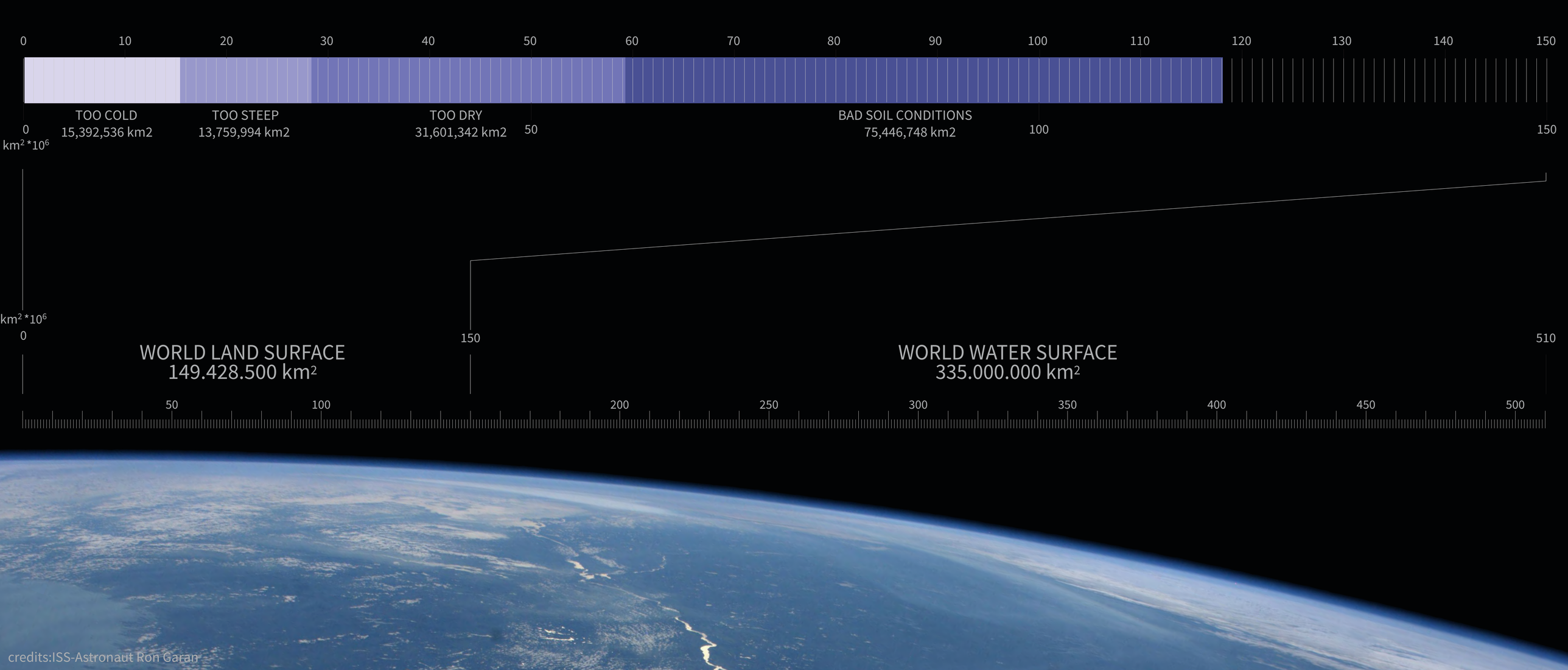
WORLD SURFACE
510 M km²

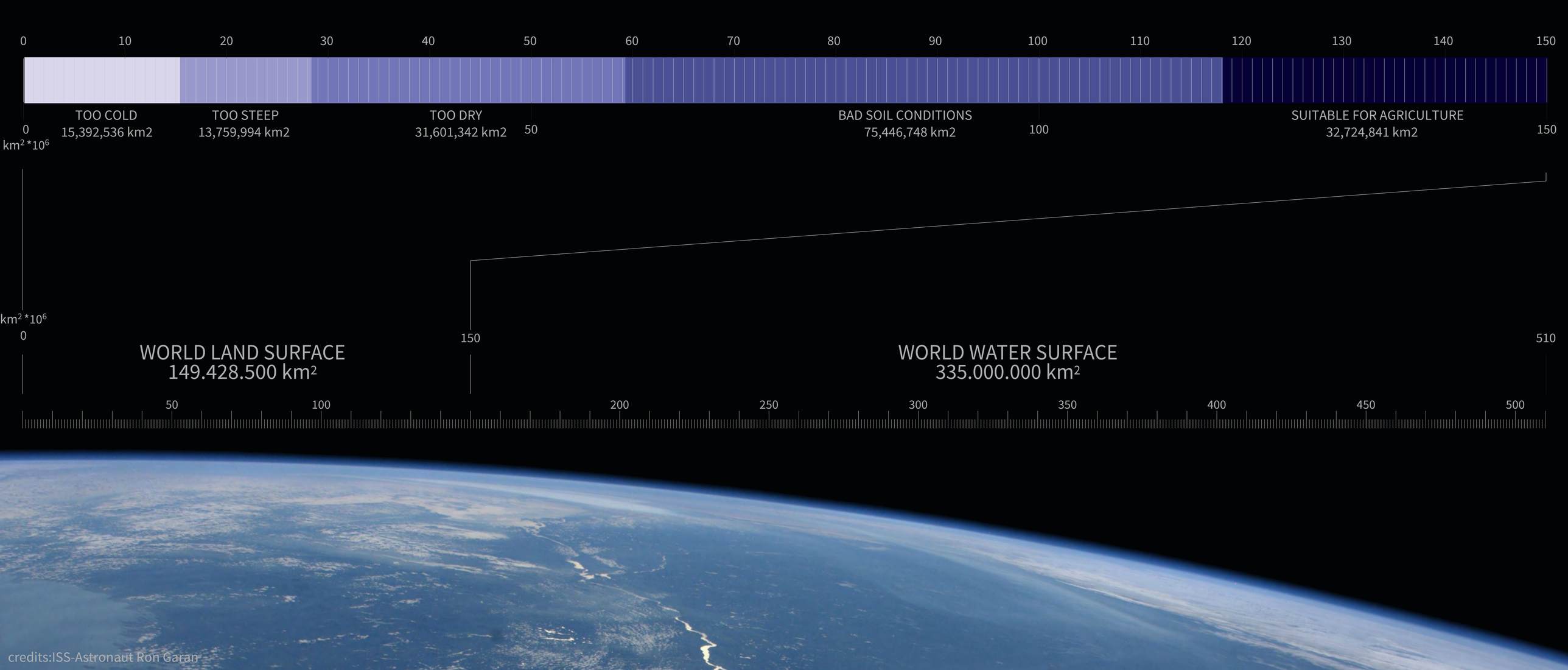
2075

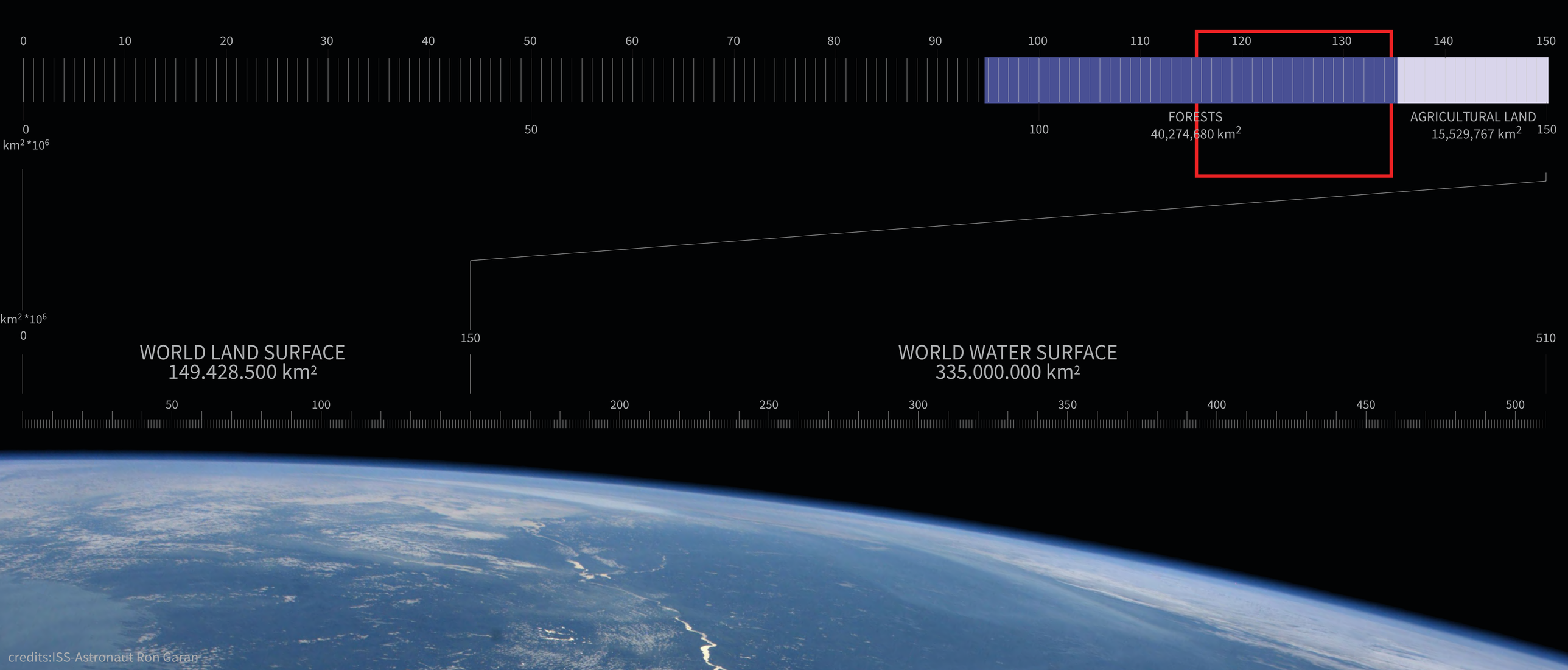

0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
TOO COLD
15,392,536 km2
0
km2 *10^6
50
100
150
km2 *10^6
0
150
510
WORLD LAND SURFACE
149.428.500 km2
WORLD WATER SURFACE
335.000.000 km2
50
100
200
250
300
350
400
450
500
credits:ISS-Astronaut Ron Garan


0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
TOO COLD
15,392,536 km2
TOO STEEP
13,759,994 km2
0
50
100
150
km2 *10^6
km2 *10^6
0
150
510
WORLD LAND SURFACE
149.428.500 km2
WORLD WATER SURFACE
335.000.000 km2
50
100
200
250
300
350
400
450
500
credits:ISS-Astronaut Ron Garan


0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
TOO COLD
15,392,536 km2
TOO STEEP
13,759,994 km2
TOO DRY
31,601,342 km2
0
50
100
150
km² *10⁶
km² *10⁶
0
150
510
WORLD LAND SURFACE
149.428.500 km²
WORLD WATER SURFACE
335.000.000 km²
50
100
200
250
300
350
400
450
500
credits:ISS-Astronaut Ron Garan


0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
TOO COLD
15,392,536 km2
TOO STEEP
13,759,994 km2
TOO DRY
31,601,342 km2
BAD SOIL CONDITIONS
75,446,748 km2
0
50
100
150
km² *10⁶
km² *10⁶
0
150
510
WORLD LAND SURFACE
149.428.500 km²
WORLD WATER SURFACE
335.000.000 km²
50
100
200
250
300
350
400
450
500
credits:ISS-Astronaut Ron Garan


0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
TOO COLD
15,392,536 km2
TOO STEEP
13,759,994 km2
TOO DRY
31,601,342 km2
BAD SOIL CONDITIONS
75,446,748 km2
SUITABLE FOR AGRICULTURE
32,724,841 km2
0
50
100
150
km² *10⁶
km² *10⁶
0
150
510
WORLD LAND SURFACE
149.428.500 km²
WORLD WATER SURFACE
335.000.000 km²
50
100
200
250
300
350
400
450
500
credits:ISS-Astronaut Ron Garan


0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
0 50 100 150
km² *10⁶
FORESTS
40,274,680 km²
AGRICULTURAL LAND
15,529,767 km²
km² *10⁶
0
150
510
WORLD LAND SURFACE
149.428.500 km²
WORLD WATER SURFACE
335.000.000 km²
50 100 200 250 300 350 400 450 500
credits:ISS-Astronaut Ron Garan

NASA Congo and Zaire - Manmade fires to provide agricultural land

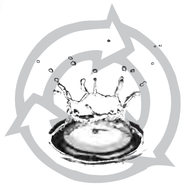
NASA Congo and Zaire - Manmade fires to provide agricultural land

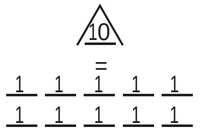
google-earth.com/vfi

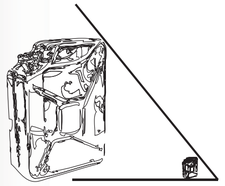

vfi
google-earth.com/vfi

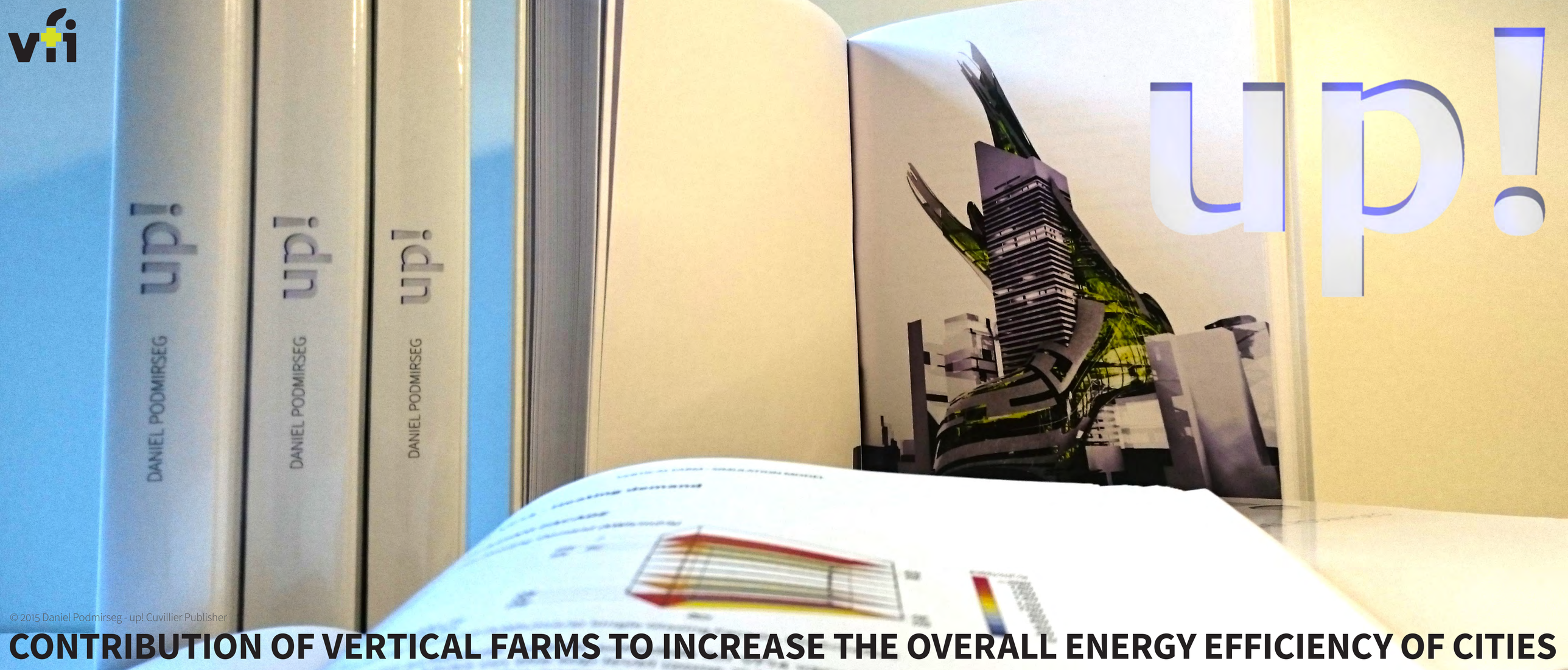
03 NÜTZEN, WAS WIR HABEN

http://ec.europa.eu/environment/integration/research/newsalert/pdf/179na4_en.pdf









CONTRIBUTION OF VERTICAL FARMS TO INCREASE THE OVERALL ENERGY EFFICIENCY OF CITIES

VIENNA

temperate climate

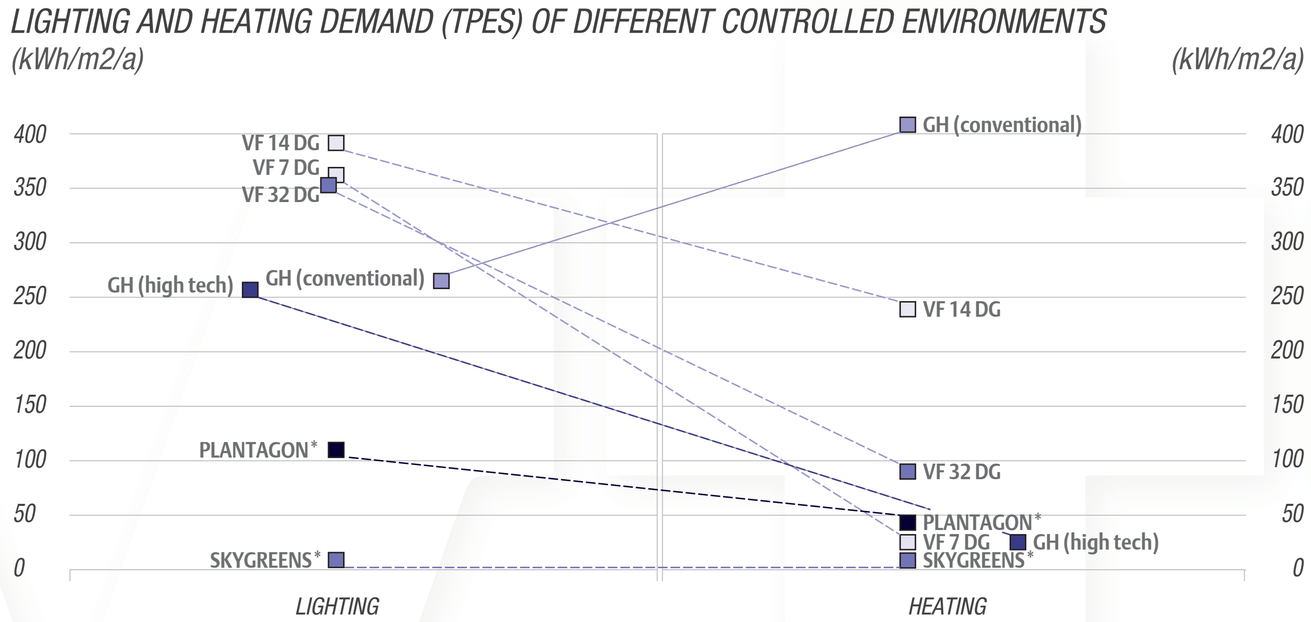
TOMATO

highest light requirement

© Chris Jacobs

SKYSCRAPER

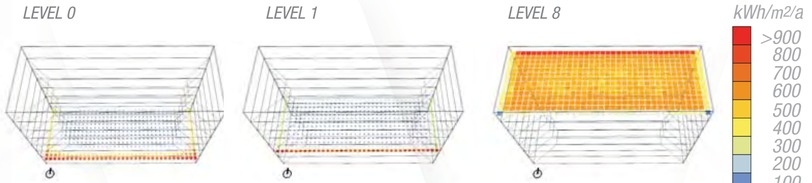
intermediate floors



* = assumptions

TOTAL PRIMARY ENERGY OF SELECTED PRODUCTION TYPES

VF 14 - DG - ANNUAL DAYLIGHT AVAILABILITY (kWh/m²/a)



TOTAL (kWh/a)
102,138.64

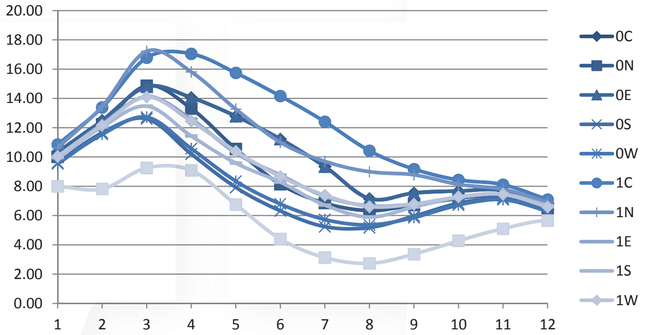
TOTAL (kWh/m²/a)
202.66

TOTAL (kWh/a)
49,696.70

TOTAL (kWh/m²/a)
98.60

TOTAL (kWh/a)
477,898.10

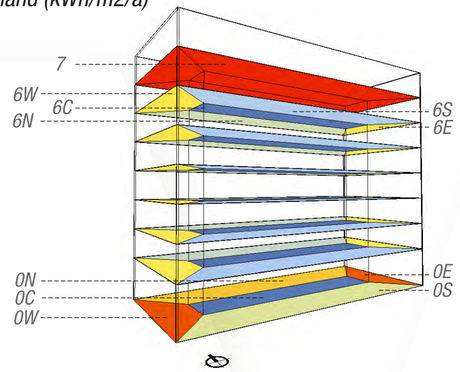
TOTAL (kWh/m²/a)
948.21

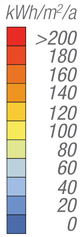


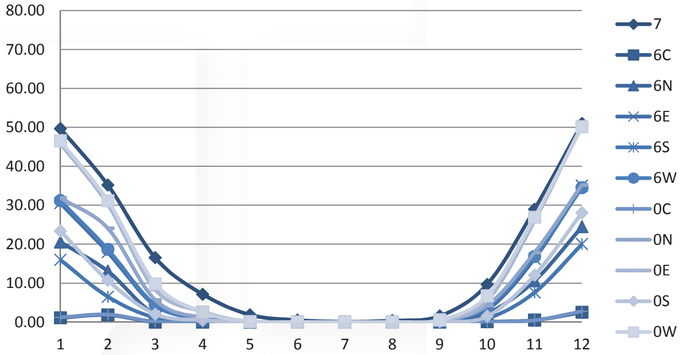
ENERGY CONSUMPTION

VF 14 - SG - HL Heating Demand (kWh/m2/a)

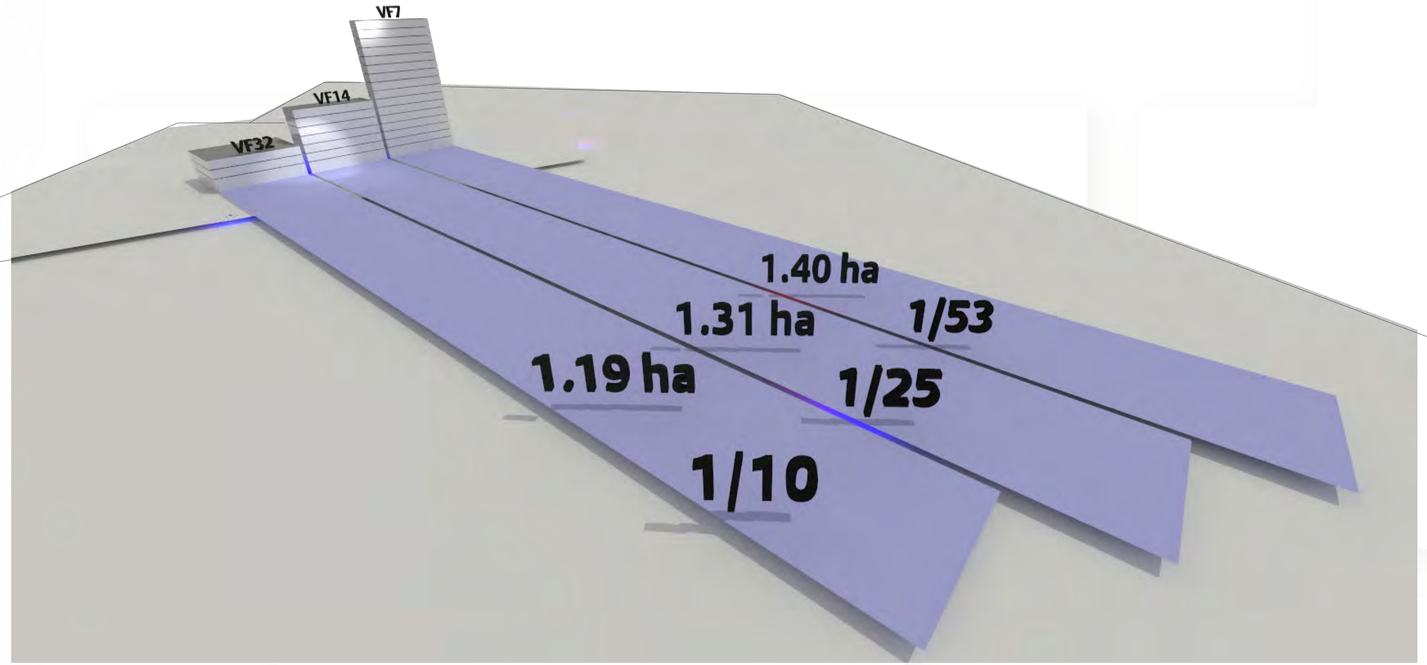
7	209.43
6C	6.01
6N	73.21
6E	108.27
6S	52.36
6W	110.38
0C	6.50
0N	120.21
0E	169.58
0S	78.20
0W	174.38
Total (kWh/a)	320,719.20
Total (kWh/m2/a)	77.33







ENERGY CONSUMPTION




FREE
PARKING
S MILWARD ST
W SIMPSON AVE
ONE WAY

Vertical Harvest
188 South Millward Street, Jackson,
WY, USA

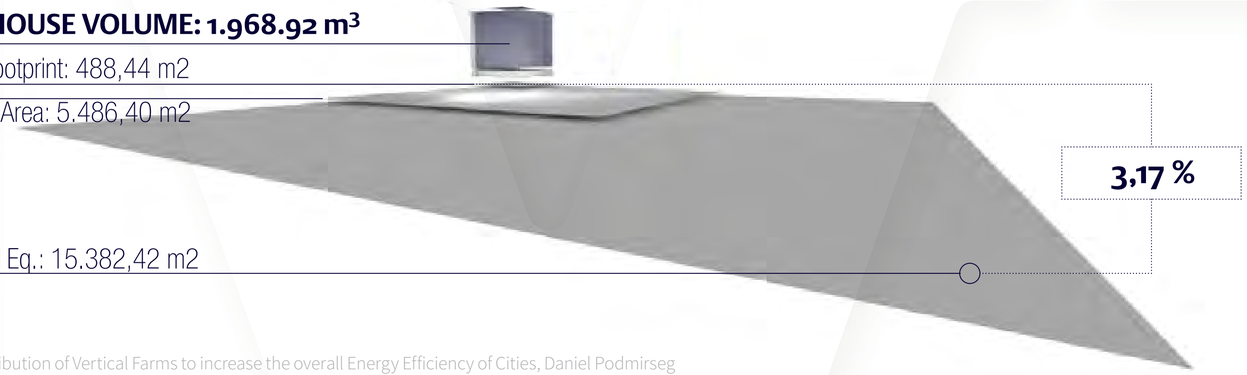
www.verticalharvest.org
Vertical Harvest
Penny McBride, Project Administrator
PO Box 7290
Jackson, WY 83002

verticalharvest@verticalharvest.org

GREENHOUSE VOLUME: 1.968.92 m³

Building Footprint: 488,44 m2

Cultivation Area: 5.486,40 m2



3,17 %

Soil Based Eq.: 15.382,42 m2

knockoutpest.com

-75%

1989

2016

2017 Hallmann et al.

pinterest.at

-300Mio.

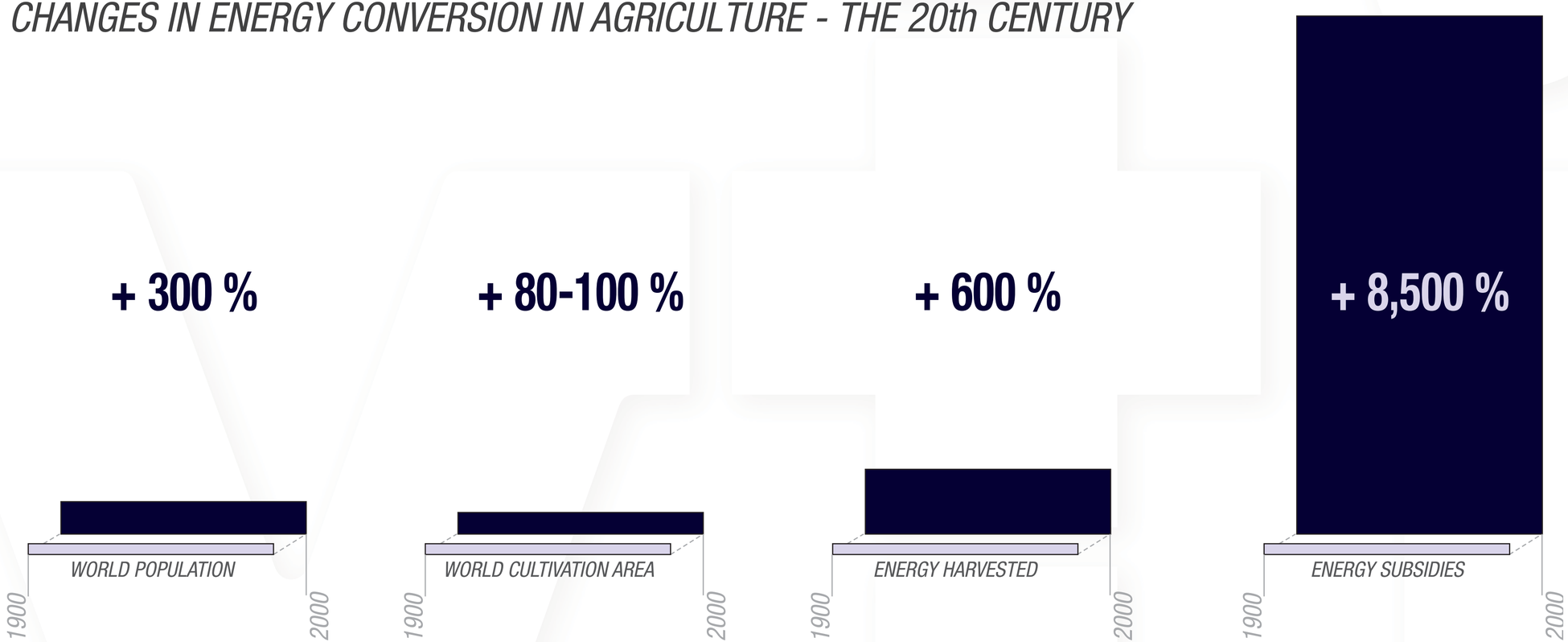
1980

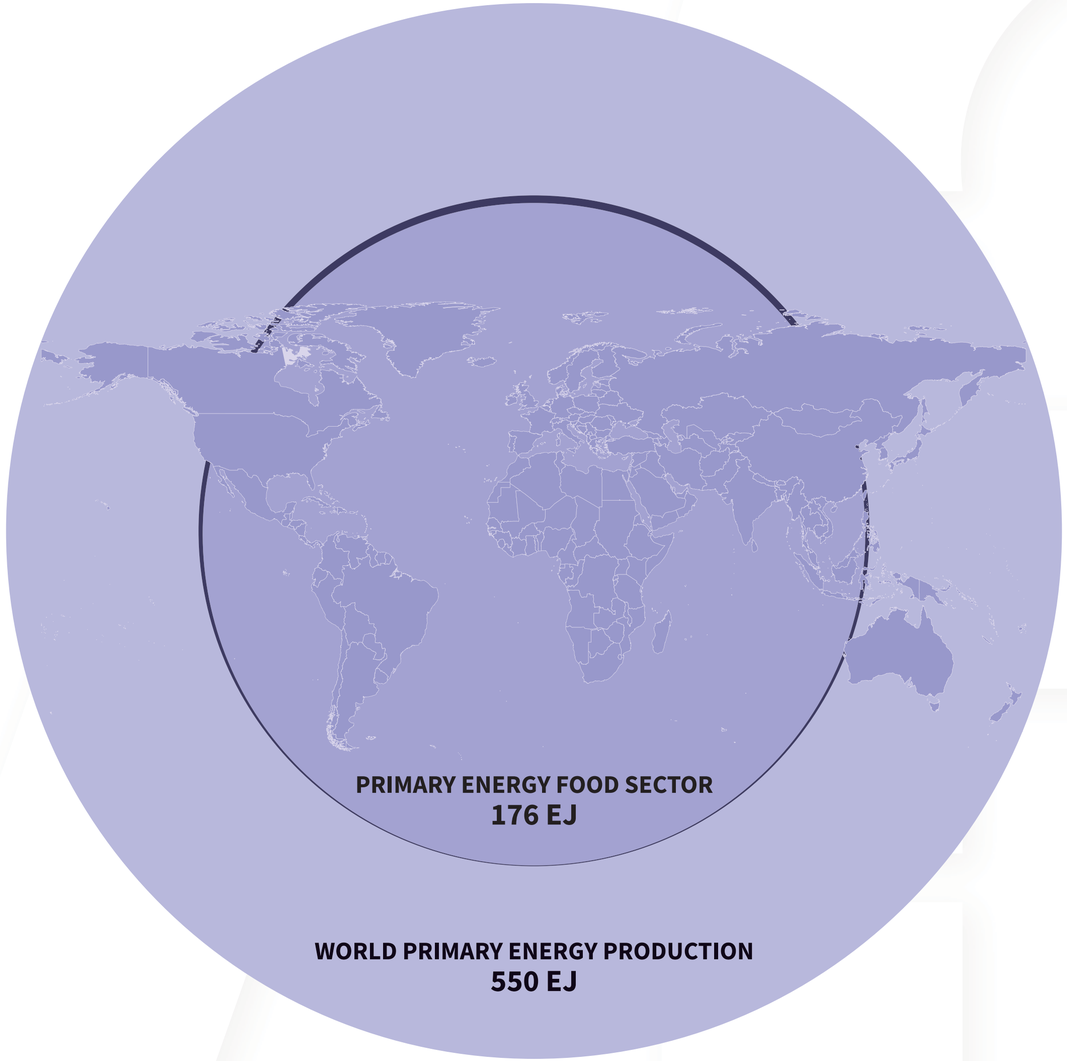
2010

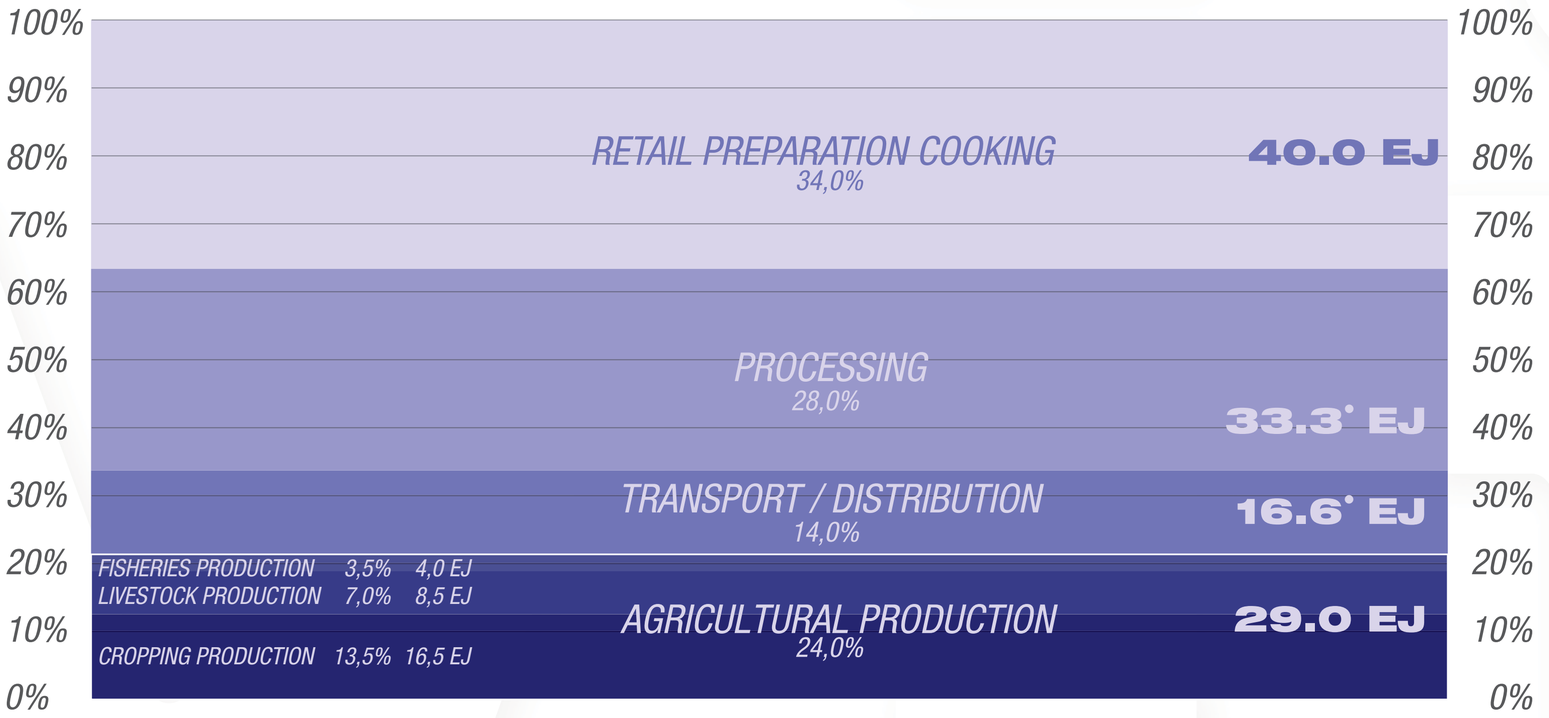
NABU Lars Lachmann

04 [ERNEUERBARE] ENERGIE

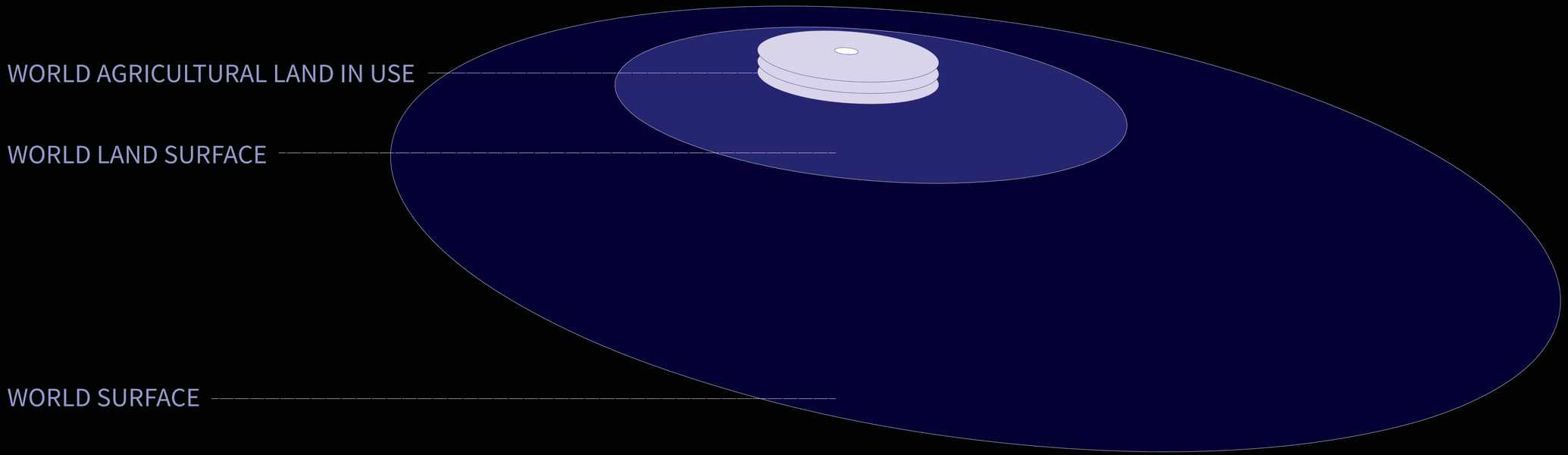
CHANGES IN ENERGY CONVERSION IN AGRICULTURE - THE 20th CENTURY





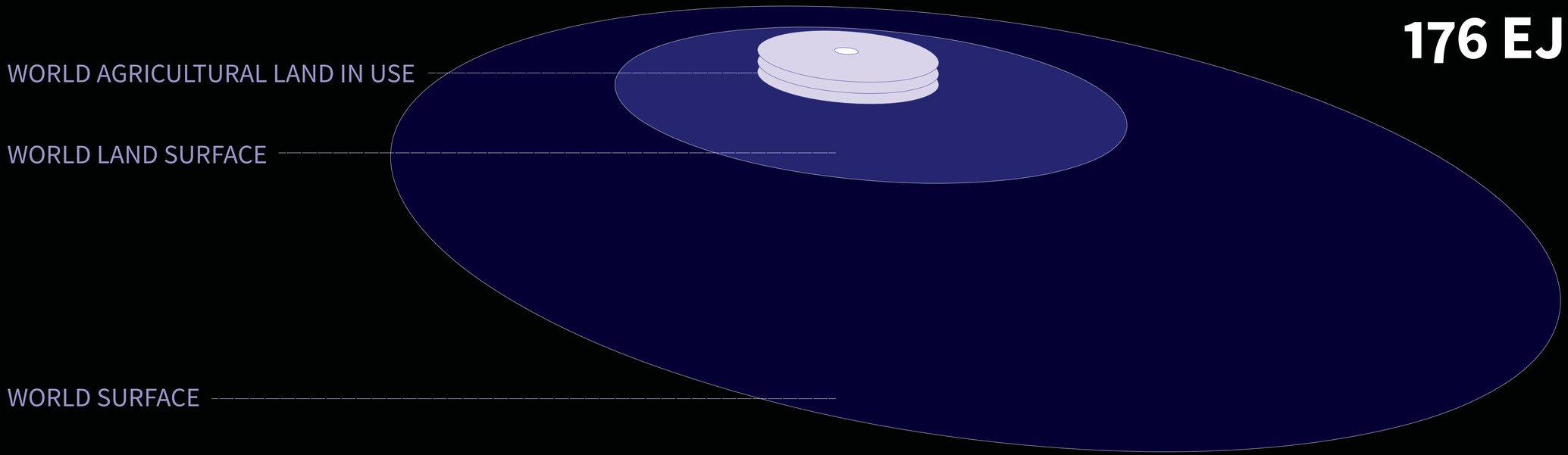


III STRATEGY
DO MORE WITH WHAT WE HAVE

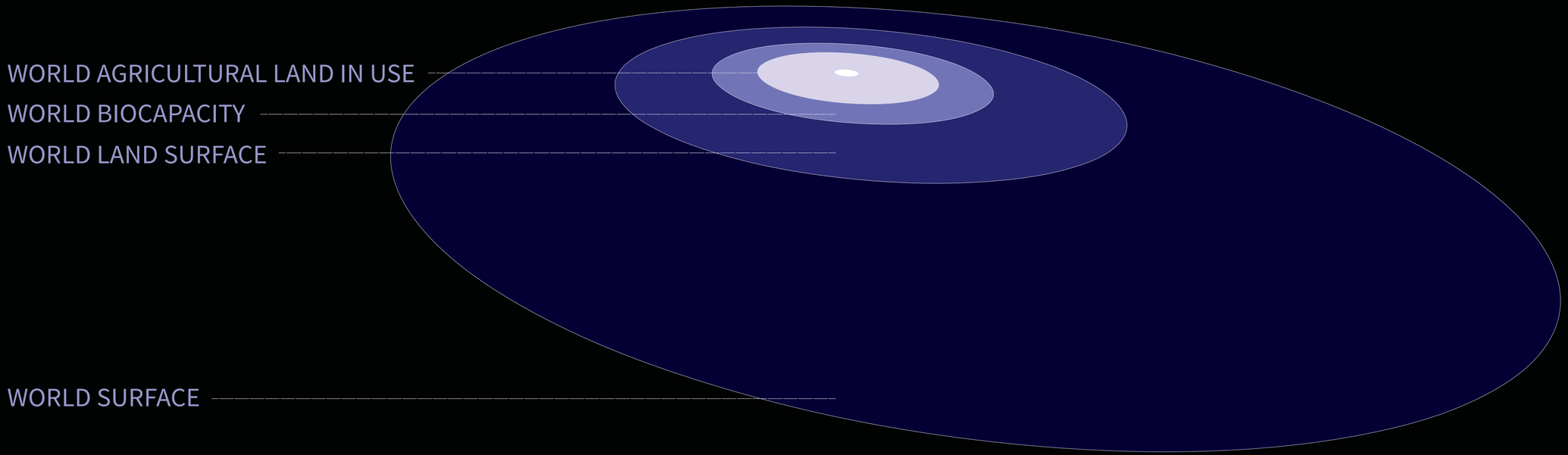


III STRATEGY
DO MORE WITH WHAT WE HAVE

2011	2075
10,000,000,000 mt	16,000,000,000 mt
176 EJ	350 EJ



III STRATEGY
LAND CONVERSION

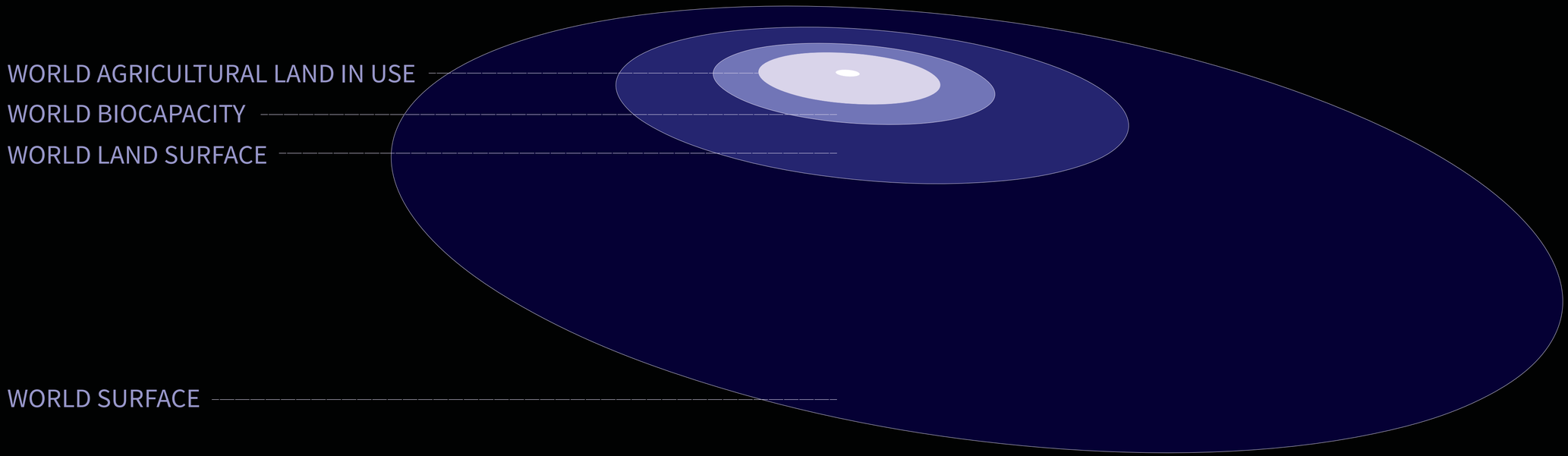


III STRATEGY
LAND CONVERSION

15,529,767 km2

32,724,842km2

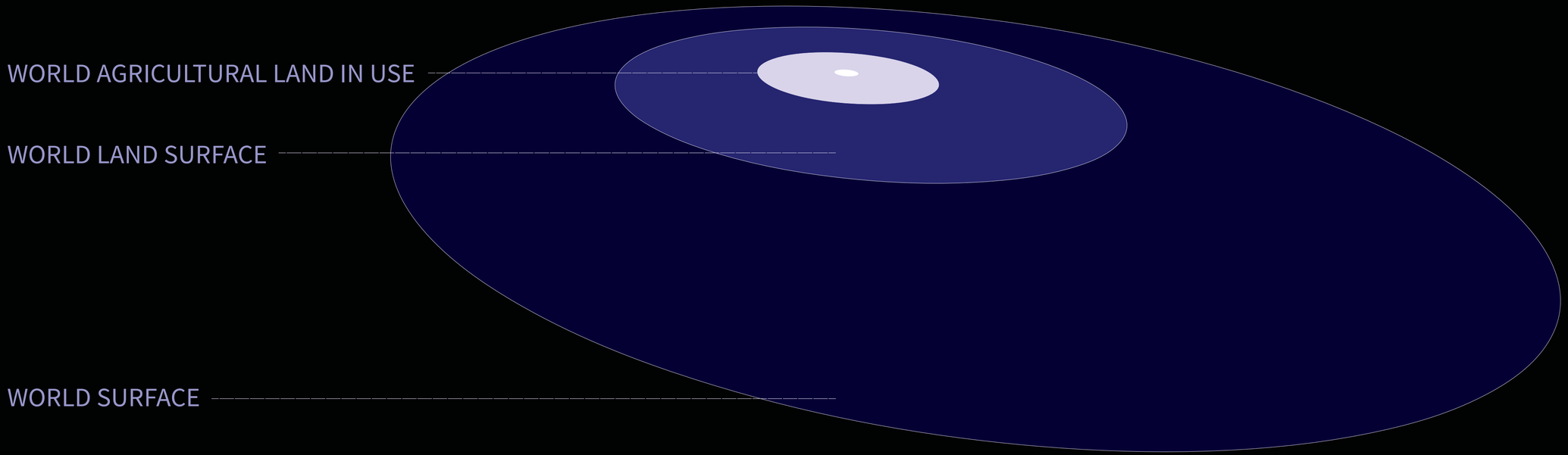
900 Gt CO2



35.3 Gt CO2 2013

III STRATEGY
CHANGES IN DIETS

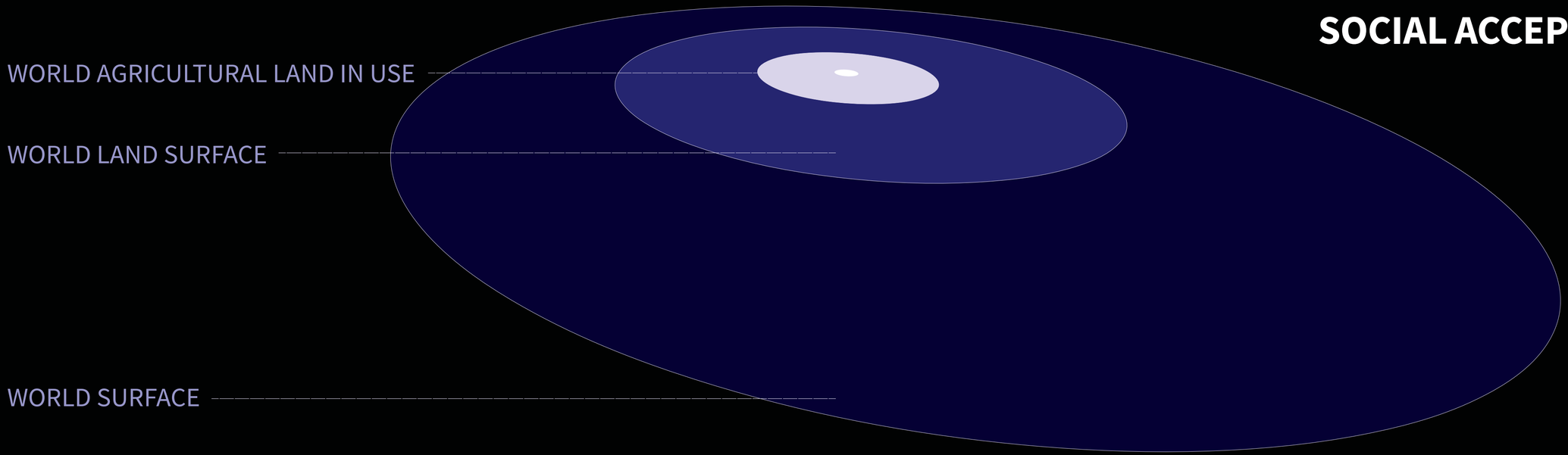
LESS DAIRY AND MEAT **MORE VEGETAL**



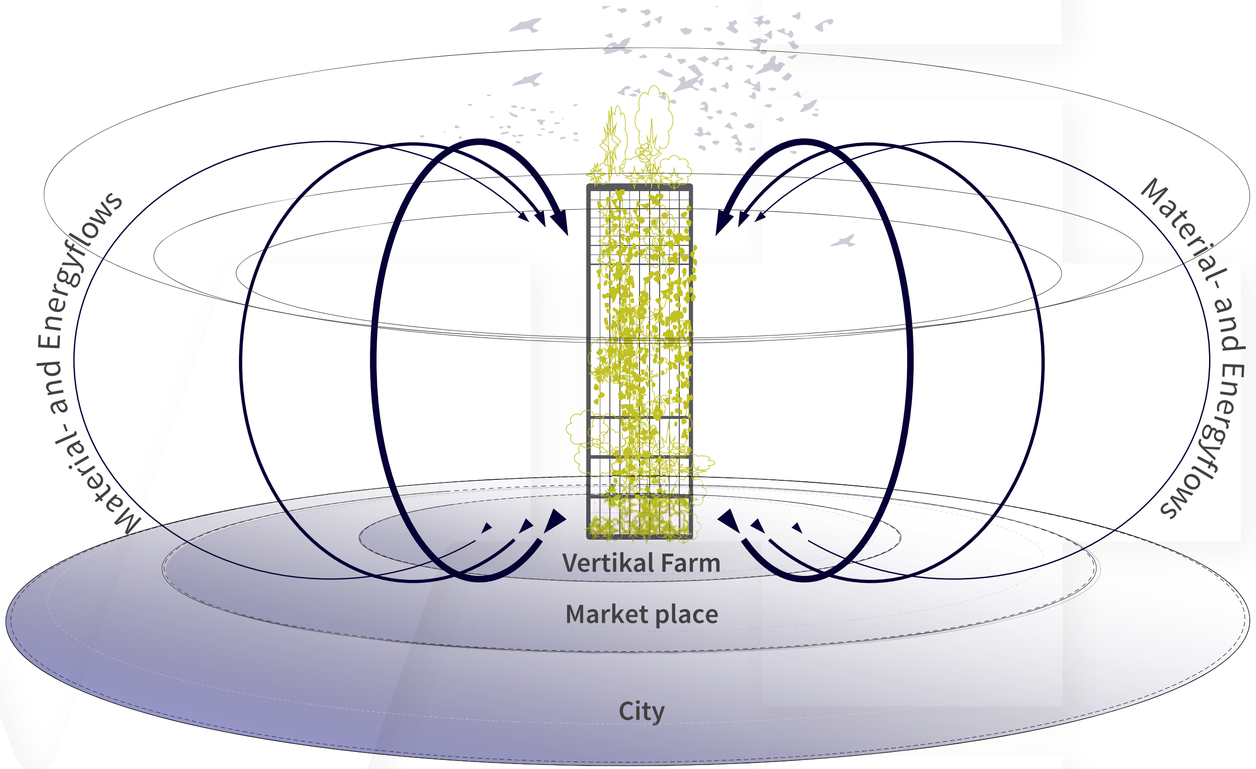
III STRATEGY
CHANGES IN DIETS

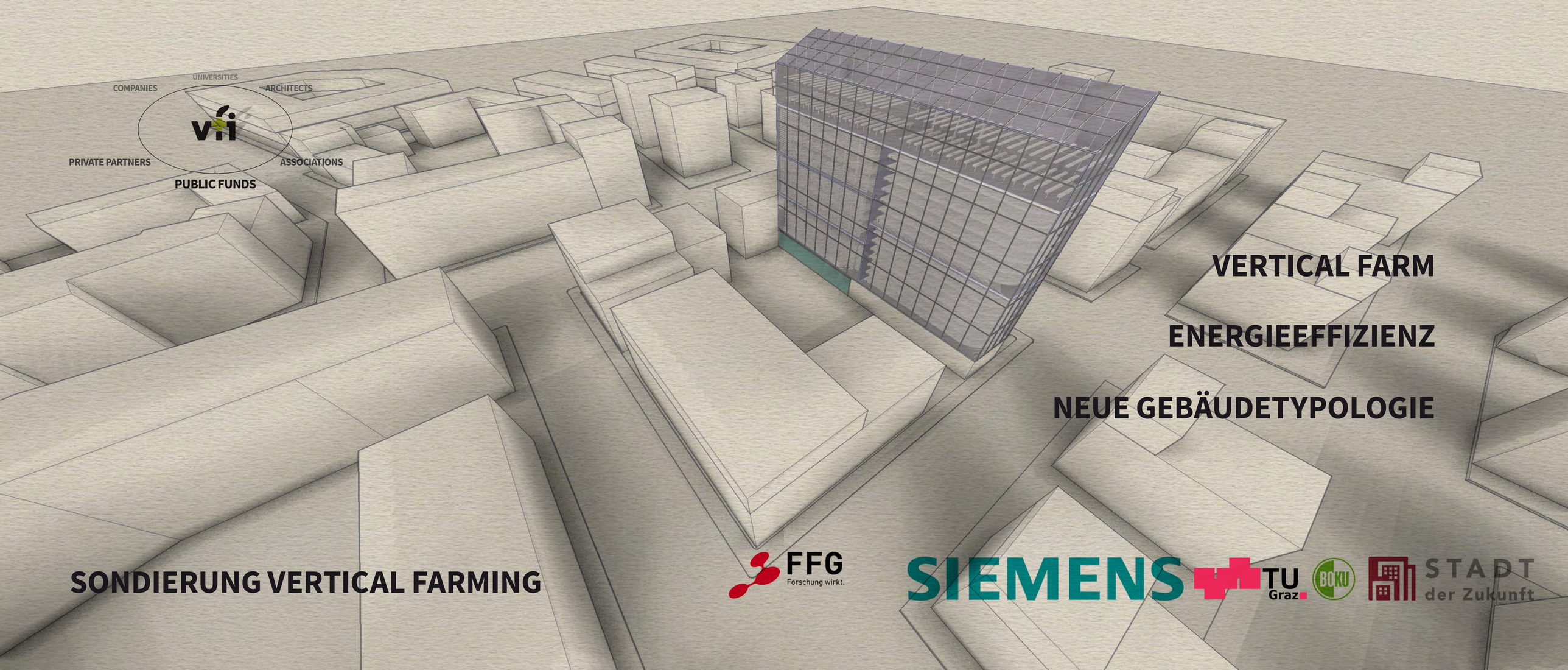
AGAINST EVERY TREND

SOCIAL ACCEPTANCE FOR POLICIES



05 KREISLAUFWIRTSCHAFT


Material- and Energyflows
Material- and Energyflows
Vertikal Farm
Market place
City



SONDIERUNG VERTICAL FARMING

VERTICAL FARM

ENERGIEEFFIZIENZ

NEUE GEBÄUDETYPOLOGIE

FFG Forschung wirkt.

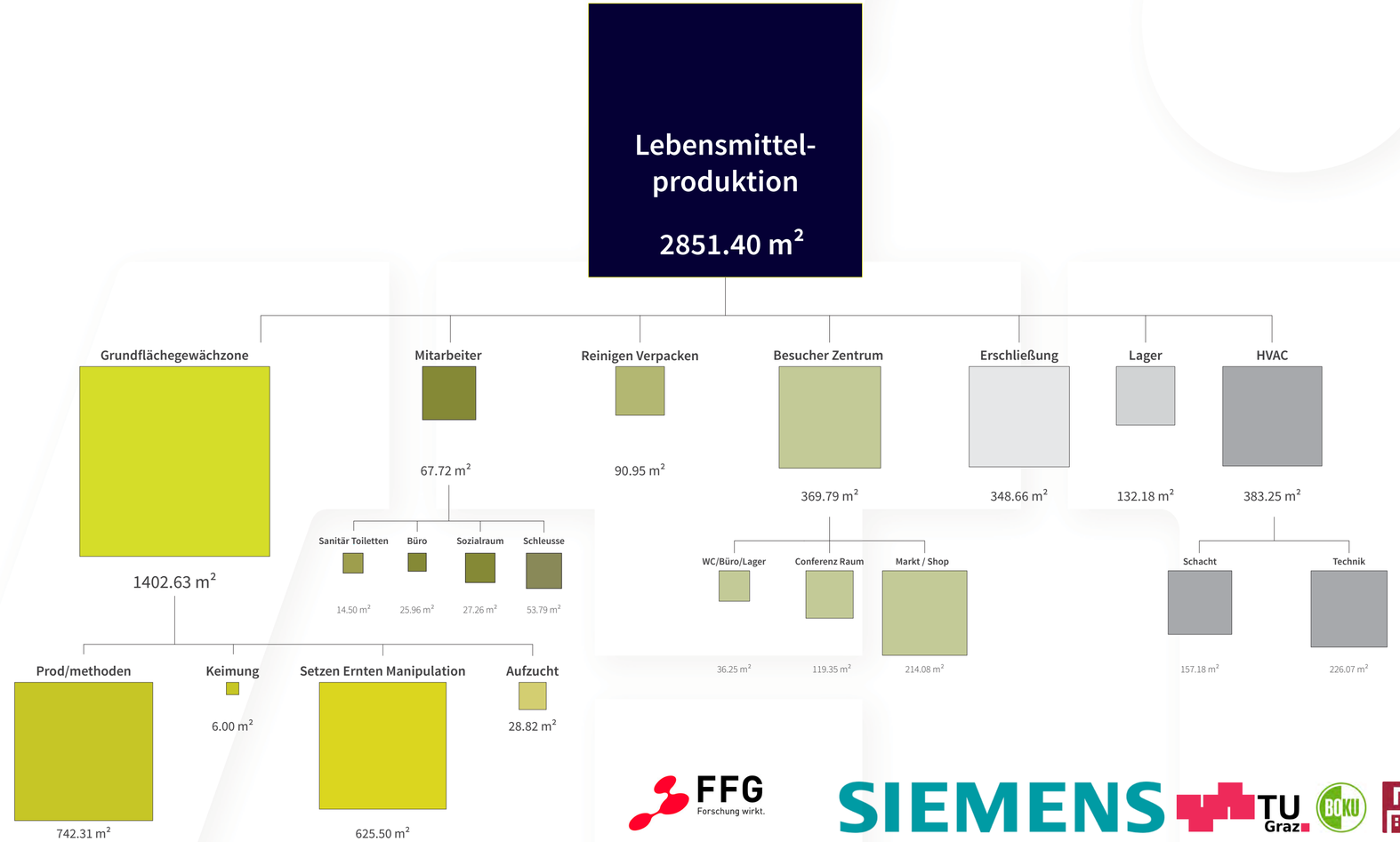
SIEMENS

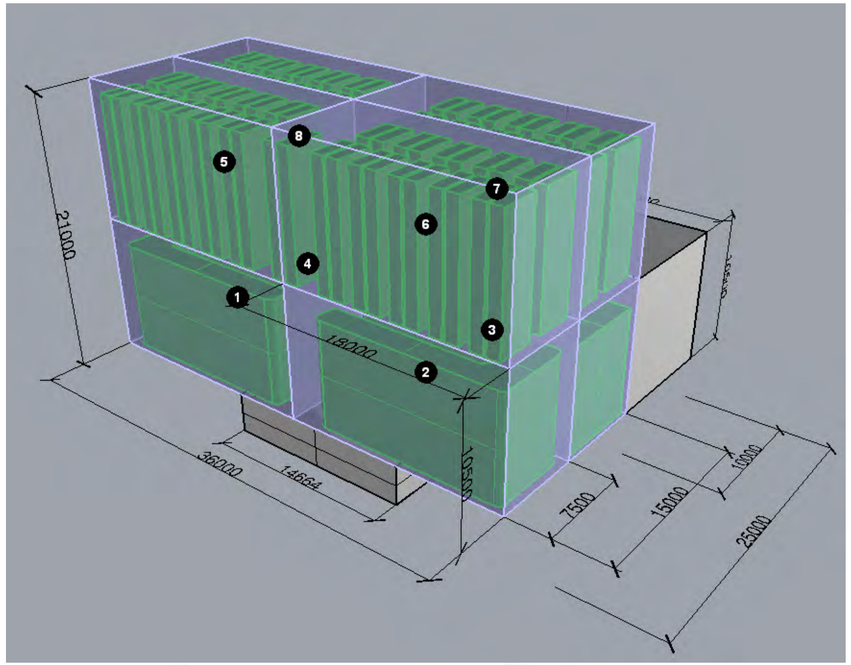
TU Graz

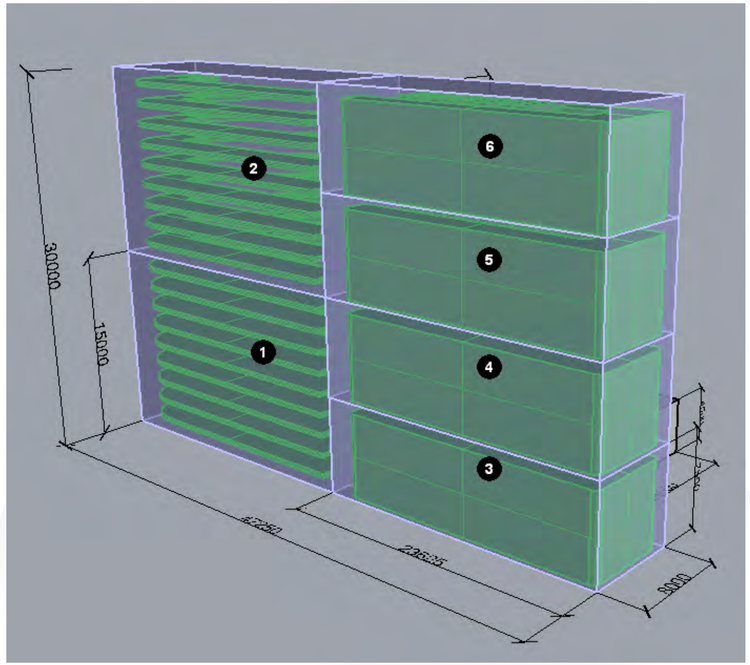
BOKU

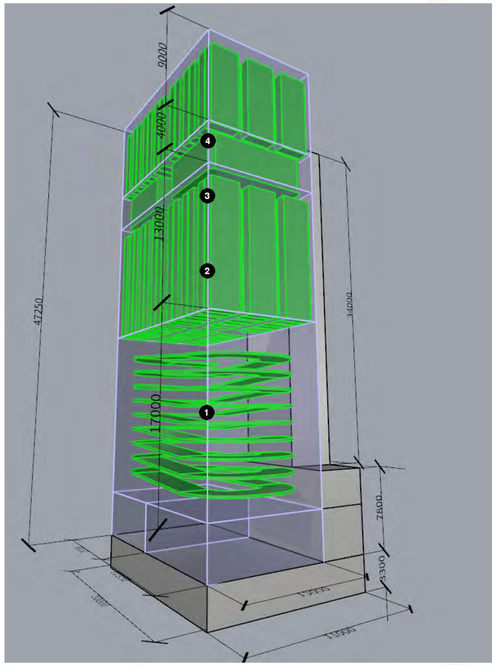
STADT der Zukunft

VF # 4


Lebensmittel-produktion
2851.40 m²
Grundflächegewächzone
1402.63 m²
Prod/methoden
742.31 m²
Keimung
6.00 m²
Setzen Ernten Manipulation
625.50 m²
Aufzucht
28.82 m²
Mitarbeiter
67.72 m²
Sanitär Toiletten
14.50 m²
Büro
25.96 m²
Sozialraum
27.26 m²
Schleusse
53.79 m²
Reinigen Verpacken
90.95 m²
Besucher Zentrum
369.79 m²
WC/Büro/Lager
36.25 m²
Conferenz Raum
119.35 m²
Markt / Shop
214.08 m²
Erschließung
348.66 m²
Lager
132.18 m²
HVAC
383.25 m²
Schacht
157.18 m²
Technik
226.07 m²







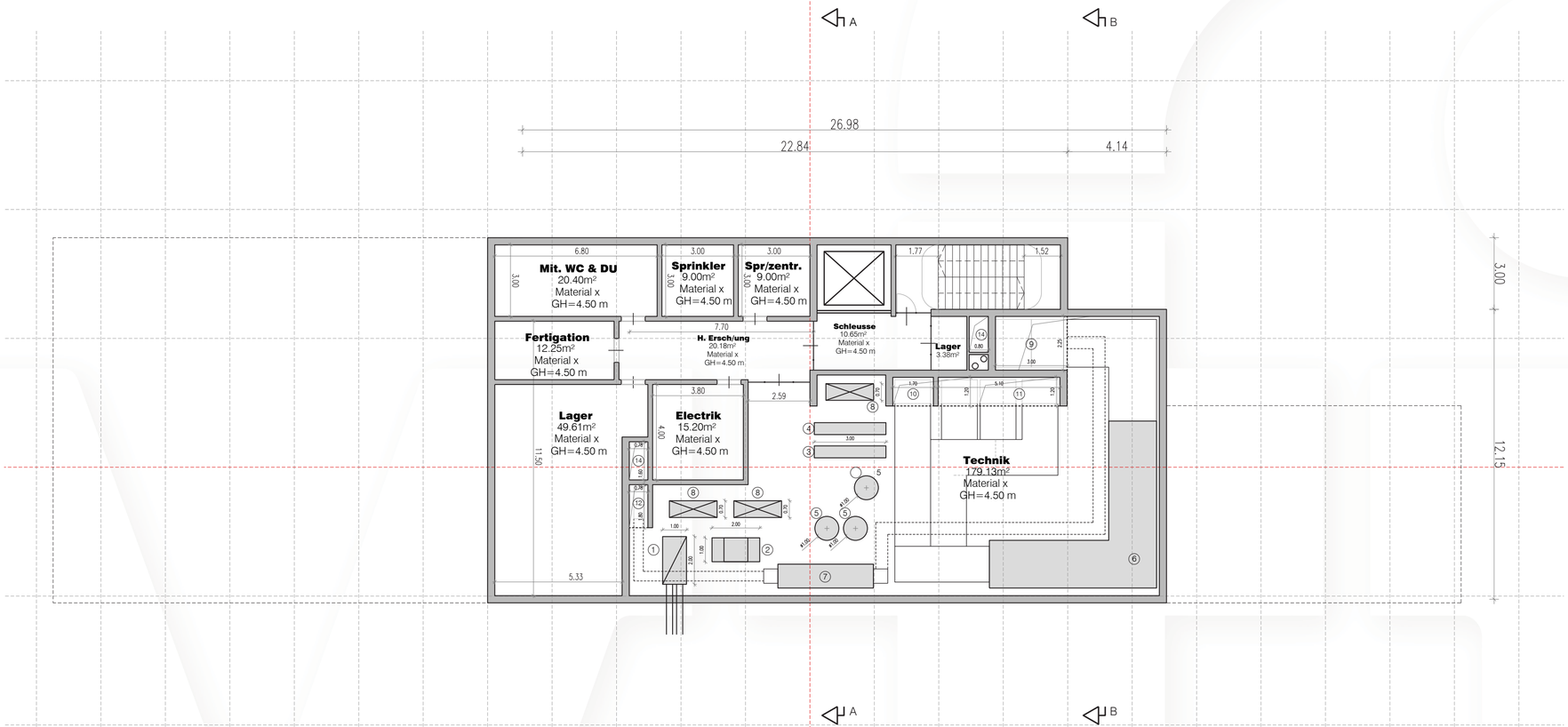
FFG Forschung wirkt.

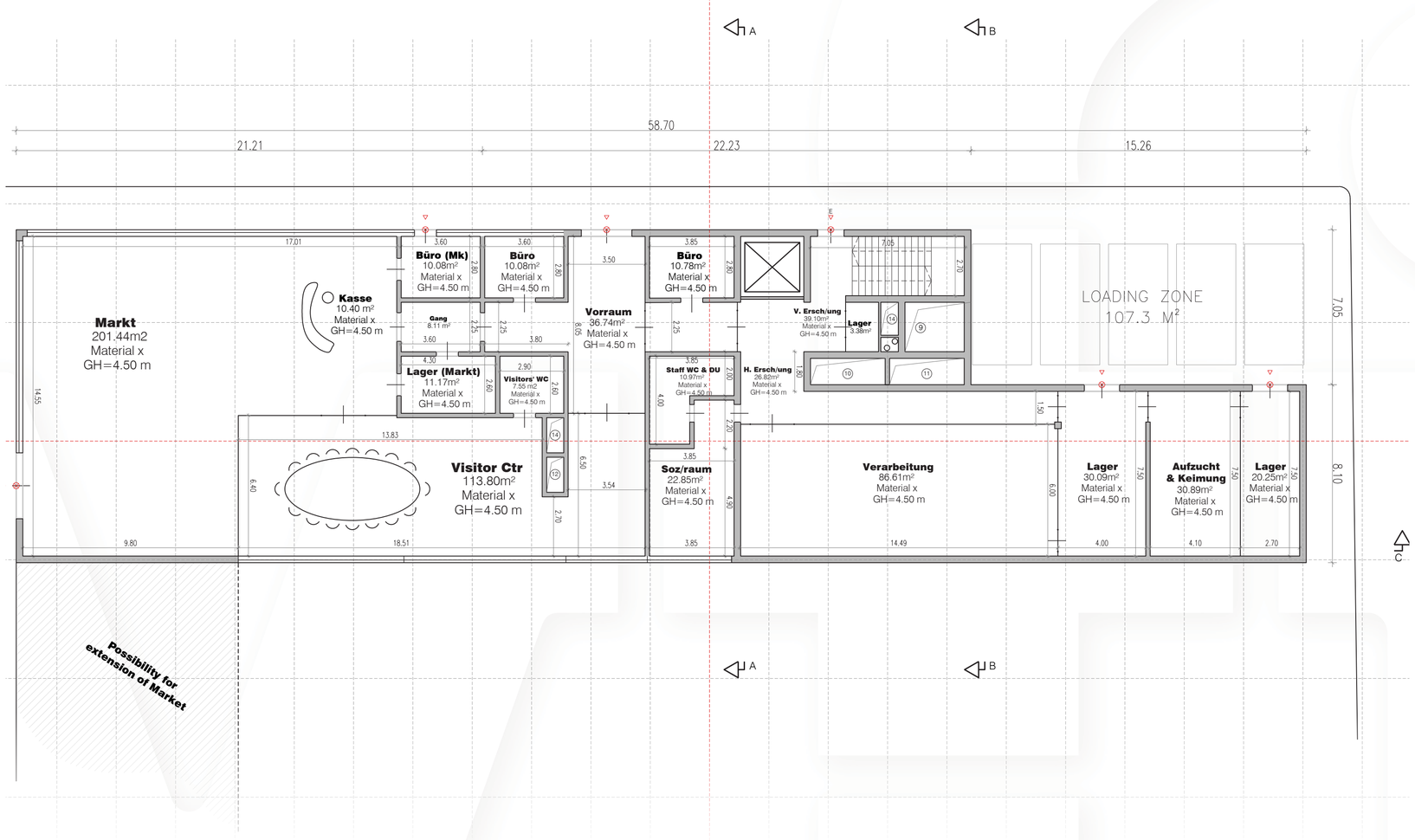
SIEMENS

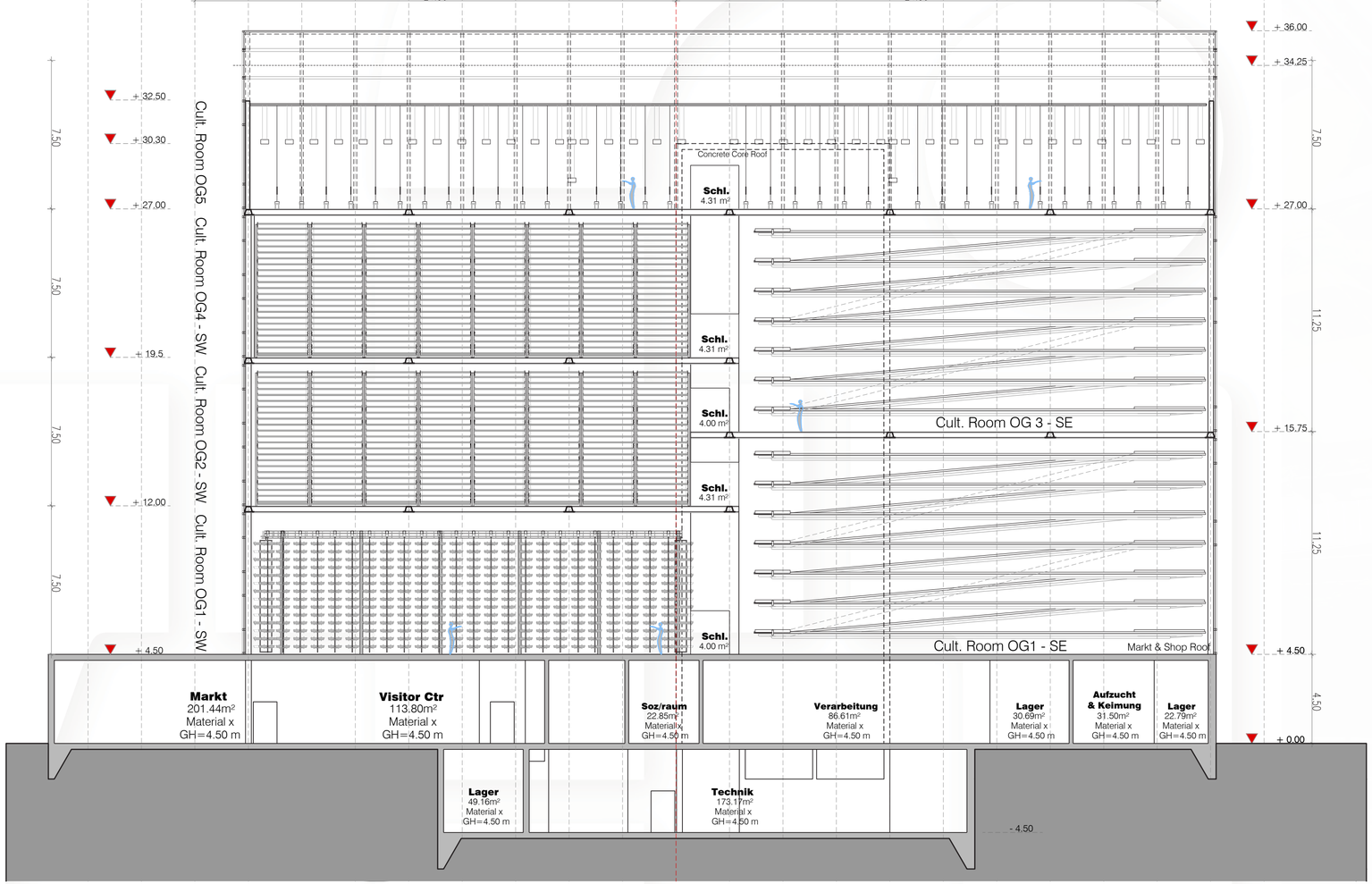
TU Graz

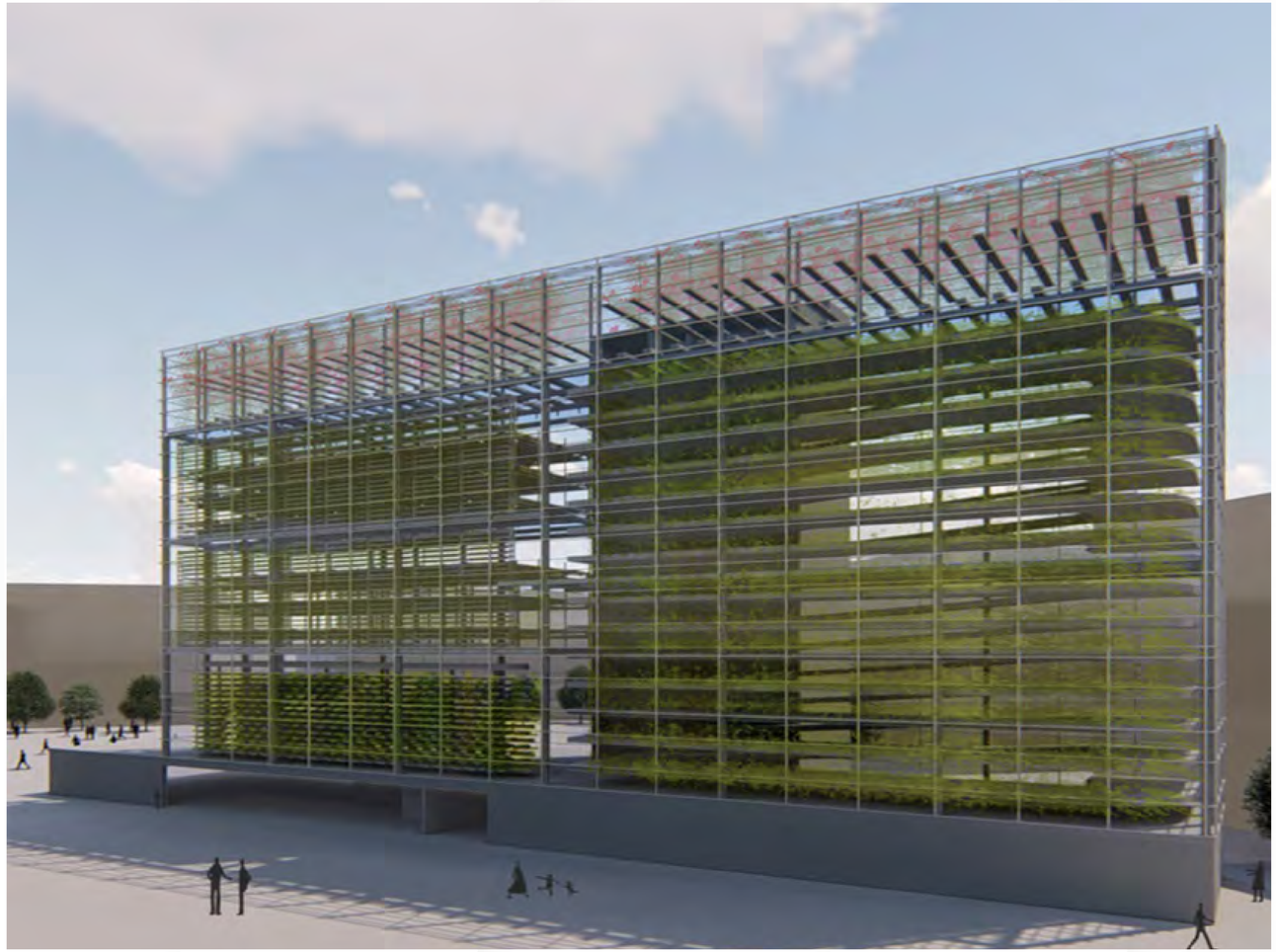
BOKU

STADT der Zukunft


A
B
26.98
22.84
4.14
3.00
12.15
Mit. WC & DU
20.40m²
Material x
GH=4.50 m
Sprinkler
9.00m²
Material x
GH=4.50 m
Spr/zentr.
9.00m²
Material x
GH=4.50 m
Fertigation
12.25m²
Material x
GH=4.50 m
H. Ersch/ung
20.18m²
Material x
GH=4.50 m
Schleusse
10.65m²
Material x
GH=4.50 m
Lager
3.38m²
Lager
49.61m²
Material x
GH=4.50 m
Electrik
15.20m²
Material x
GH=4.50 m
Technik
179.13m²
Material x
GH=4.50 m
6.80
3.00
3.00
3.00
3.00
3.00
1.77
1.52
7.70
3.80
2.59
11.50
4.00
5.33
2.00
1.00
3.00
4.00
4.00
4.00


A
B
58.70
21.21
22.23
15.26
Markt
201.44m2
Material x
GH=4.50 m
Kasse
10.40 m²
Material x
GH=4.50 m
Büro (Mk)
10.08m²
Material x
GH=4.50 m
Büro
10.08m²
Material x
GH=4.50 m
Büro
10.78m²
Material x
GH=4.50 m
Gang
8.11 m²
Lager (Markt)
11.17m²
Material x
GH=4.50 m
Visitors' WC
7.55 m2
Material x
GH=4.50 m
Vorraum
36.74m²
Material x
GH=4.50 m
Staff WC & DU
10.97m²
Material x
GH=4.50 m
V. Ersch/ung
39.10m²
Material x
GH=4.50 m
H. Ersch/ung
26.82m²
Material x
GH=4.50 m
Lager
3.38m²
LOADING ZONE
107.3 M²
Visitor Ctr
113.80m²
Material x
GH=4.50 m
Soz/raum
22.85m²
Material x
GH=4.50 m
Verarbeitung
86.61m²
Material x
GH=4.50 m
Lager
30.09m²
Material x
GH=4.50 m
Aufzucht
& Keimung
30.89m²
Material x
GH=4.50 m
Lager
20.25m²
Material x
GH=4.50 m
Possibility for
extension of Market


+ 36.00
+ 34.25
+ 32.50
+ 30.30
+ 27.00
+ 19.5
+ 15.75
+ 12.00
+ 4.50
+ 0.00
- 4.50
7.50
11.25
4.50
Cult. Room OG5
Cult. Room OG4 - SW
Cult. Room OG2 - SW
Cult. Room OG1 - SW
Concrete Core Roof
Schl. 4.31 m²
Schl. 4.31 m²
Schl. 4.00 m²
Schl. 4.31 m²
Schl. 4.00 m²
Cult. Room OG 3 - SE
Cult. Room OG1 - SE
Markt & Shop Roof
Markt 201.44m² Material x GH=4.50 m
Visitor Ctr 113.80m² Material x GH=4.50 m
Soz/raum 22.85m² Material x GH=4.50 m
Verarbeitung 86.61m² Material x GH=4.50 m
Lager 30.69m² Material x GH=4.50 m
Aufzucht & Keimung 31.50m² Material x GH=4.50 m
Lager 22.79m² Material x GH=4.50 m
Lager 49.16m² Material x GH=4.50 m
Technik 173.17m² Material x GH=4.50 m



FFG Forschung wirkt.

SIEMENS

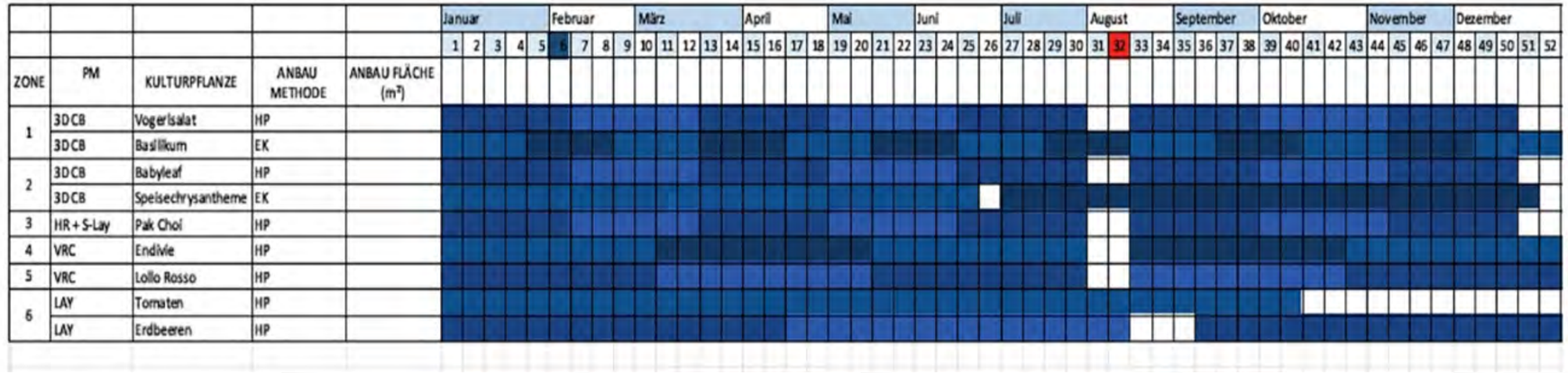
TU Graz

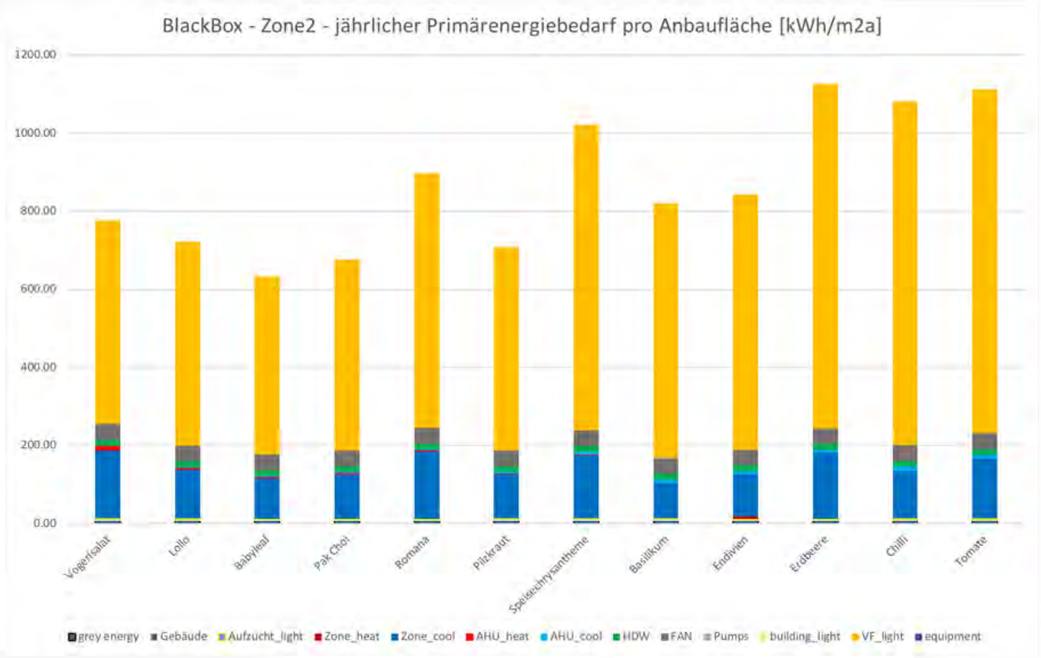
BOKU

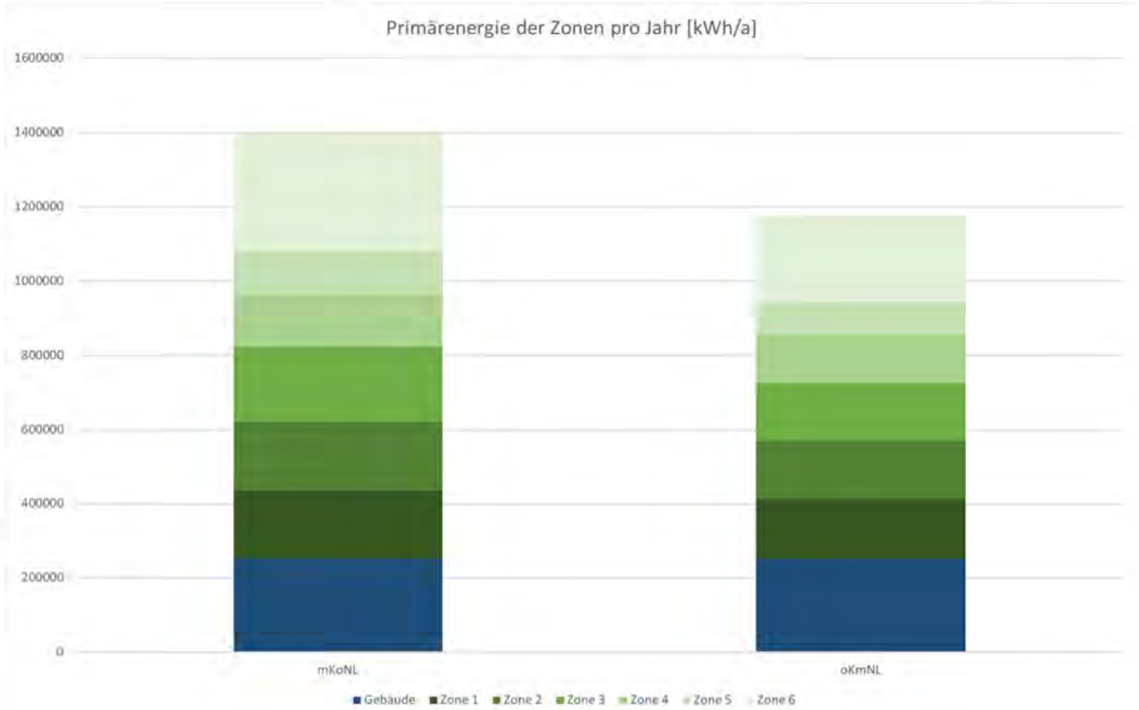
STADT der Zukunft

Cultivation Sch.

ZONE	PM	KULTURPFLANZE	ANBAU METHODE	ANBAU FLÄCHE (m^2)
1	3DCB	Vogerlsalat	HP	
	3DCB	Basilikum	EK	
2	3DCB	Babyleaf	HP	
	3DCB	Speisechrysantheme	EK	
3	HR + S-Lay	Pak Choi	HP	
4	VRC	Endivie	HP	
5	VRC	Lollo Rosso	HP	
6	LAY	Tomaten	HP	
	LAY	Erdbeeren	HP	




BlackBox - Zone2 - jährlicher Primärenergiebedarf pro Anbaufläche [kWh/m2a]
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Vogerlsalat
Lollo
Babyleaf
Pak Choi
Romana
Pflücksalat
Spielschrysantheme
Basilikum
Endivien
Erdbeere
Chilli
Tomate
grey energy
Gebäude
Aufzucht_light
Zone_heat
Zone_cool
AHU_heat
AHU_cool
HDW
FAN
Pumps
building_light
VF_light
equipment


Primärenergie der Zonen pro Jahr [kWh/a]
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
mKoNL
oKmNL
Gebäude
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6

Greenhouse / Vertical Farm		**Sundrop, Australia**	**Houwelling's Tomatoes, Camarill**	**Zeiler Tomaten, Muenchendorf**	**VF #4**
		Warm-summer Medit. climate	Warm-summer Medit. climate	TEMPERATE-continental climate	TEMPERATE-continental climate
Footprint - building	**m²**	**340 000,00**	**518 000,00**	**65 560,00**	**786,24**
Footprint - greenhouse	**m²**	**200 000,00**	**500 000,00**	**63 000,00**	**1 402,39**
Anbaumethode	-	Hydroponics	Hydroponics	Hydroponics - cocosubstrate	Hydroponics
Yearly Output	kg/a	17 000 000,00	48 000 000,00	2 000 000,00	185 000,00
Yearly Output / Greenhouse area	kg/m²/a	85,00	96,00	31,75	131,92
Yearly Output / Greenhouse Volume	kg/m³/a	13,08	12,80	4,88	15,46
Total Energy consumption	MWh/m² GH/a	0,29	0,21	0,55	0,45
Total Energy consumption	MWh/m³ GH/a	0,04	0,04	0,08	0,14
Electricity consumption	MWh/a	3 826,00	9 565,00	4 780,00	292,80
Light consumption	MWh/a	14 314,00	35 785,00	3 830,00	1 164,00
Heat consumption	MWh/a	40 356,00	58 215,00	26 019,00	165,00
Water consumption (for plants)	m³/a	450 000,00	1 200 000,00	138 000,00	5 580,96
Water consumption / Total Greenhouse ar	m³/m²/a	2,25	2,40	2,19	1,56

Total Farm Area = 2550,05 m²

Conclusio:

- Berücksichtigung des Energiebedarfs der Pflanzen - Anpassen der Kulturfolge an äußere Bedingungen
- Anpassung geeigneter Produktionsmethoden an die räumlichen Gegebenheiten (Raumhöhe, Trakttiefe)
- Verhältnis Gebäudegrundriss / Anbaufläche: 1:64
- Reduktion des Wasserbedarfs durch geeignete Gebäudetechnik von über 80%

Nächste Schritte:

- Weiterentwicklung des Funktions- und Raumprogramms
- Optimierungspotentiale LCA - Materialien
- Flächenaktivierung für Fassadenbegrünung oder Energieproduktion

UNIVERSITIES
COMPANIES
ARCHITECTS
PRIVATE PARTNERS
ASSOCIATIONS
PUBLIC FUNDS

wolkenfarm

WOLKENFARM :: DIE VERTIKALE FARM UND DIE SCHULE DER ZUKUNFT

SONDIERUNG SMART PÖLTEN 2.0

GRÜNSTATTGRAU.AT
VERBAND FÜR BAUWERKSBEGRÜNUNG

Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau

STADT der Zukunft

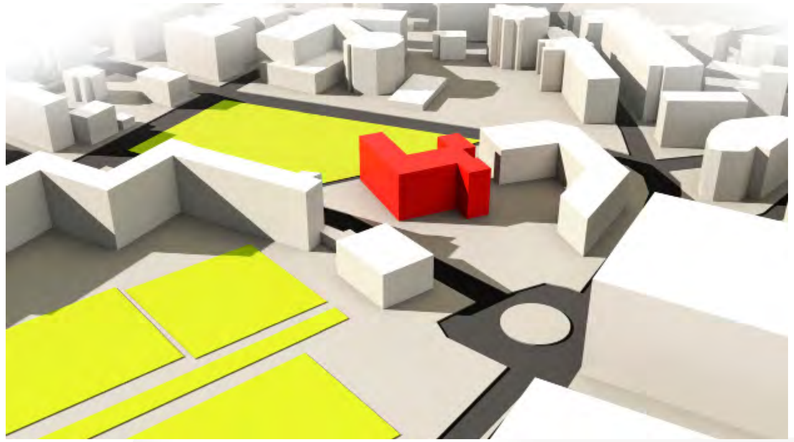
FFG
Forschung wirkt.

GRÜNSTATTGRAU.AT
VERBAND FÜR BAUWERKSBEGRÜNUNG

Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau

STADT der Zukunft

FFG
Forschung wirkt.



GRÜNSTATTGRAU.AT
VERBAND FÜR BAUWERKSBEGRÜNUNG

Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau

STADT der Zukunft

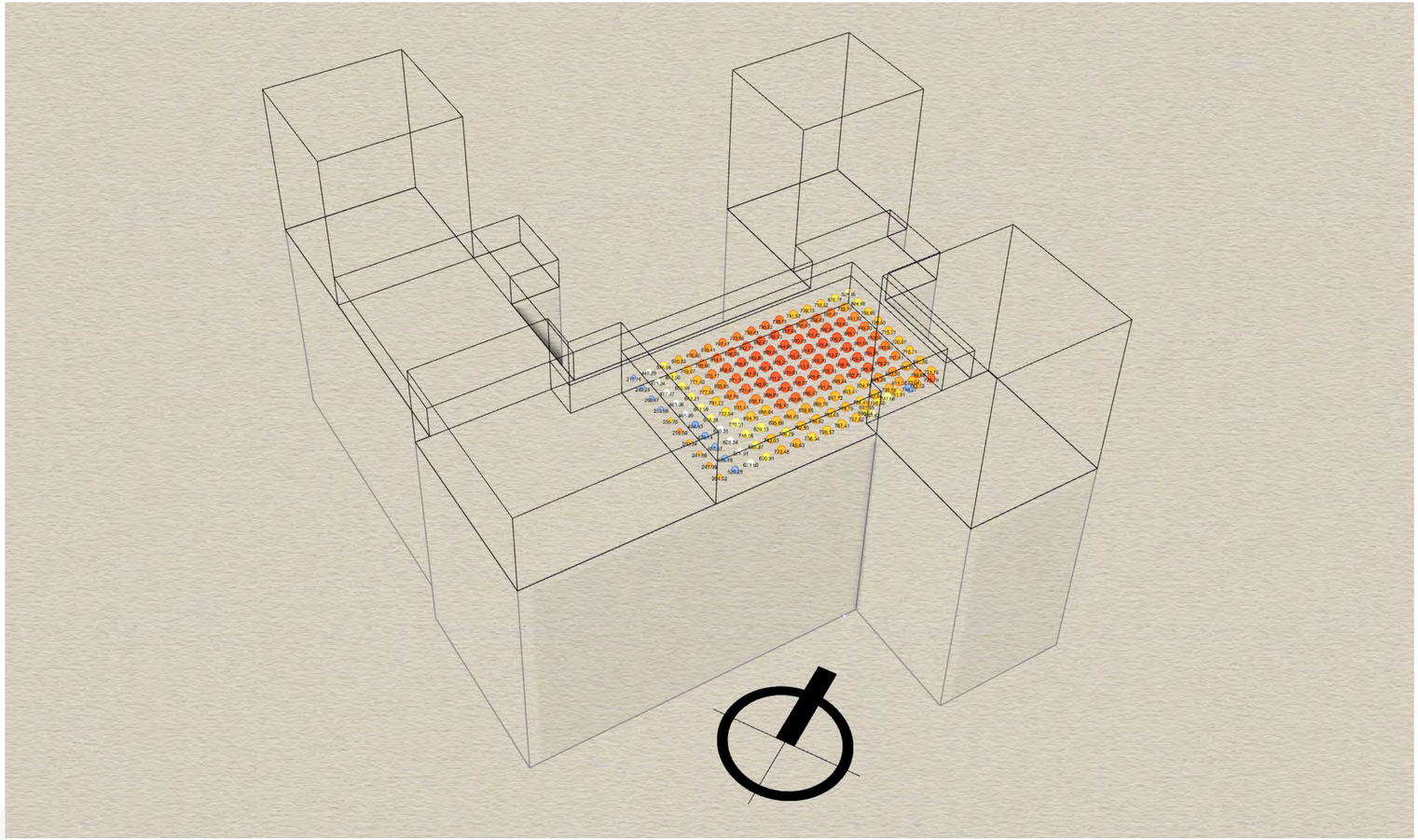
FFG
Forschung wirkt.

GRÜNSTATTGRAU.AT
VERBAND FÜR BAUWERKSBEGRÜNUNG

Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau

STADT der Zukunft

FFG
Forschung wirkt.

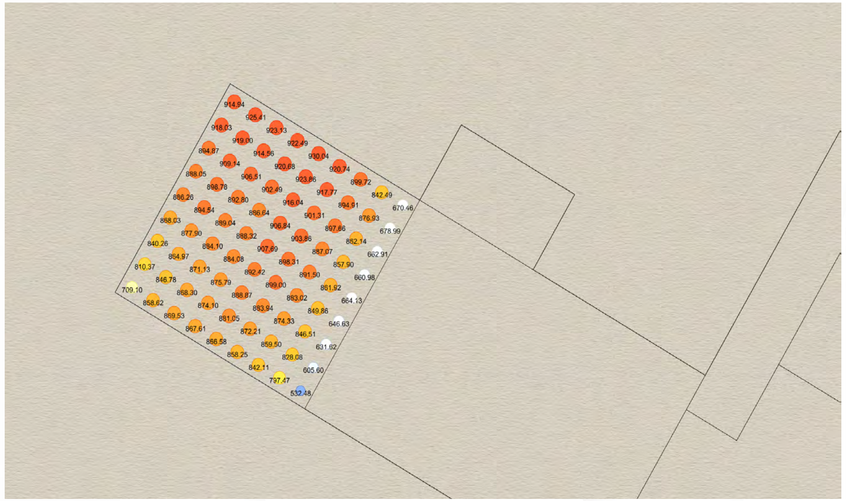


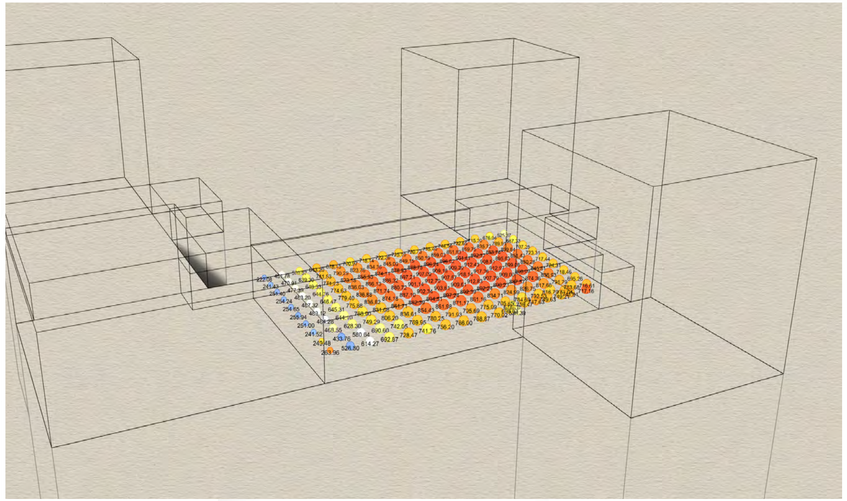
GRÜNSTATTGRAU.AT
VERBAND FÜR BAUWERKSBEGRÜNUNG

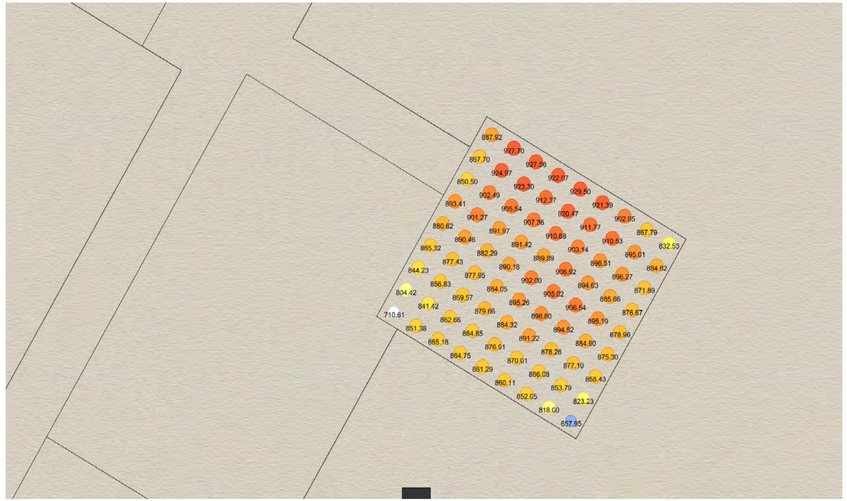
Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau

STADT der Zukunft

FFG
Forschung wirkt.





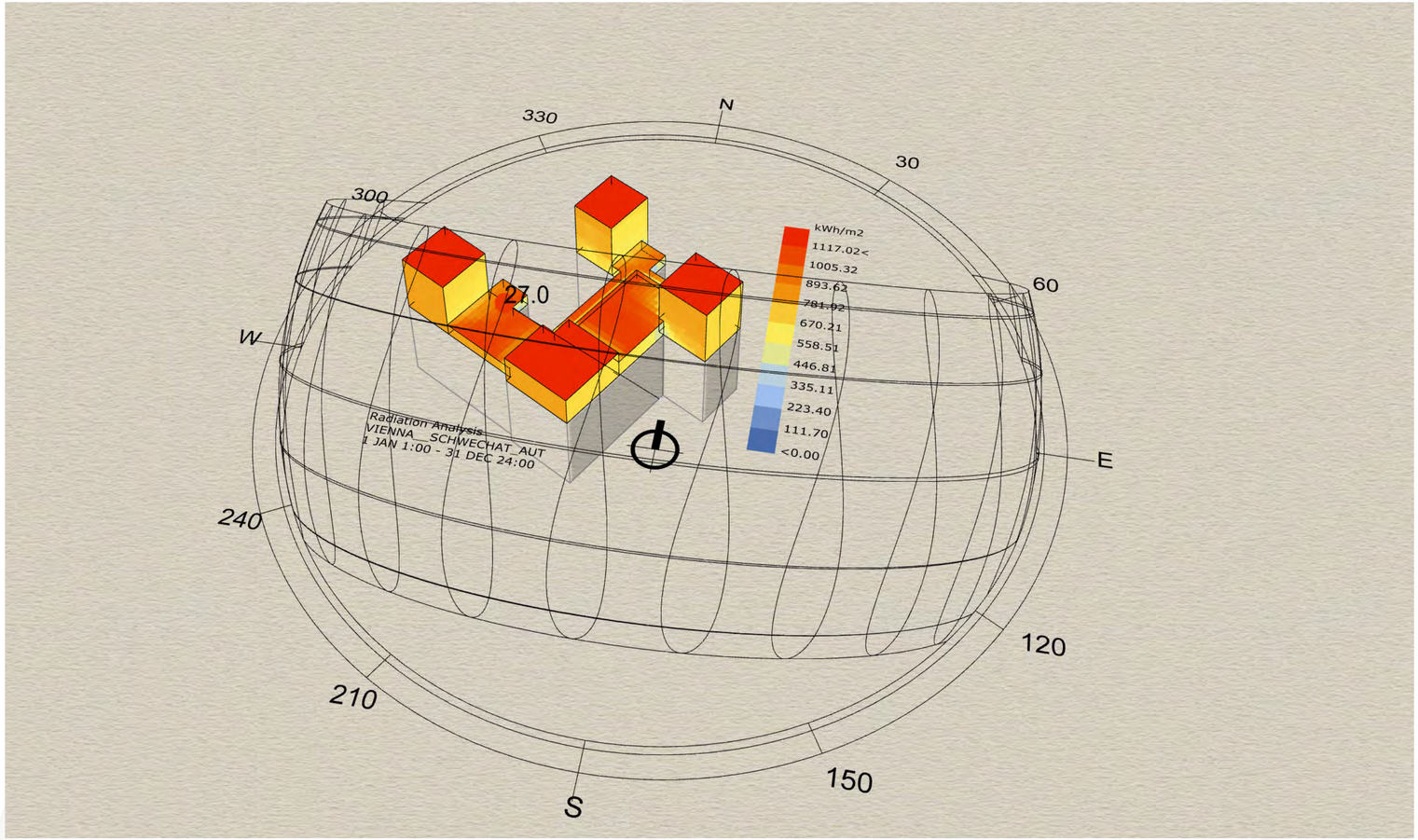


GRÜNSTATTGRAU.AT
VERBAND FÜR BAUWERKSBEGRÜNUNG

Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau

STADT der Zukunft

FFG
Forschung wirkt.

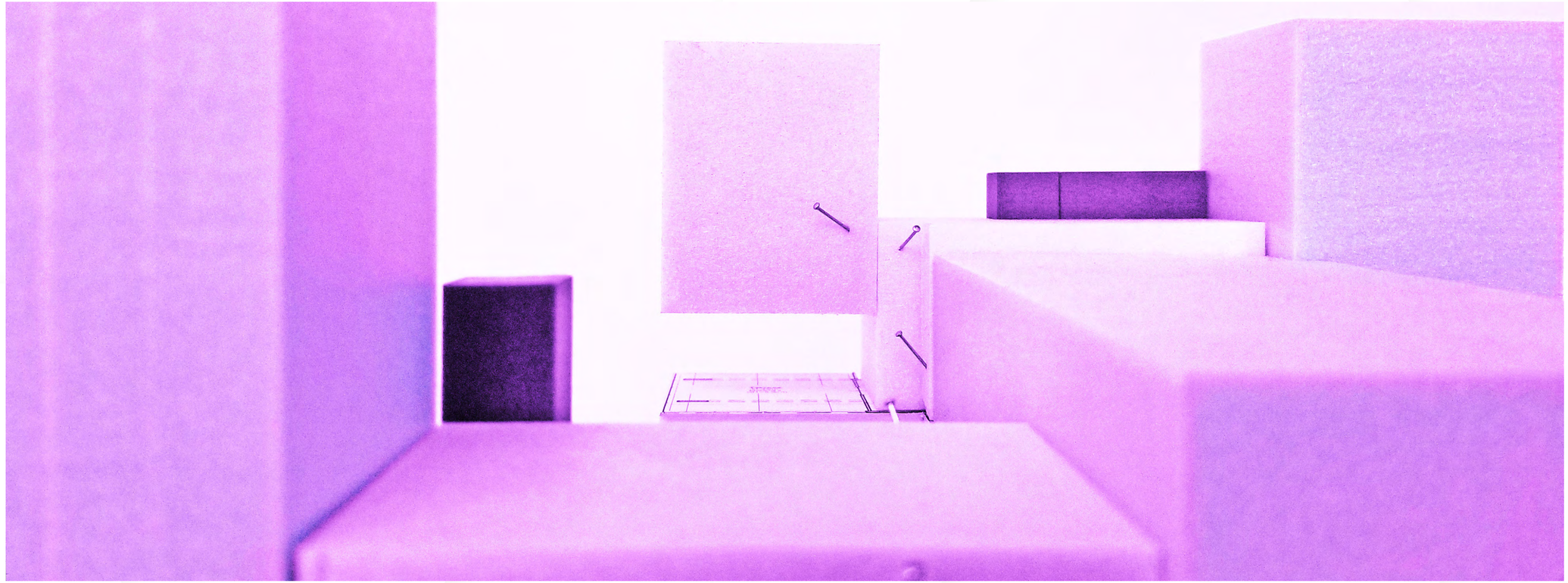


GRÜNSTATTGRAU.AT
VERBAND FÜR BAUWERKSBEGRÜNUNG

Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau

STADT der Zukunft

FFG
Forschung wirkt.



GRÜNSTATTGRAU.AT
VERBAND FÜR BAUWERKSBEGRÜNUNG

Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau

STADT der Zukunft

FFG
Forschung wirkt.

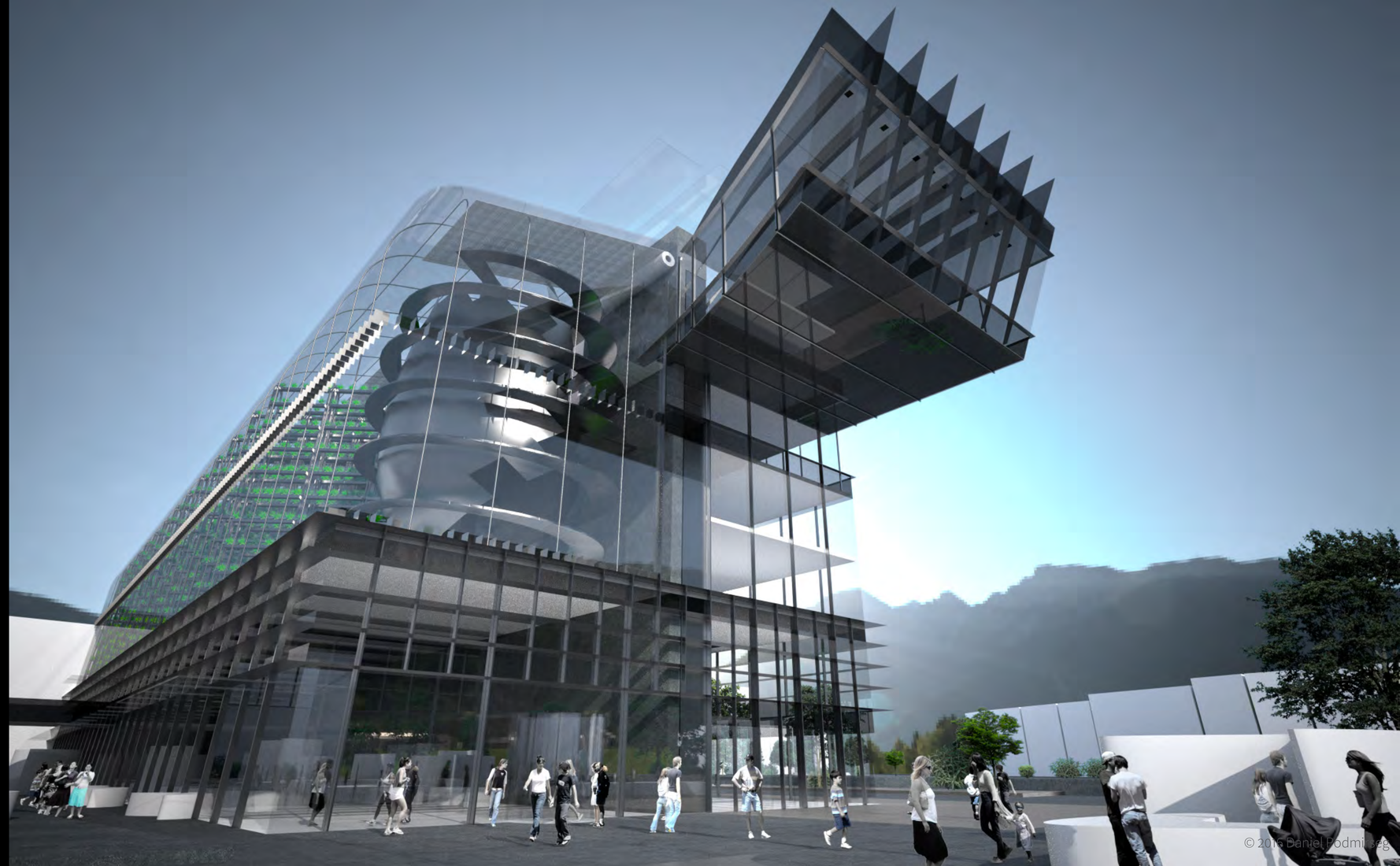
Zwischenbericht:

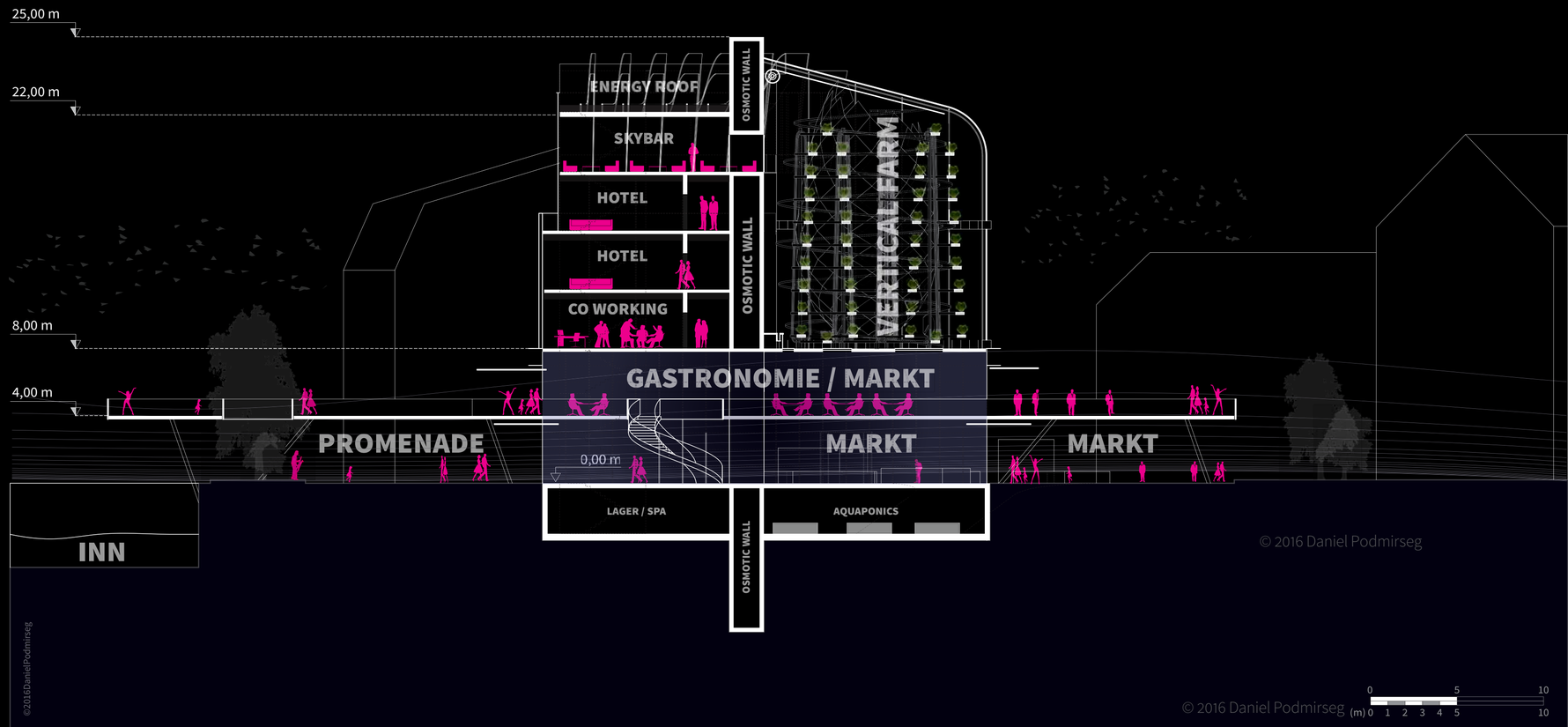
- hohe Akzeptanz von Vertical Farming seitens Bevölkerung und Polytechnikum
- erneute Verbesserung der Energiebilanz
- Erhöhung der Flächeneffizienz
- Hohes Potential im Schaffen von öffentlichen Räumen, Raum für (Aus-)Bildung, Potentiale der Fassadenbegrünung

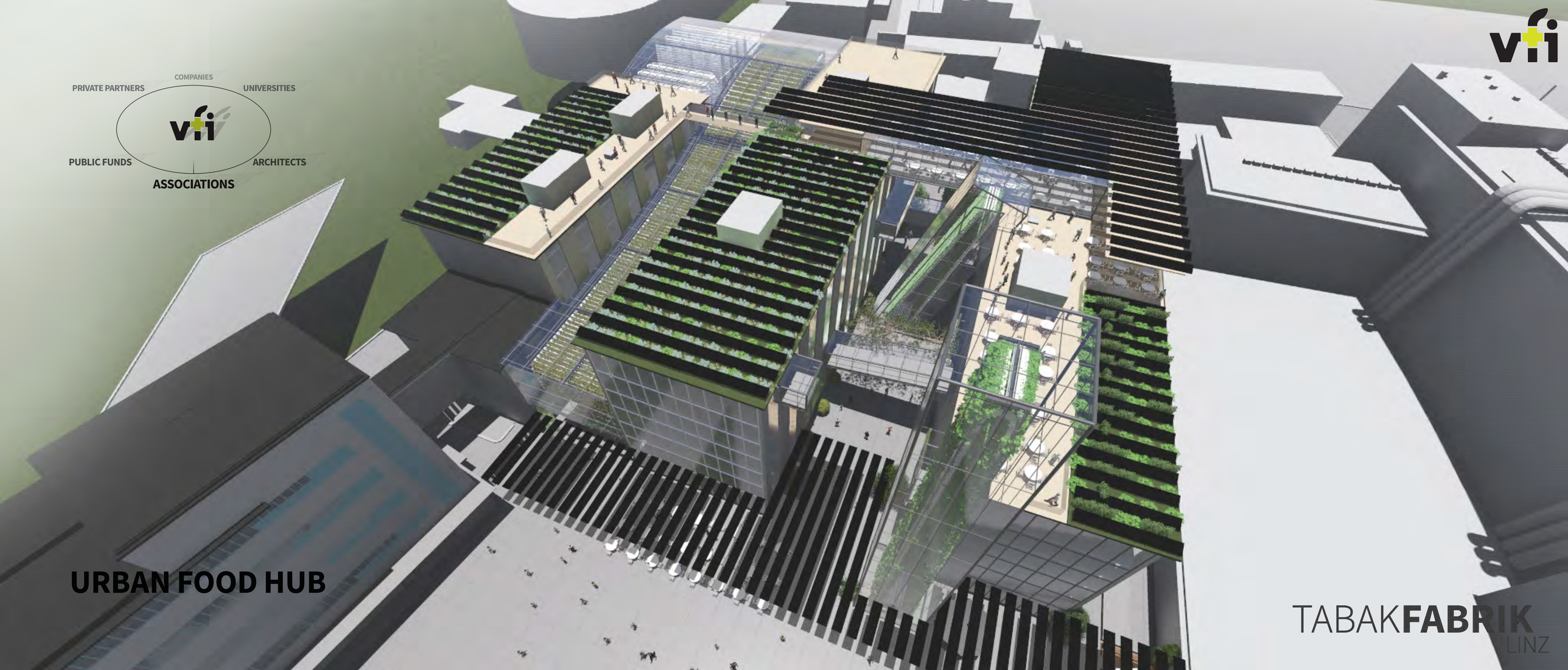
Nächste Schritte:

- Business Model
- LCA
- Kostenschätzung

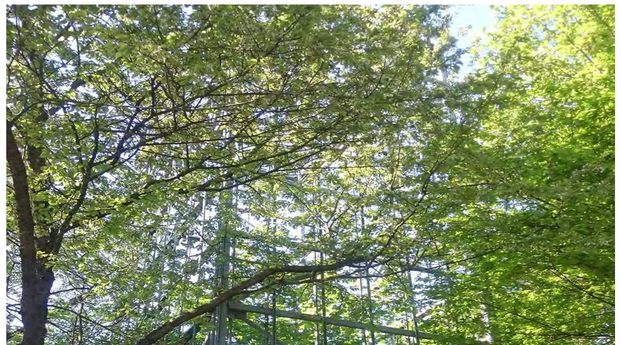
GRÜNSTATTGRAU.AT VERBAND FÜR BAUWERKSBEGRÜNUNG
Marketing St. Pölten GmbH
WPU GmbH
Wirtschaftstreuhänger Scharau
STADT der Zukunft
FFG Forschung wirkt.


© 2015 Daniel Podmilsak


25,00 m
22,00 m
8,00 m
4,00 m
0,00 m
ENERGY ROOF
SKYBAR
HOTEL
HOTEL
CO WORKING
OSMOTIC WALL
OSMOTIC WALL
OSMOTIC WALL
VERTICAL FARM
GASTRONOMIE / MARKT
PROMENADE
MARKT
MARKT
LAGER / SPA
AQUAPONICS
INN
© 2016 Daniel Podmirseg
©2016DanielPodmirseg
© 2016 Daniel Podmirseg
0 5 10
(m) 0 1 2 3 4 5 10


COMPANIES
PRIVATE PARTNERS
UNIVERSITIES
PUBLIC FUNDS
ARCHITECTS
ASSOCIATIONS
URBAN FOOD HUB
TABAKFABRIK
LINZ

06 HISTORY'S TEACHING



Ruthner Turm, WIG 1964 © Wiener Gartenbauamt


YOGA
BAWART
DIA RAHMEN
ENGLISH FOR YOU 3

07 DISSEMINATION


VIENNA
DESIGN
WEEK
vfi
technisches museum wien
TU igee
panpanic
www.verticalfarminstitute.org


technisches
museumwien
Devilskin
vfi

SKY BERRIES conference

MADE POSSIBLE BY

bau.energie.umwelt cluster niederösterreich

Europäische Union Investitionen in Wachstum & Beschäftigung. Österreich.

Europäische Union Investitionen in Wachstum & Beschäftigung. Österreich.

Ein Fonds der Stadt Wien

URBAN CROP SOLUTIONS

Helga

PFLAUM KARLBERGER WIENER OPETNIK RECHTSANWÄLTE

Tian

RUTRONIK ELECTRONICS WORLDWIDE

ATP architects engineers

Klement HAUSTECHNIK

OSRAM Opto Semiconductors

GRÜNSTATTGRAU.AT INNOVATIONSLABOR BAUWERKSBEGRÜNUNG

nourivit

flattec FLACHDACH-SYSTEME FÜR PROFIS.

sanlight

enerep schöner Tag

accent accelerating ideas

POD MIR SEG

Raiffeisen BANK

AQUA PONIC AUSTRIA

blün

PARGA Wasser ist unser Element

Association for Vertical Farming

MEMBERS


THE GREEN CITY
DAS GRÜN
DAS S
FERTI
IST


MEET
EURO CITIES
SECities
MHP
ofo
SKY

SKY BERRIES
conference

2019 :: SOPHIENSÄLE :: WIEN

SKYBERRIES ACADEMY

SKYBERRIES :: THE VFI DISSEMINATION PROGRAMME

vertical farm institute

PARTNER OF THE VFI

SSI SCHÄFER PÖYRY

SPONSORED BY

sanlight ELITECAD XEOMETRIC accent accelerating ideas GRÜN STATT GRAU ÖGNI

SUPPORTED BY

foodtank Resilient Cities 2019 aab Association of Applied Biologists iGrow STUDENTS' INNOVATION CENTRE NGIN FOOD GREEN IN FUTURE ECN


SKY BERRIES ACADEMY
SESSION
SESSION


TECHNOLOGY
TECHNOLOGY
TECHNOLOGY
BUSINESS
BUSINESS


SKY BERRIES ACADEMY
SINGAPORE
SEE YOU IN 2019

https://www.jpl.nasa.gov/news/news.php?release=2014-039. Edited by Daniel Podmirseg

Vertical Farming

Energie- und ressourceneffiziente Lebensmittelproduktion in dicht verbauten Gebieten

FFG
Forschung wirkt.

THEMENWORKSHOP

vertical farm institute

Daniel Podmirseg
Wien, am 01.10.2018