

6D-Modell: Digitalisierung für eine nachhaltige Welt

Infrastruktur Digital, Planen und Bauen 4.0

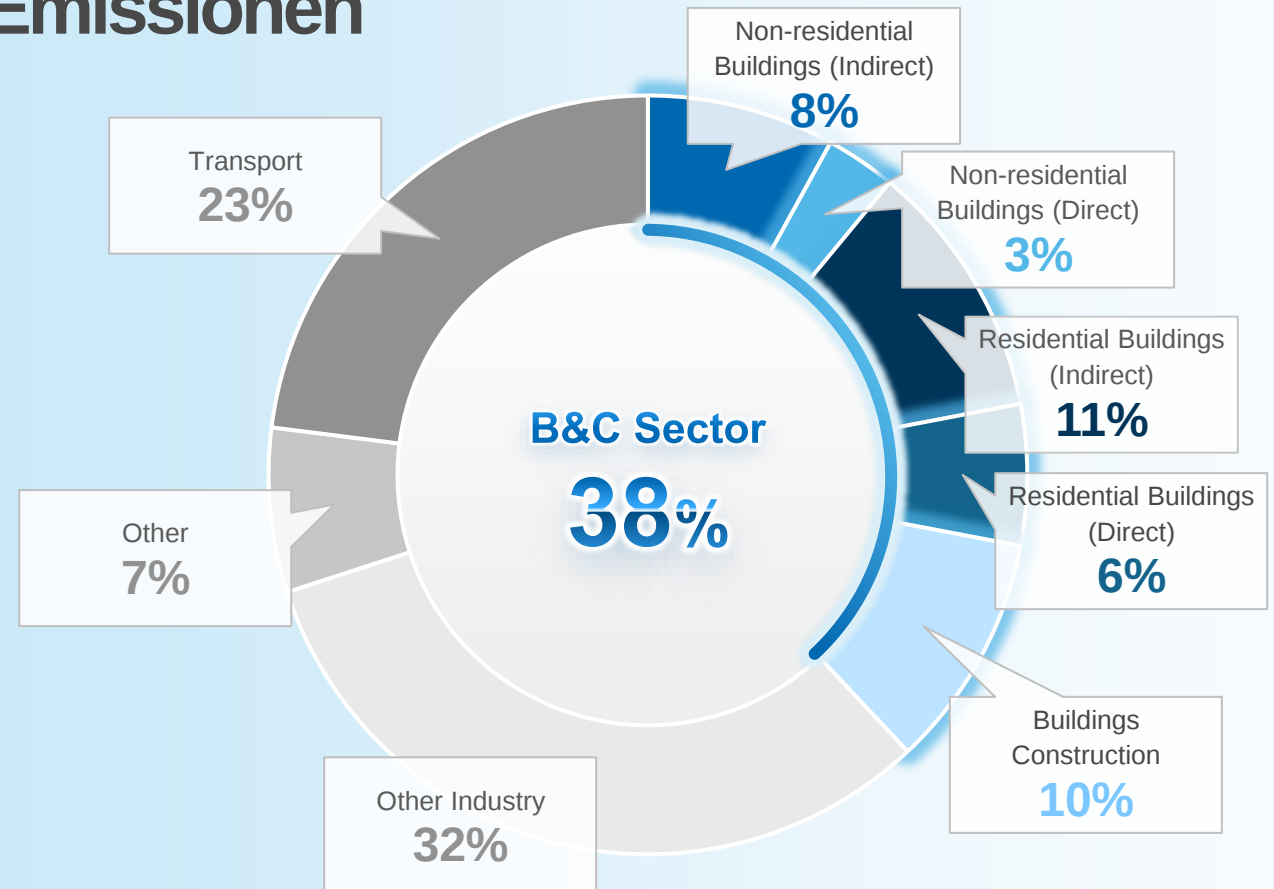
Michael Woitag
CTO RIB Software SE



CO2-Emissionen unserer Industrie

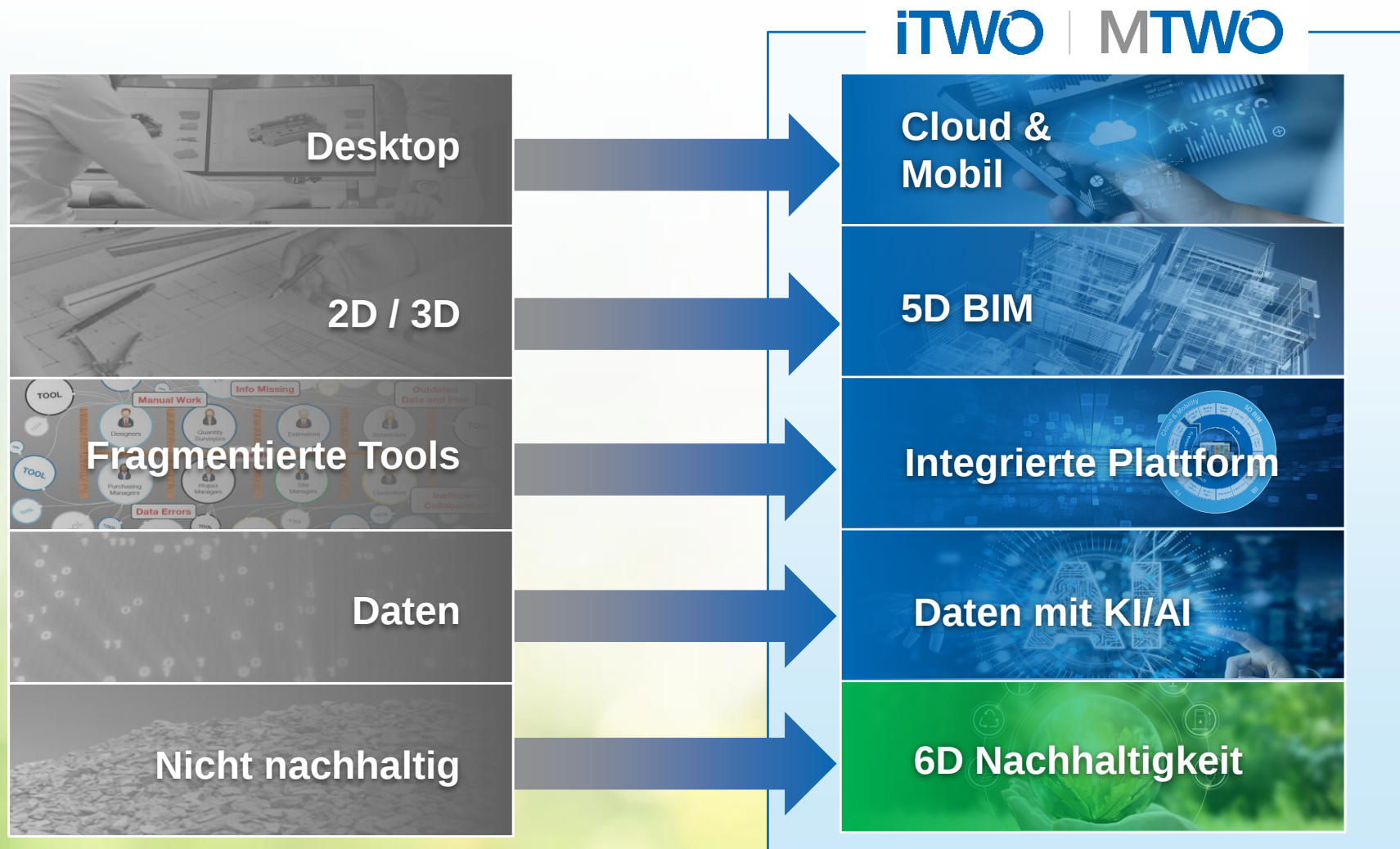
Im Jahr 2019 stiegen die CO2-Emissionen des Sektors Building & Construction (B&C) auf den höchsten Wert **38%** der globalen Energie bezogenen CO₂-Emissions (13.6 GtCO₂).

Emissionen



Notes: Buildings construction industry is the portion (estimated) of overall industry devoted to manufacturing building construction materials such as steel, cement and glass. Indirect emissions are emissions from power generation for electricity and commercial heat.

Industrie-Trends



Industrie-Trends

Wie MTWO zur CO2-Reduzierung beiträgt?

CO2-Probleme in der Bauindustrie



6-10%
des globalen
anthropogenen CO2-
Ausstoßes ist **Beton**



10%
der Baumaterialien
gehen in den **Abfall**



30%
der Bautätigkeiten
sind **Nacharbeiten**

MTWO Solution



6D-Simulation vor
dem physischen
Bau



Hyper-Effizienz
durch verbundene
Bau-Prozesse



Weniger Beton / Material

Weniger Abfall

Weniger Nacharbeiten

CO2-Reduzierung durch MTWO



CO2 durch Material

1. Produktion
2. Transport
3. Nicht-nachhaltiges Material



CO2 durch Geräte

1. Energieverbrauch
2. Transport



CO2 durch Personal

1. Baustellen-Aktivitäten
2. Büro-Aktivitäten
3. Transport und Reise

Construction Carbon Lifecycle Management

Planen

Bauen

Betreiben

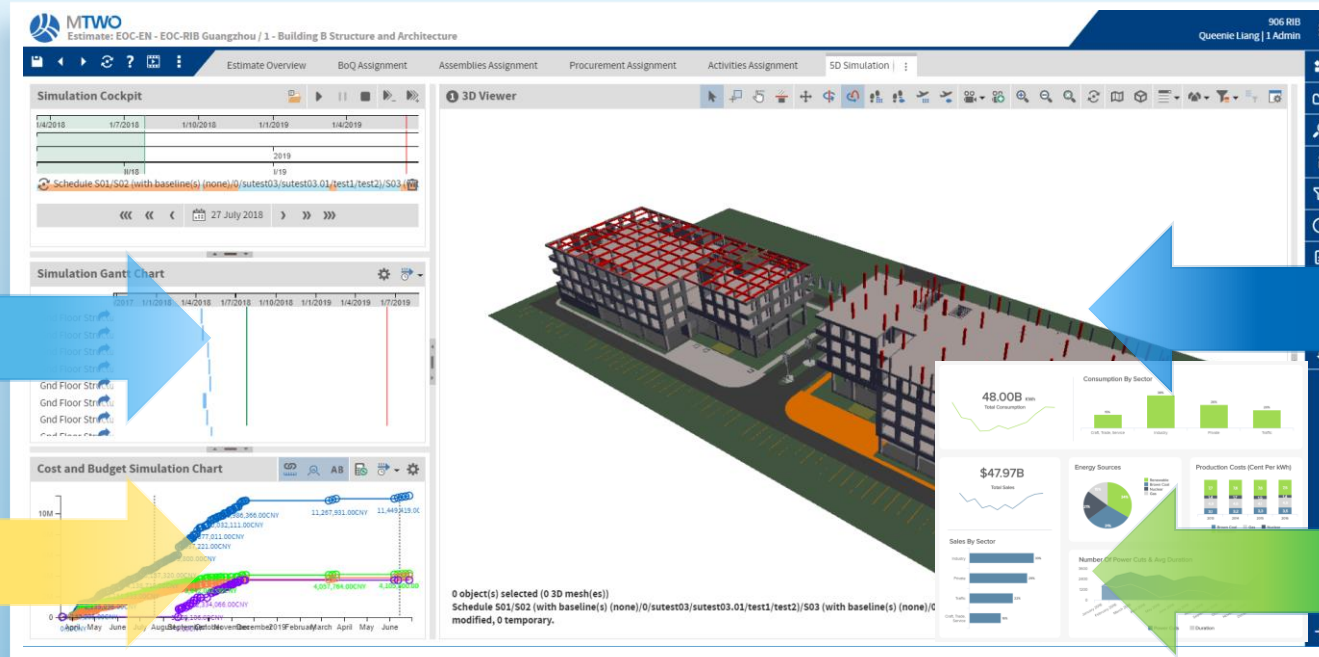
Abreißen

4D
Zeit

5D
Kosten

3D
Model

6D
Nachhaltigkeit



Quantifizieren

Messung des Kohlenstoffausstoßes durch Kohlenstoff-Objektbibliothek



Simulieren

6D-Simulation für Kohlenstoffemission und Zeit-Kosten-Analyse



Monitoren

Überwachung und Reduzierung von Kohlenstoffemissionen durch effektives Lebenszyklusmanagement von Gebäuden

Basis der Kalkulation

Material Records

Material Group	Code	Description	UoM	Estimate Price	List Price	Curre
33562	335831201	Doorstrijkmortel - voor sterk zuigende ste	TON	150.00	150.00	EUR
3358312	335831201	Doorstrijkmortel - voor sterk zuigende ste	TON	150.00	150.00	EUR
3358312	335831201	Doorstrijkmortel - voor sterk zuigende ste	TON	150.00	150.00	EUR
3358312	335831201	Doorstrijkmortel - voor sterk zuigende ste	TON	150.00	150.00	EUR
33034	3308701	Wapening thermische onderbreking	M	115.00	115.00	EUR
33034	330861	Zwelband bentonietstrip	M	7.00	7.00	EUR
33034	330858	stortvoeg d=40cm zonder aangelaste pl...	M	23.00	23.00	EUR
33034	330857	stortvoeg d=30cm zonder aangelaste pl...	M	20.00	20.00	EUR
33034	330855	stortvoeg plaat/wand dubbel met aange...	ST	48.00	48.00	EUR
33034	330854	stortvoeg plaat/wand dubbel met aange...	stortvoeg plaat/wand dubbel met aangelas			
33034	330852	stortvoeg d=40cm met aangelaste staal...	M	33.00	33.00	EUR
33034	330851	stortvoeg d=30cm met aangelaste staal...	M	27.00	27.00	EUR
33034	330843	Injectiemortel		7.00	7.00	EUR
33034	33084			8.00	8.00	EUR
33034	33084			6.00	6.00	EUR
33034	33083			250.00	250.00	EUR
330833	33083			250.00	250.00	EUR
330833	33083			250.00	250.00	EUR
330833	33083			250.00	250.00	EUR



Material

Plants

Code	Description	Reg Number	UoM	Plant Group
DOM-001	TOWER CRANE LH 50TM		EACH	C.0.10
DOM-002	STEAM GENERATOR CLASS 120KW		EACH	R.7.0
DOM-003	TOWER CRANE LH180TM		EACH	C.0.10
DOM-004	TOWER CRANE MAST 2m		EACH	C.0
COPY DOM-001	TOWER CRANE LH 50TM		EACH	C.0.10
DOMGER-0554	MERCEDES BENZ SLK (LBEX1993)	LBEX1993	EACH	DOMEUROLIST
DOMGER-0559	TOWER CRANE LH 50TM		EACH	C.0.10
572	OPEL ASTRA ECOFLEX 2010	LBXQ3357	EACH	DOMEUROLIST
MGER-0001			*	C
ETM-0050	Excavator CAT 330CF		123	DOMEUROLIST
ETM-0051	Excavator CAT 335CF		EACH	DOMEUROLIST
DOMGER-0650	Stop Signals For roads		EACH	DOMEUROLIST
BUL...				UROLIST
BUL...				UROLIST
BUL...				UROLIST
BUL...				UROLIST
BUL...				UROLIST
BUL...				UROLIST



Geräte

Code	Description	UoM	Fixed Unit	Market Rate	Currency
489246	Means of small mechanization with e...	h	☐	2.76	EUR
489303	Boring unit for piling in soil	h	☐	62.00	EUR
L1	Installation Hours	HRS	☒	20.00	EUR
L10	MEP Hours	HRS	☒	25.00	EUR
L13	Managers and Engineers	HRS	☐	0.00	EUR
L2	Earthwork Hours	HRS	☒	20.00	EUR
L3	Formwork Hours	HRS	☒	20.00	EUR
L4	Steelwork Hours	HRS	☒	40.00	EUR
L5	Concrete Hours	HRS	☒	30.94	EUR
L6	Masonry Hours	HRS	☐	20.00	EUR
L7	Finishing Hours	HRS	☒	20.00	EUR
L8	Drywall hours	HRS	☒	20.00	EUR
L9	Ot			00	EUR
12	Un			00	EUR



Personal and
Nachunternehmer

CO2-Berechnung

Objektbibliothek in MTWO-Stammdatenbank



Material



Geräte



Personal

BOQ

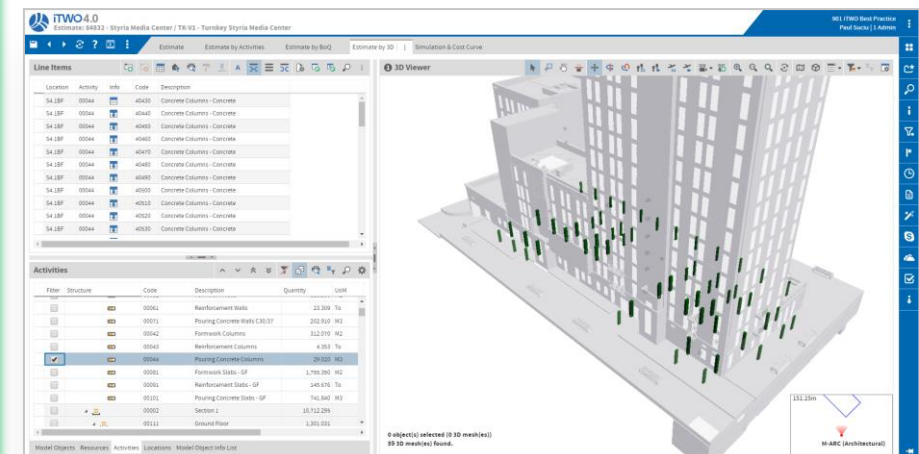
Kosten-Kalkulation

MTWO 4.0
Price Comparison: 0001 - Styria Media Center / BQ: 6737 - Structural Works - Concrete

Price Comparison (BoQ)

Structure	Line Name	Compare Description	Reference No.	Outline Specification	Base BoQ	Target	Target Cost	Kammer	BoQ/BoQ Unit	SC Construction	SA	MMT	MMT	Account	Min	Max
	BOQ Total				2,860,036.43	2,860,036.43	2,792,803.00	2,800,000.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00
	BOQ Name				2,860,036.43	2,860,036.43	2,792,803.00	2,800,000.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00
	Level 1				2,860,036.43	2,860,036.43	2,792,803.00	2,800,000.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00
	Level 2				2,860,036.43	2,860,036.43	2,792,803.00	2,800,000.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00
	Item				2,860,036.43	2,860,036.43	2,792,803.00	2,800,000.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00	2,792,803.00
	Unit Rate (DC)				114.99	114.99	109.00	109.00	109.00	109.00	109.00	109.00	109.00	109.00	109.00	109.00
	Final Price (DC)				279,093.22	279,093.22	279,093.22	279,093.22	279,093.22	279,093.22	279,093.22	279,093.22	279,093.22	279,093.22	279,093.22	279,093.22
	Item				345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96
	Unit Rate (DC)				48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97
	Final Price (DC)				345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96	345,149.96
	Item				82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08
	Unit Rate (DC)				48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97	48.97
	Final Price (DC)				82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08	82,063.08
	Level 2				2,224,332.62	2,224,332.62	2,145,634.63	2,262,226.89	2,145,634.63	2,145,634.63	2,145,634.63	2,145,634.63	2,145,634.63	2,145,634.63	2,145,634.63	2,145,634.63
	Item				608,819.48	608,819.48	602,828.75	622,119.27	602,828.75	602,828.75	602,828.75	602,828.75	602,828.75	602,828.75	602,828.75	602,828.75
	Unit Rate (DC)				108.41	108.41	108.41	108.41	108.41	108.41	108.41	108.41	108.41	108.41	108.41	108.41
	Final Price (DC)				608,819.48	608,819.48	602,828.75	622,119.27	602,828.75	602,828.75	602,828.75	602,828.75	602,828.75	602,828.75	602,828.75	602,828.75
	Item				1,081,639.70	1,081,639.70	1,076,991.20	1,170,466.08	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20
	Unit Rate (DC)				79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21	79.21
	Final Price (DC)				1,081,639.70	1,081,639.70	1,076,991.20	1,170,466.08	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20	1,076,991.20
	Item				402,877.44	402,877.44	402,877.44	402,877.44	402,877.44	402,877.44	402,877.44	402,877.44	402,877.44	402,877.44	402,877.44	402,877.44

CO2-Kalkulation



Kalkulation des CO2-Fußabdruck

MTWO Estimate: 72415 - Residential Tower Helsinki / 1 - Structural Works / 000060 901 iTWO Best Practice Fraunhofer, Reinhardt (Local) | 1 Admin

Estimate Estimate by Activities Estimate by BoQ Estimate by 3D Simulation & Cost Curve Risk Escalation

Line Items Structure

Filter	Structure	Count	Quantity	Σ	Cost Total	Σ	Budget	Σ	Quantity Total
	10.10. 20. Concrete; Conc...	13	13.000		85,373.56		20,833.90		154.539
	10.10. 30. Formwork; Con...	15	15.000		518,170.86		544,079.41		11,515.164
	10.10. 40. Formwork; Cor...	14	14.000		218,549.90		229,477.40		3,582.844
	10.10. 50. Reinforcement;...	29	29.000		35,491.33		50,164.83		85.815
	10.20. Reinforced Concrete ...	58	58.000		1,683,864.53		1,759,204.8...		22,036.429
	10.20. 10. Concrete; Conc...	16	16.000		324,453.54		340,676.21		2,938.397
	10.20. 20. Formwork; Con...	14	14.000		1,355,234.73		1,422,996.47		19,088.082
	10.20. 30. Reinforcement;...	28	28.000		4,176.26		1,757,441,1...		9.950
	10.30. Reinforced Concrete ...	14	14.000		33,335.70		25,097.01		438.150
	10.30. 10. Concrete; Conc...	6	6.000		5,643.75		5,174.76		37.665
	10.30. 20. Formwork; Con...	6	6.000		21,079.41		19,609.48		389.085
	10.30. 30. Reinforcement;...	2	2.000		6,612.54		312.77		11.400
	10.40. Structural Works, Mi...	14	14.000		101,206.58		106,266.90		20,241.315
	10.40. 10. Structural Wor...	14	14.000		101,206.58		106,266.90		20,241.315
	Unassigned	76	76.000		566,992.30		399,473.24		9,283.872
	1 Main BoQ	56	56.000		564,830.61		397,203.46		9,133.920
	10. Structural Works	2	2.000		1,751.97		0.00		2.000
	10.10. Reinforced Concrete ...	1	1.000		1,700.87		0.00		1.000
	10.10. 10. Concrete; Conc...	1	1.000		1,700.87		0.00		1.000
	10.20. Reinforced Concrete ...	1	1.000		51.10		0.00		1.000

Struktur

Line Items

Info	Code	Description	Markup Cost/Unit	Markup Cost/Unit I	Markup Cost Total	Grand Total	Revenue	Margin1(Revenue-C	Margin
	000020	Concrete Walls, C3...	12.90	12.90	2,320.97	-8,418,485.68	0.00	0.00	
	000030	Reinforcement Ba...	58.93	58.93	142.32	1,663.89	0.00	0.00	
	000040	Reinforcement Me...	33.68	33.68	180.86	1,961.00	0.00	0.00	
	000050	Concrete Walls, C3...	11.26	11.26	2,268.74	24,598.85	0.00	0.00	
	000060	Concrete Walls, C3...	14.06	14.06	1,268.26	79,282.94	0.00	0.00	
	000070	Reinforcement Ba...	58.93	58.93	0.00	0.00	0.00	0.00	
	000080	Reinforcement Me...	33.68	33.68	247.55	2,684.06	0.00	0.00	
	000090	Concrete Walls, C3...	11.26	11.26	1,132.56	12,279.77	0.00	0.00	
	000100	Concrete Walls, C3...	11.42	11.42	462.24	5,011.84	0.00	0.00	
	000110	Reinforcement Ba...	58.93	58.93	154.70	1,677.32	0.00	0.00	
	000120	Reinforcement Me...	33.68	33.68	222.96	2,417.48	0.00	0.00	
	000130								

Artikel und Leistungsverzeichnis

Resources

Structure	Short Key	Code	Description	Quantity	UoM	Quantity/Unit Item	Quantity Total	Cost
	M	114	Ready-mixed concrete C35/45	1.000	M3	1.000	90.202	
	C	31131	Concrete Pump Vehicle	0.150	HRS	0.150	13.530	
	C	L5	Concrete Hours	1.150	HRS	1.150	103.732	
	M	211	KS Blocks, 06 DF (248x175x238)	1.000	M3	1.000	90.202	

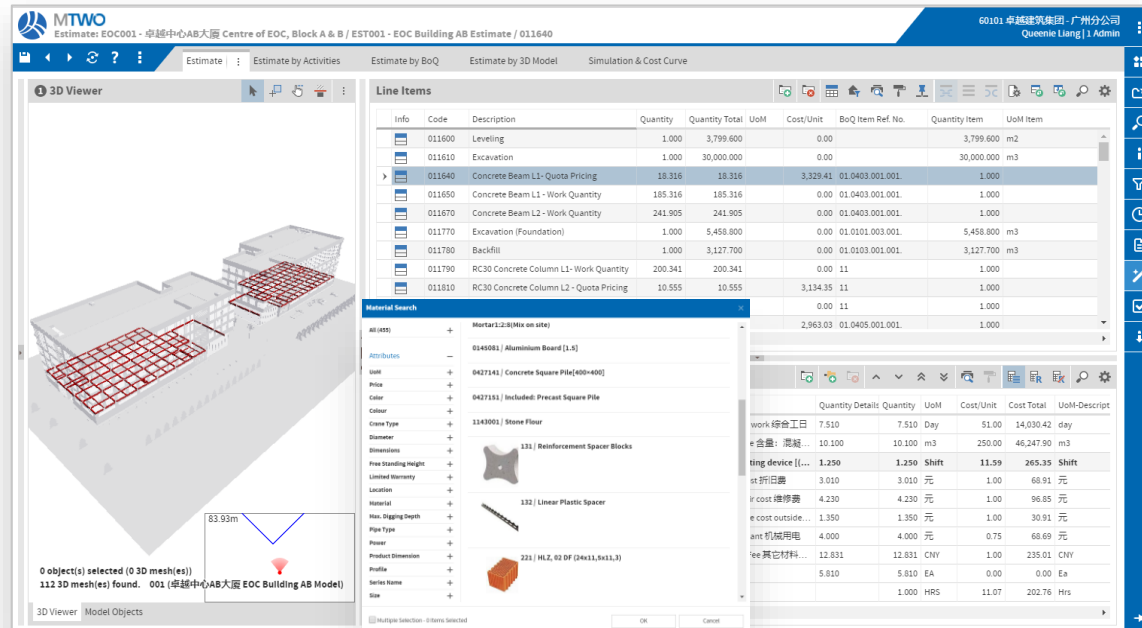
Ressourcen: Personal, Material, Geräte, Nachunternehmer, ...

CO2-Planung: Material-Einkauf

Planen

Bauen

Betreiben



Faktoren

- CO2e Emissionen (kg/m³) der verschiedenen Materialien
- CO2 Emissionen für verschiedene Lieferanten
- Entfernung der Lieferanten zur Baustelle
- Art des Transports
- Verbindung zu den Kosten für die umfassende Betrachtung

.....

e.g.	Type	Quantity (m3)	Per Unit CO2e Emission (kg/m ³)	Vehicle of Transport	Distance from site (km)	Per km CO2e Emission (kg/km)	Total Emission (kg CO2e)	Cost per Quantity (m ³)	Total Cost
Vendor A	Concrete	8020.0	301.97	Road	50	0.062	2,421,803	\$ 80	\$641,600.00
Vendor B	Concrete	8020.0	289.44	Road	250	0.062	2,321,324	\$ 90	\$721,800.00
Vendor C	Green Concrete	8020.0	239.19	Road	100	0.062	1,918,310	\$ 120	\$962,400.00

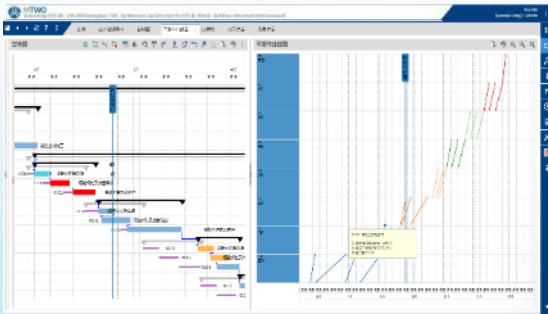
Monitoring von CO2

Planen

Bauen

Betreiben

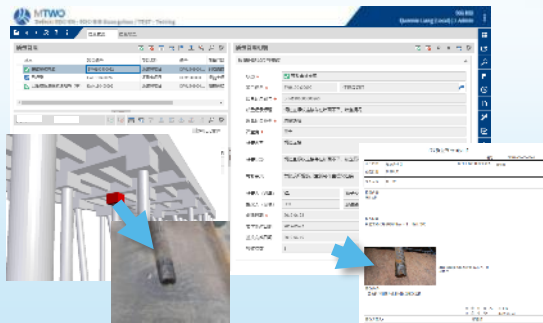
Fortschritt



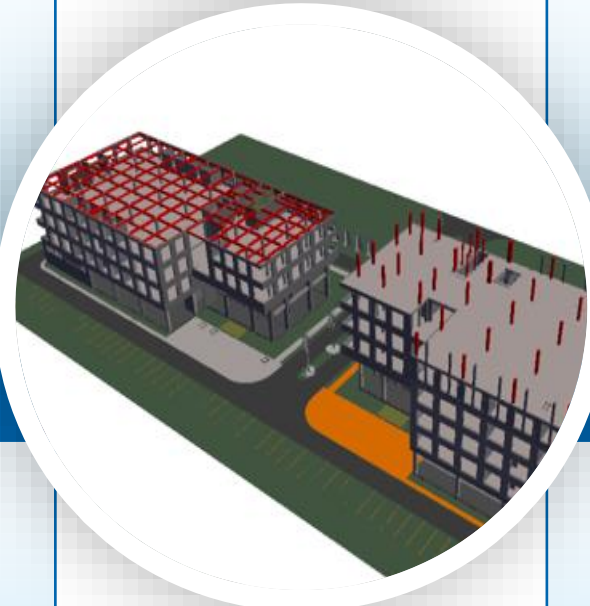
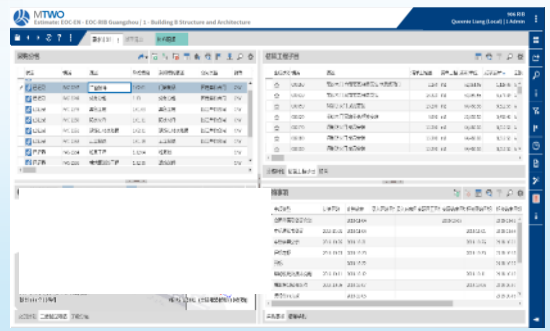
CO2 Emissionen



Qualität & Sicherheit



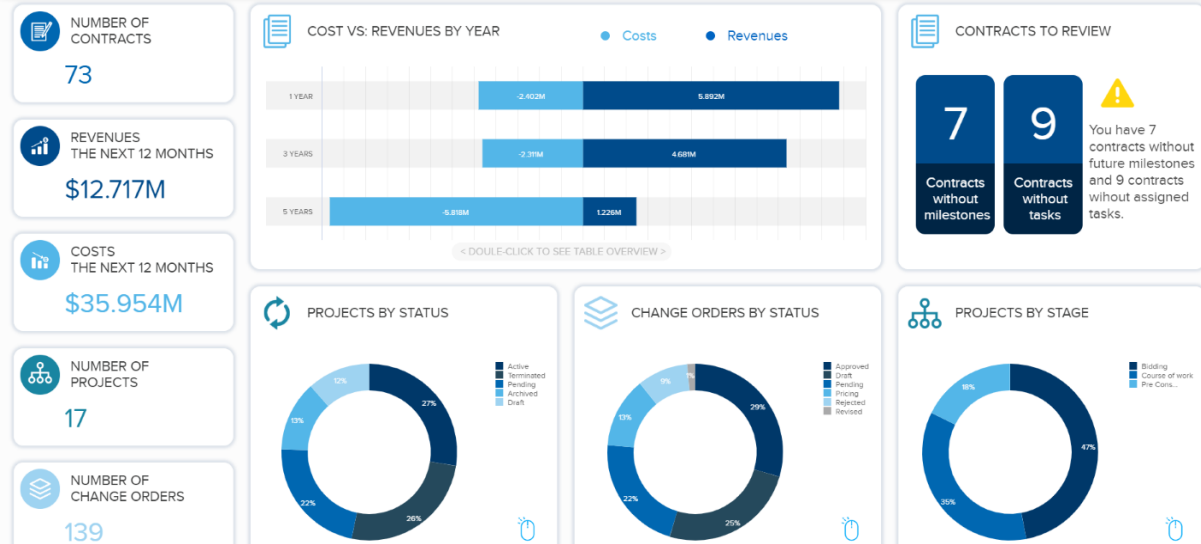
Kostenkontrolle



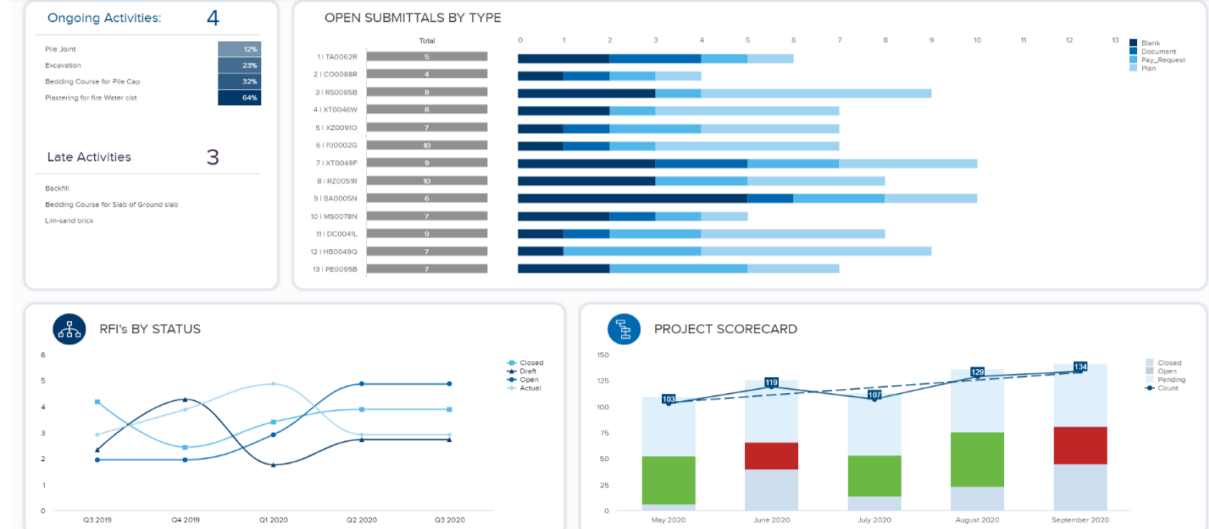
Dashboards und Prognosen

11

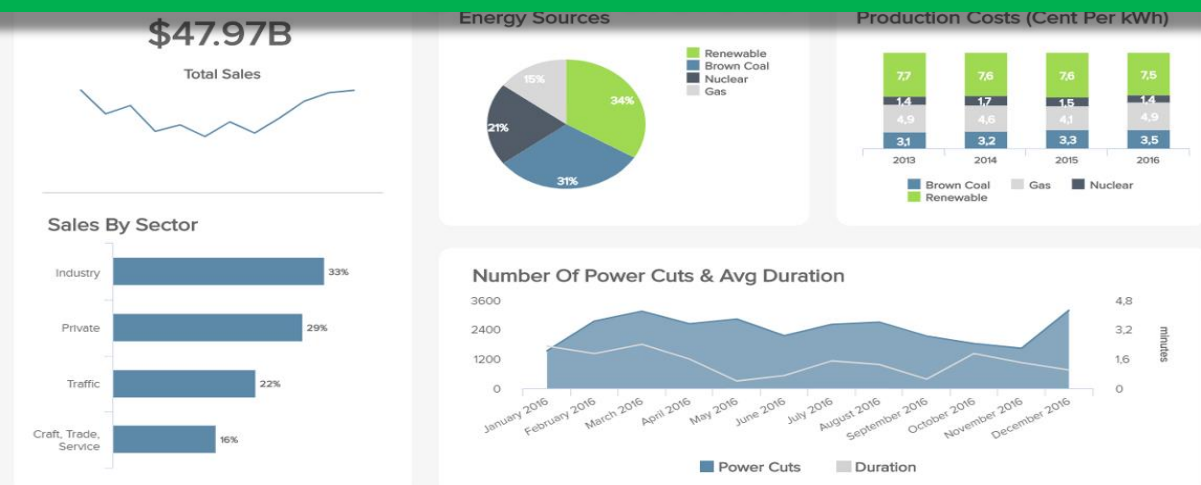
Finanz-Übersicht



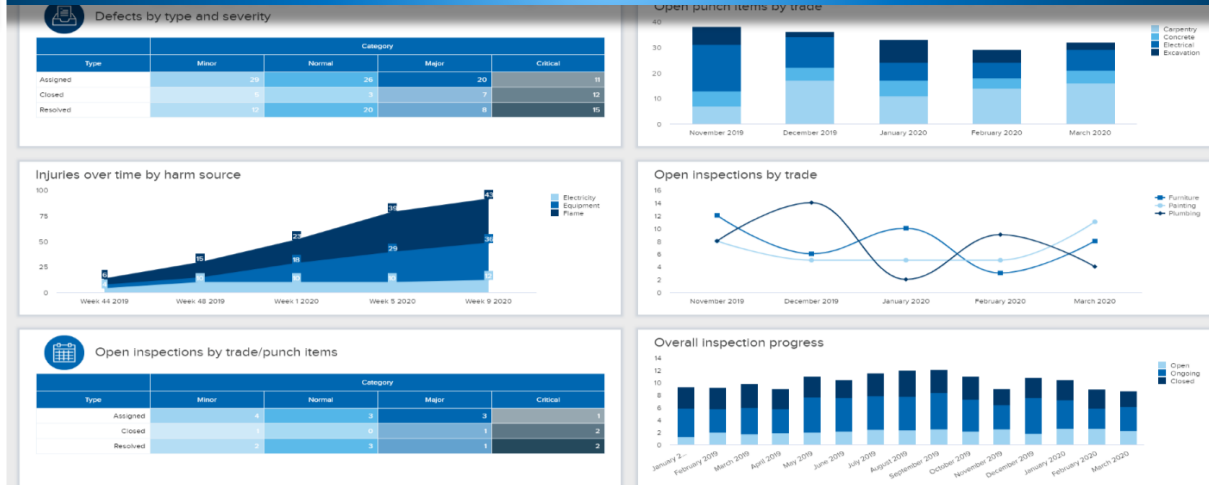
Projekt-Management-Überblick



CO2-Übersicht



Überblick zur Qualität und Sicherheit



Total CO2 Fußabdruck

12

Qualifizieren

Simulieren

Monitoren

MTWO

Planen

Bauen

Betreiben



Reduktion

2020 brachte eine beschleunigte Digitalisierung, aber auch erhöhte Cybersicherheitsrisiken.

435%

Anstieg von
Ransomware
Attacken in 2020

87%

Organisationen, bei denen
versucht wurde, eine
Sicherheitslücke
auszunutzen

Höhere Sicherheit durch Verlagerung in die Cloud



Höchste Standards
mit Enterprise-Class-Security-Technologie



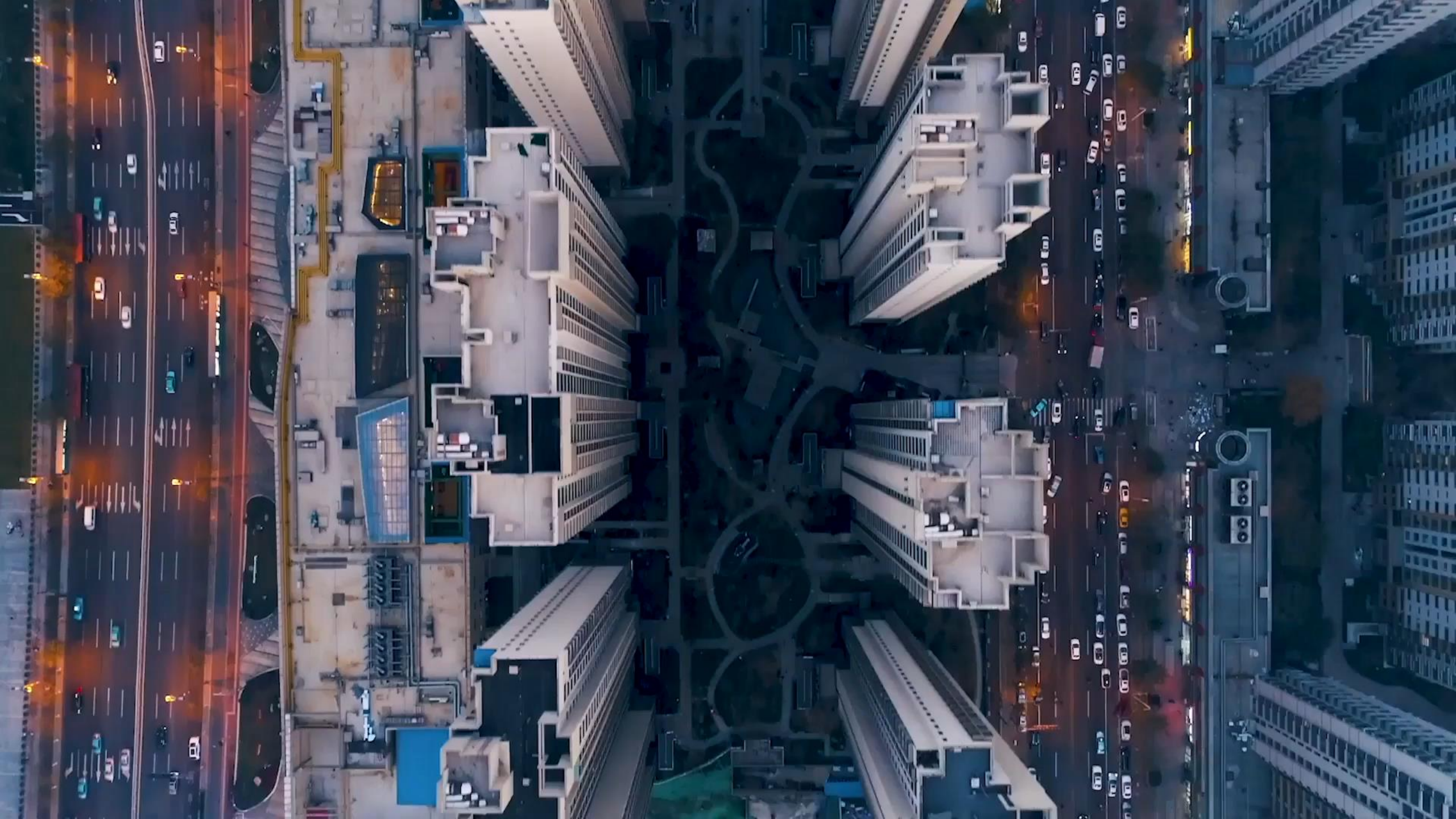
24/7 Monitoring und Support



Nutzung von Hochsicherheits-Rechenzentren



6D Nachhaltigkeit



Running Together

