

Klimaneutralität Energieausweis 2028 Serienfehler vermeiden

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Inhalt

- Motivation und Disclaimer
- Szenarien der Transformation – CO₂ Budget
- Energieausweis 2028
- Risiko Serienfehler - Maßnahmen zur Senkung des Risikos

Klimaveränderungen
Gesellschaftliche Entwicklungen
Reaktionen

"Representative Concentration Pathways" (RCPs)

Shared Socioeconomic Pathways (SSPs)

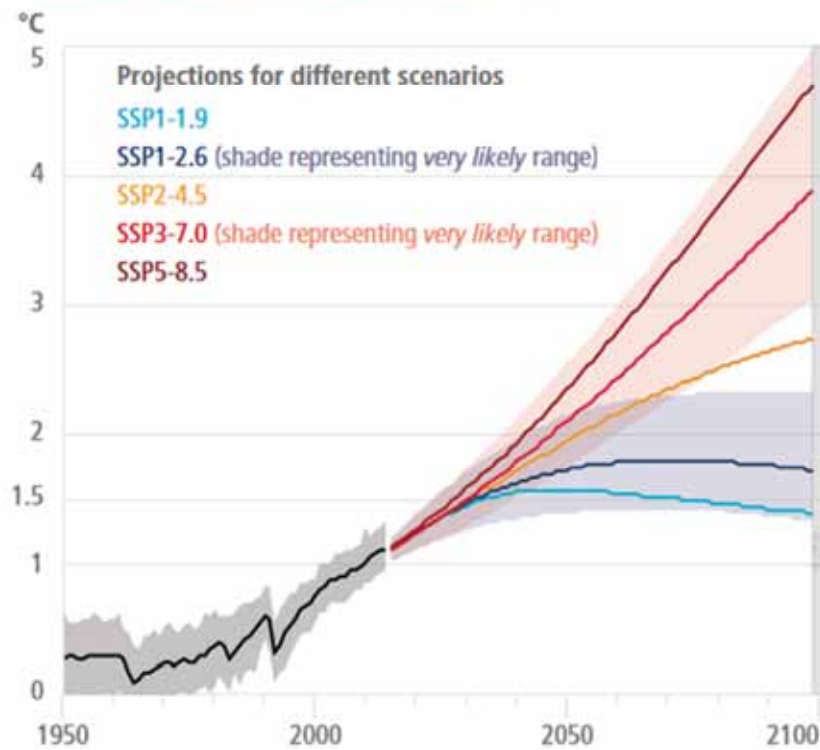
Reasons for Concern (RFC)

IPCC, 2022: Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegria, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegria, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33, doi:10.1017/9781009325844.001.

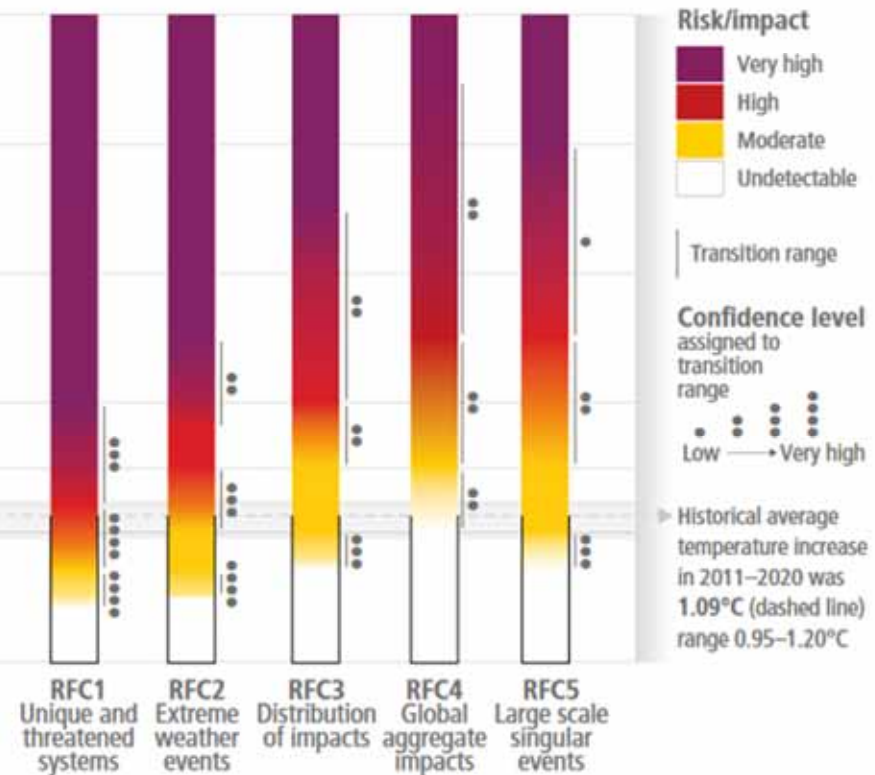
Summary for Policymakers

Global and regional risks for increasing levels of global warming

(a) Global surface temperature change
Increase relative to the period 1850–1900



(b) Reasons for Concern (RFC)
Impact and risk assessments assuming low to no adaptation



Jede Tonne CO₂-Emissionen erhöht die globale Erwärmung

Anstieg der globalen Oberflächentemperatur seit 1850-1900 (°C) als Funktion der kumulativen CO₂-Emissionen (Gt CO₂)

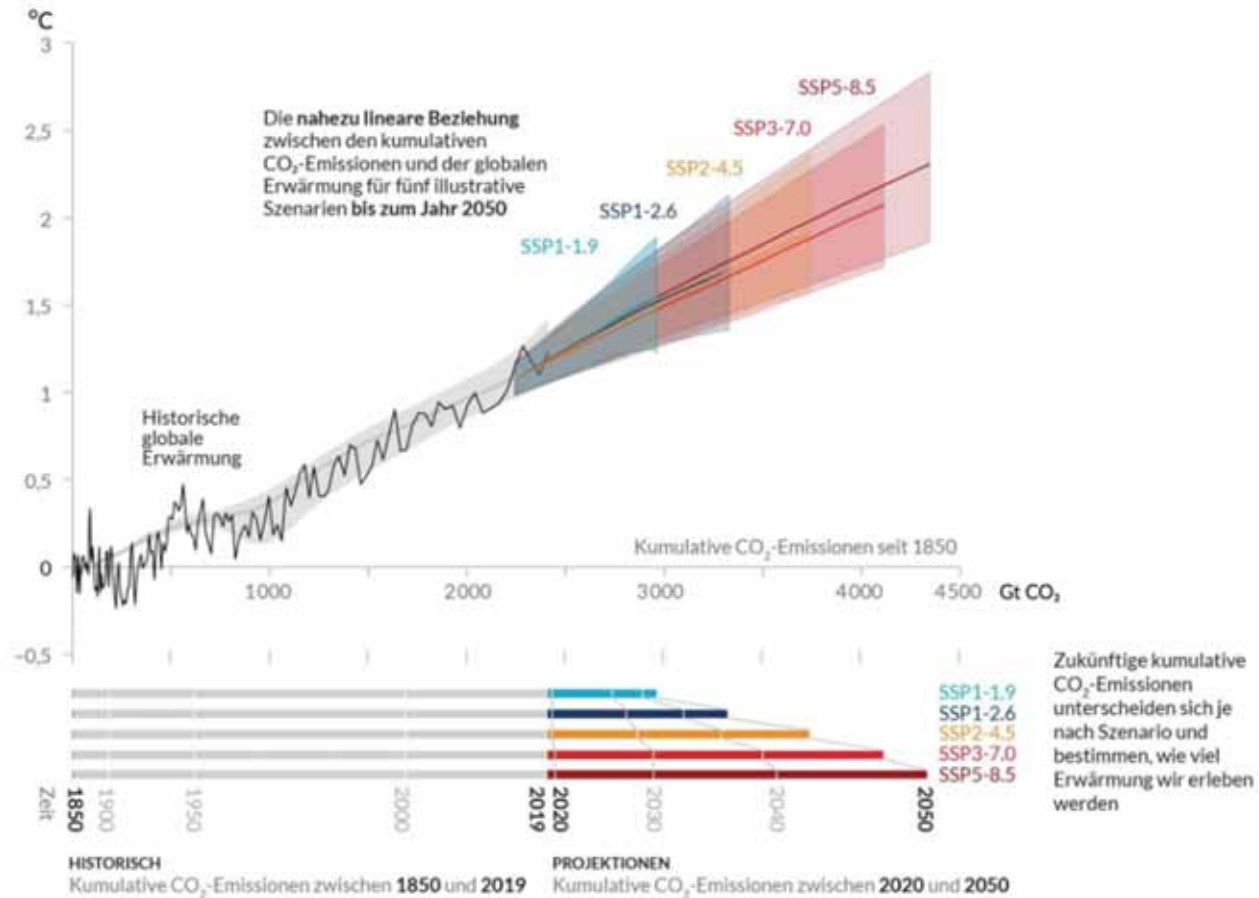


Abbildung 1 Anstieg der globalen Oberflächentemperatur seit 1850-1900 (°C) als Funktion der kumulativen CO₂-Emission (GtCO₂), Quelle: (IPCC, 2021)

Figure ES.1 Historical trends and future projections for greenhouse gas emissions

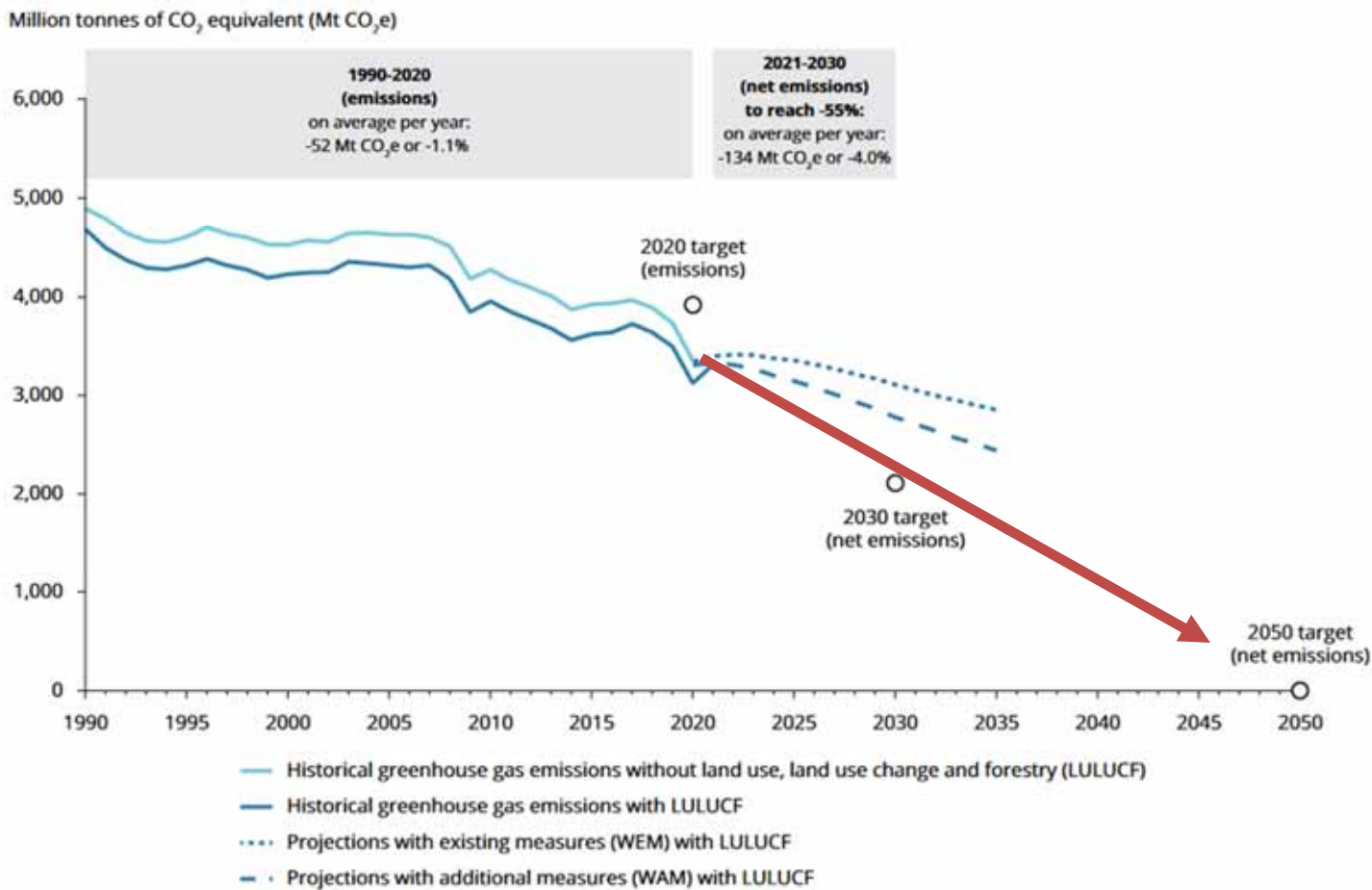


Tabelle 2 Treibhausgas- und CO₂-Budgets für Österreich ab 2022

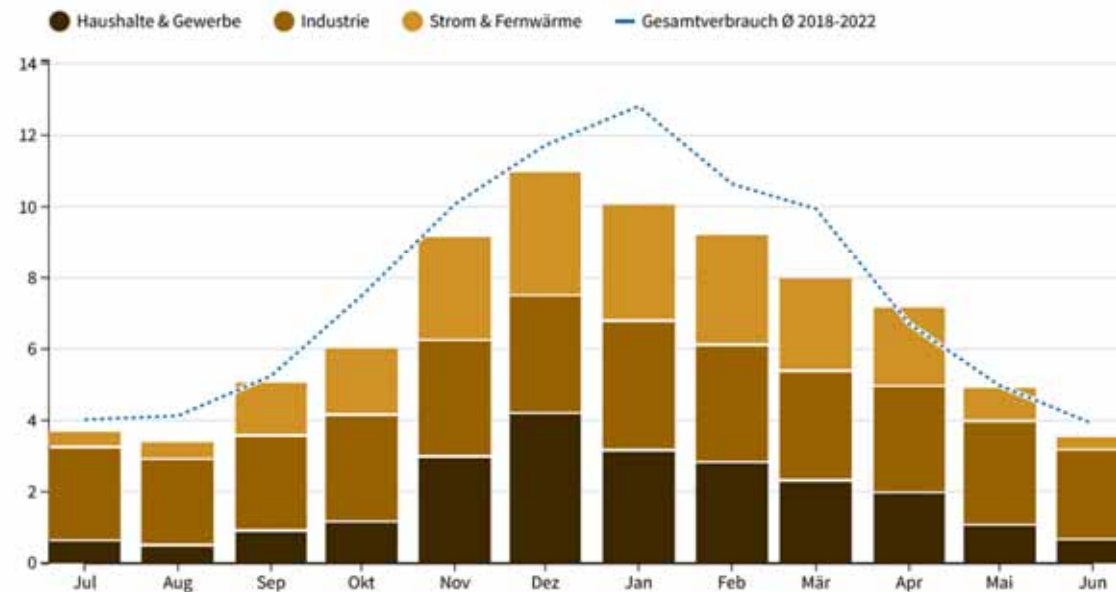
Für Österreich aus globalen THG-Budgets (siehe Tabelle 1) THG- und CO₂-Budgets ab 2022 auf Basis global gleicher pro-Kopf Zurechnung ab 2016 für unterschiedliche Wahrscheinlichkeiten (50% und 66%) für die Einhaltung des +1,5°-Zieles. Alle Werte sind gerundet.

Temperaturgrenzwert	Wahrscheinlichkeit der Einhaltung der Temperaturgrenzwerte	
	50%	66%
THG-Budget (alle Treibhausgase)		
+1,5 °C (OHNE zwischenzeitlich geringfügig höherer Temperatur)	510 MtCO ₂ eq	280 MtCO ₂ eq
+1,5 °C (MIT zwischenzeitlich geringfügig höherer Temperatur von bis zu ~1,65°C)	610 MtCO ₂ eq	340 MtCO ₂ eq
Kohlenstoffbudget (nur CO₂)		
+1,5 °C (OHNE zwischenzeitlich höhere Temperatur bis Ende des Jahrhunderts)	430 MtCO ₂	240 MtCO ₂
+1,5 °C (MIT zwischenzeitlich geringfügig höherer Temperatur von bis zu ~1,65°C)	520 MtCO ₂	280 MtCO ₂

Tonnen	Tonnen/Kopf
280	32
340	39

Tonnen	Tonnen/Kopf
510	59
610	70
430	49
520	60

Wie viel Gas verbraucht wer in Österreich?



Gasverbrauch der vergangenen 12 Monate in TWh nach Sektoren und im Vergleich zum durchschnittlichen Gasverbrauch von 2018-2022. Quelle: E-Control

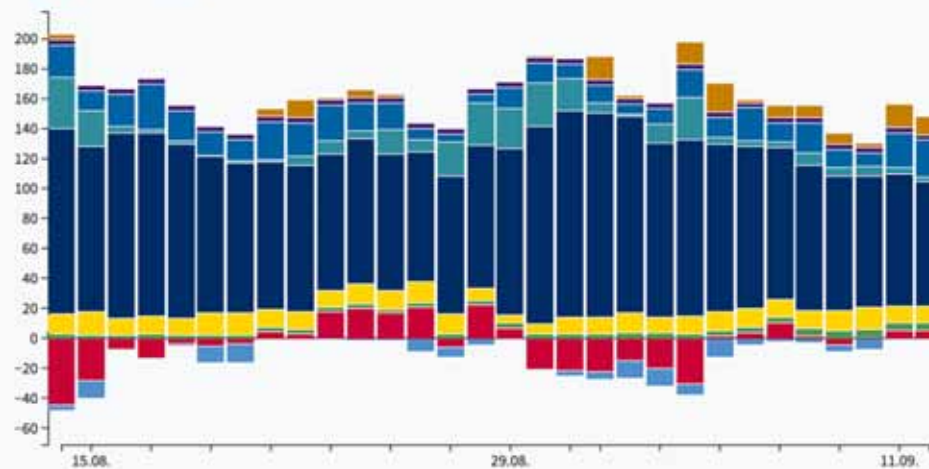
[Daten-Tabelle](#)

Stromversorgung der vergangenen 30 Tage bzw. 12 Monate

Anzeigen der vergangenen:

30 Tage 52 Wochen

● Erdgas ● Sonstiges ● Pumpspeicher-Erzeugung ● Wind ● Wasser ● Sonne ● Biomasse
● Nettoimporte ● Pumpspeicher-Verbrauch



Stromversorgung in den vergangenen 30 Tagen bzw. 12 Monaten. Quelle: ENTSO-E

[Daten-Tabelle](#)

Die Infografik veranschaulicht die Stromversorgung der vergangenen 30 Tage beziehungsweise zwölf Monate in Gigawattstunden pro Tag, unterteilt in erneuerbare und fossile Energiequellen, Strom aus Pumpspeichern und Nettoimporten*.

Übersicht der Energieträger

- Kohle
- Öl
- Gas
- Erneuerbare Abfälle
- Biogene Energien
- Umgebungswärme
- Wasserkraft
- Wind
- Photovoltaik
- Ferroalloye
- Elektrische Energie
- Verluste

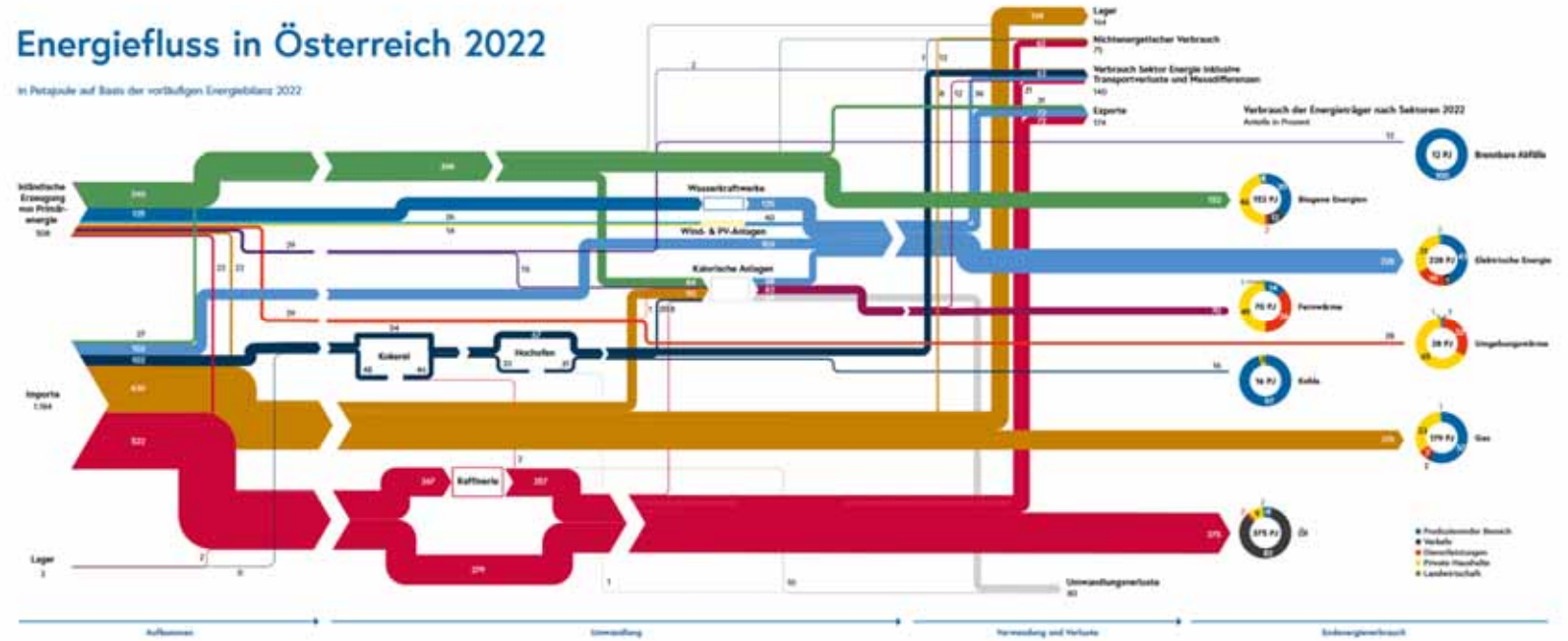
Der Diagramm wurde auf Basis der vorläufigen Energiebilanz 2022 (Stand 30.09.2022) der Statistik Austria erstellt.

Aufgrund der geringfügigen Überhöhung der Energieflüsse sind durch entsprechende Reduzierungen bei anderen Einträgen kein exakter Energieerhaltungsprinzip der Summe der ein- und ausgehenden Flüsse zu erwarten.

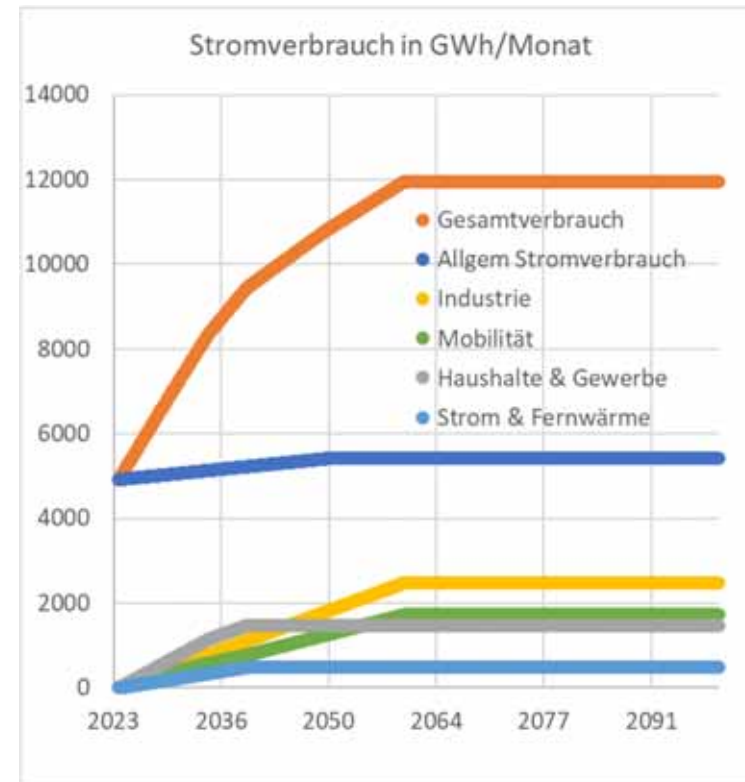
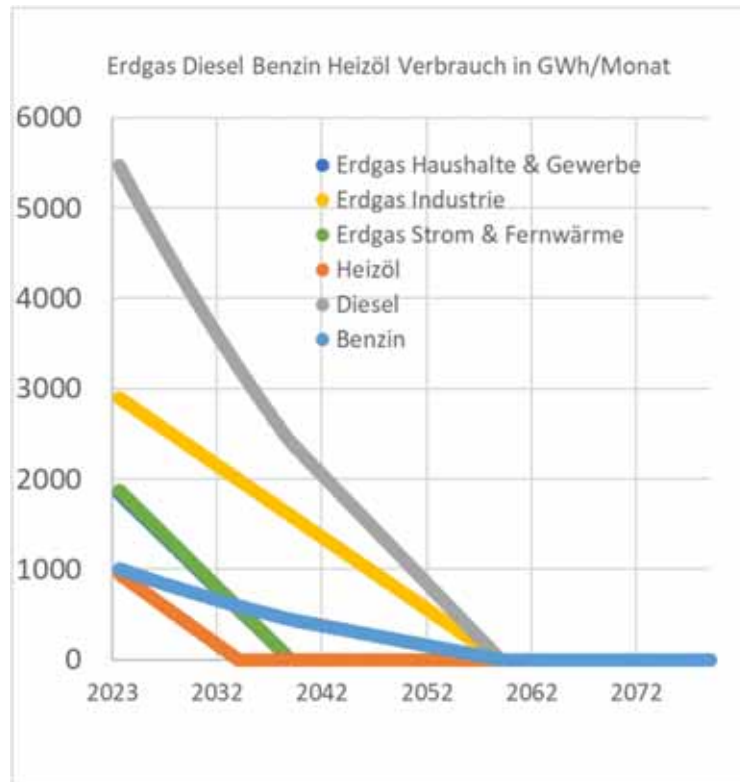


Energiefluss in Österreich 2022

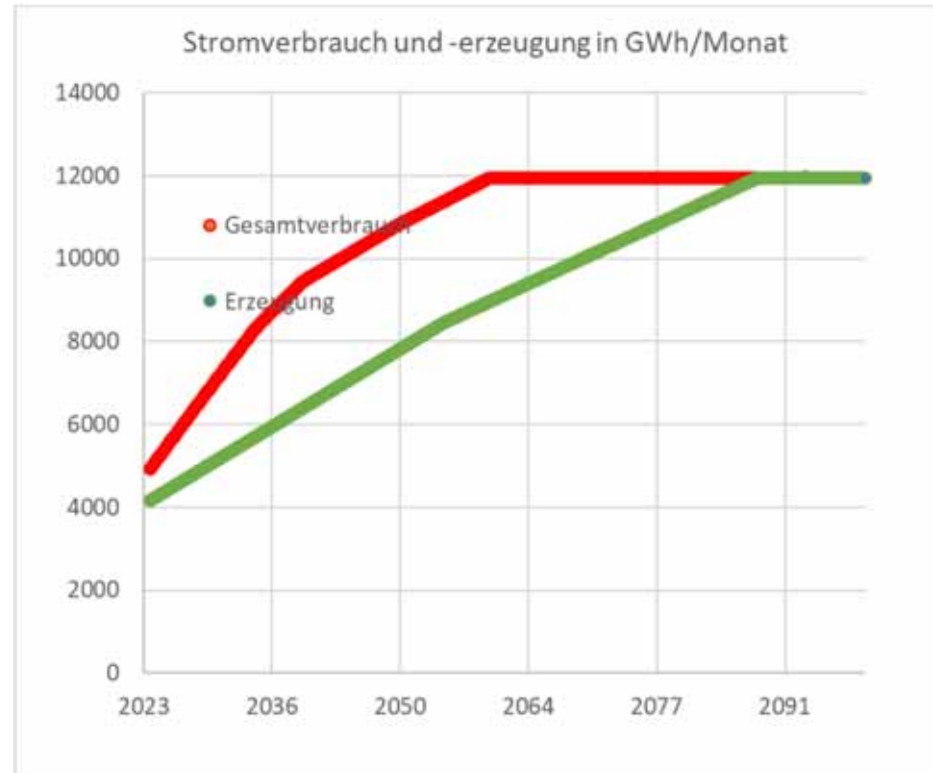
In Petajoule auf Basis der vorläufigen Energiebilanz 2022

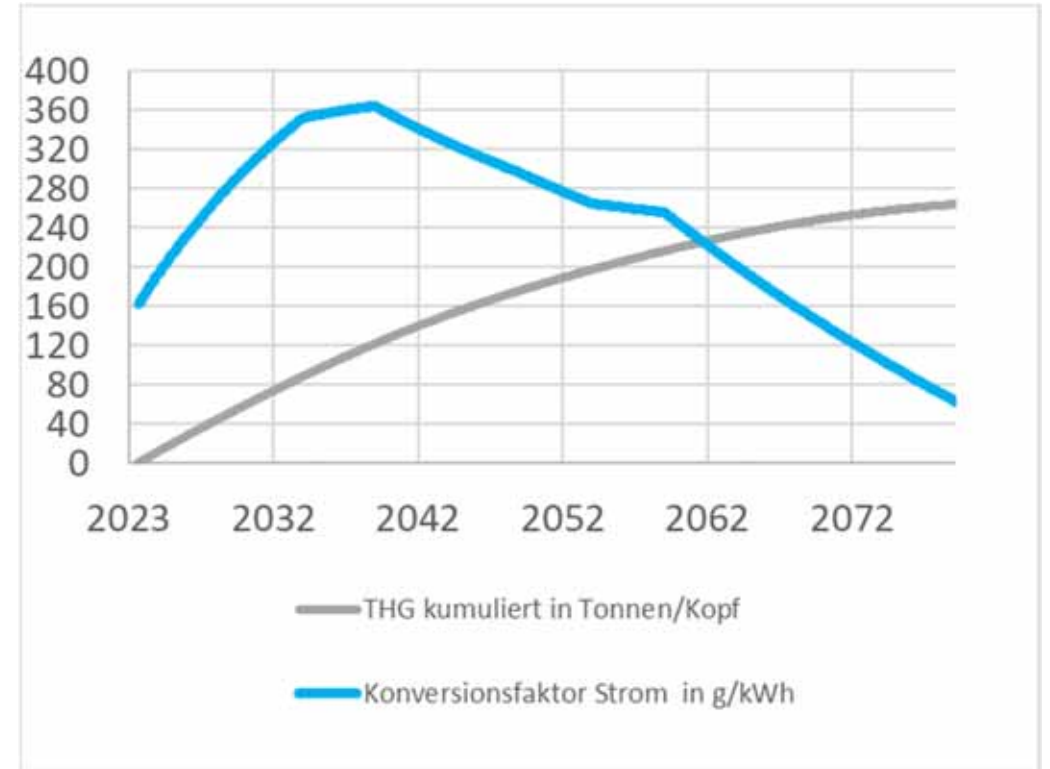
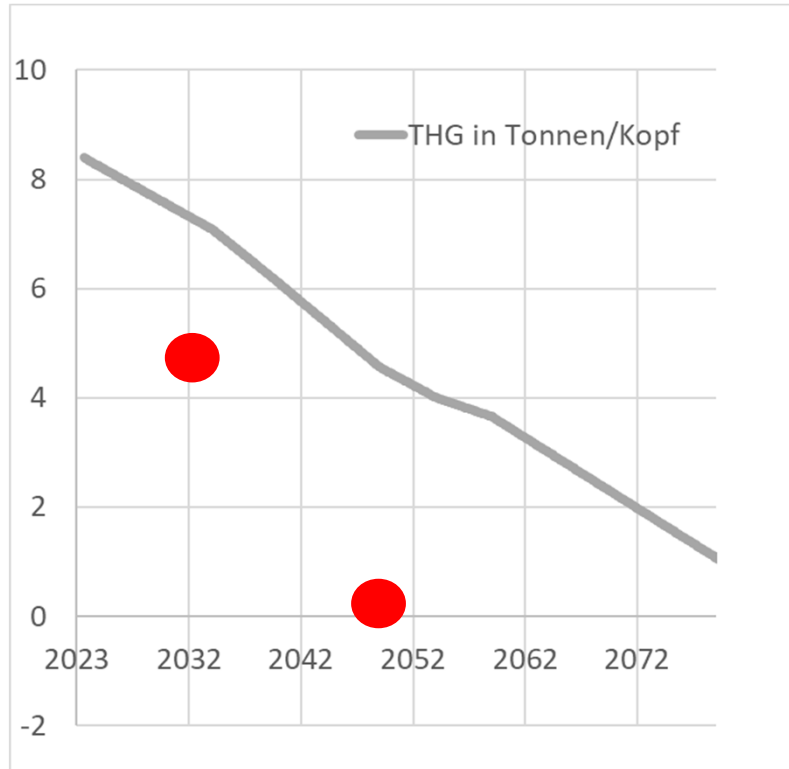


Transformation des Energiesystem – CO₂ Budget



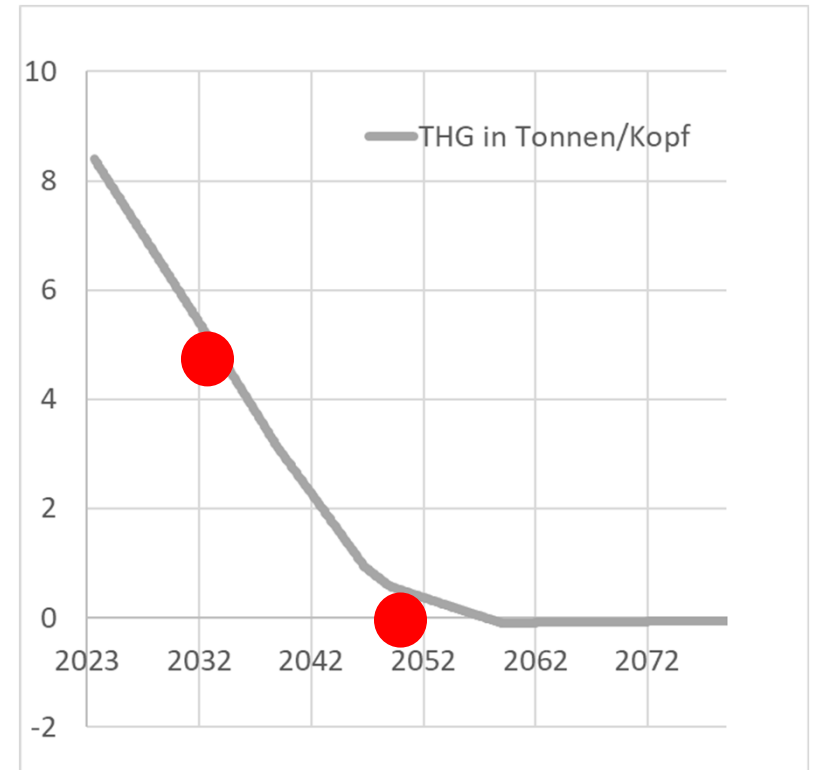
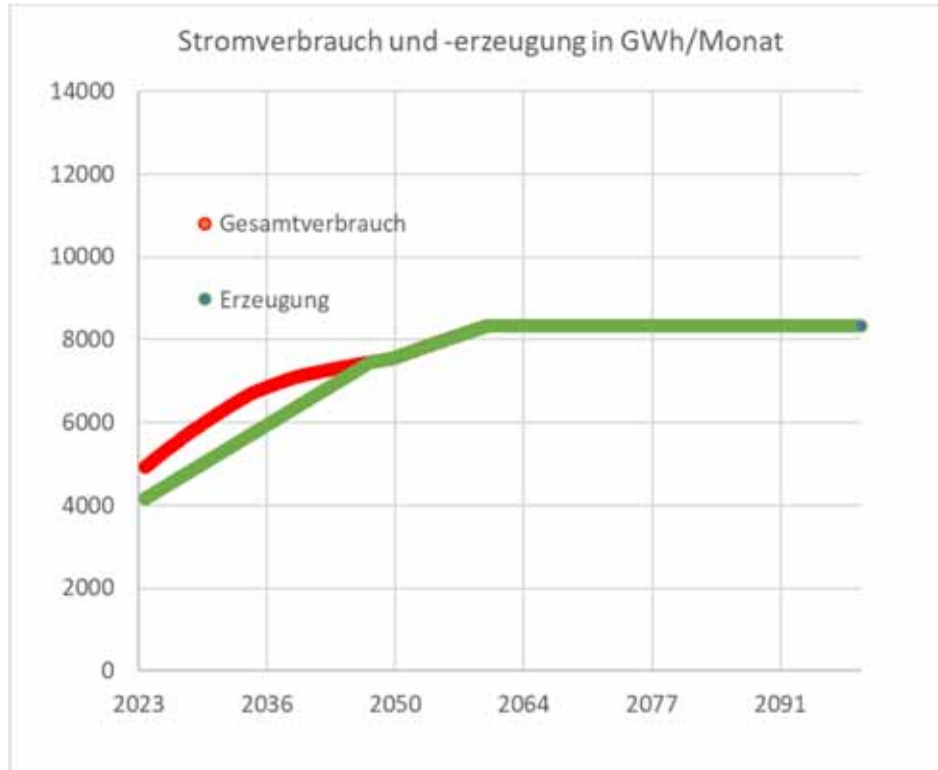
Energiemenge mit unterem Heizwert errechnet





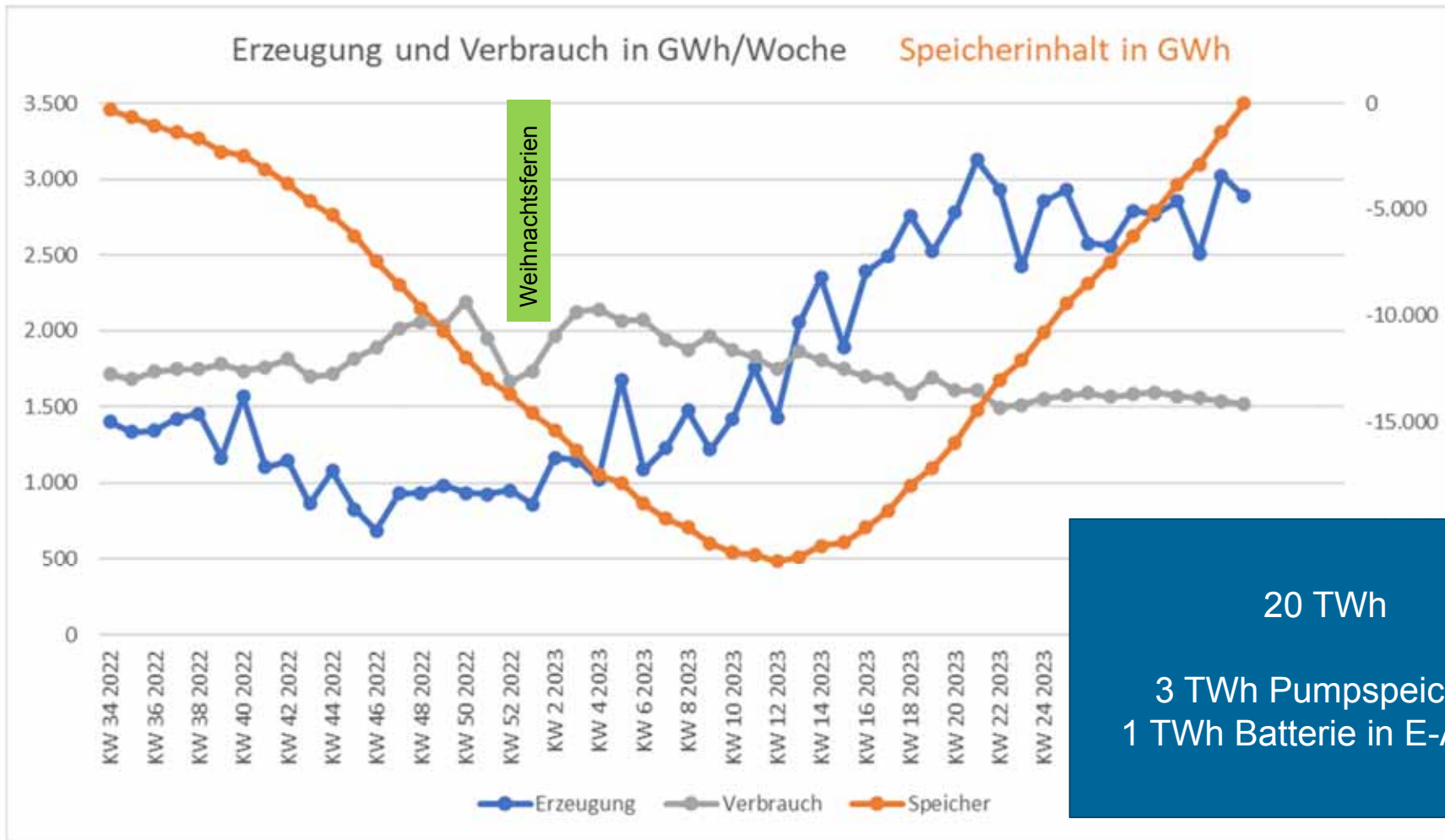
	Investition		Ausbau		Stromverbrauch 2100	
Gesamt	472.115	EU				
Transfer	25.201	EU				
Wind	756	EU				
PV	12.801	EU				
Wasser	kein invest					
Speicher	433.356	EUR/Kopf				

Strom-Erzeugungskosten 0,5 EUR/kWh.
 Transfer über 80 Jahre 315 EUR/Kopf und Jahr



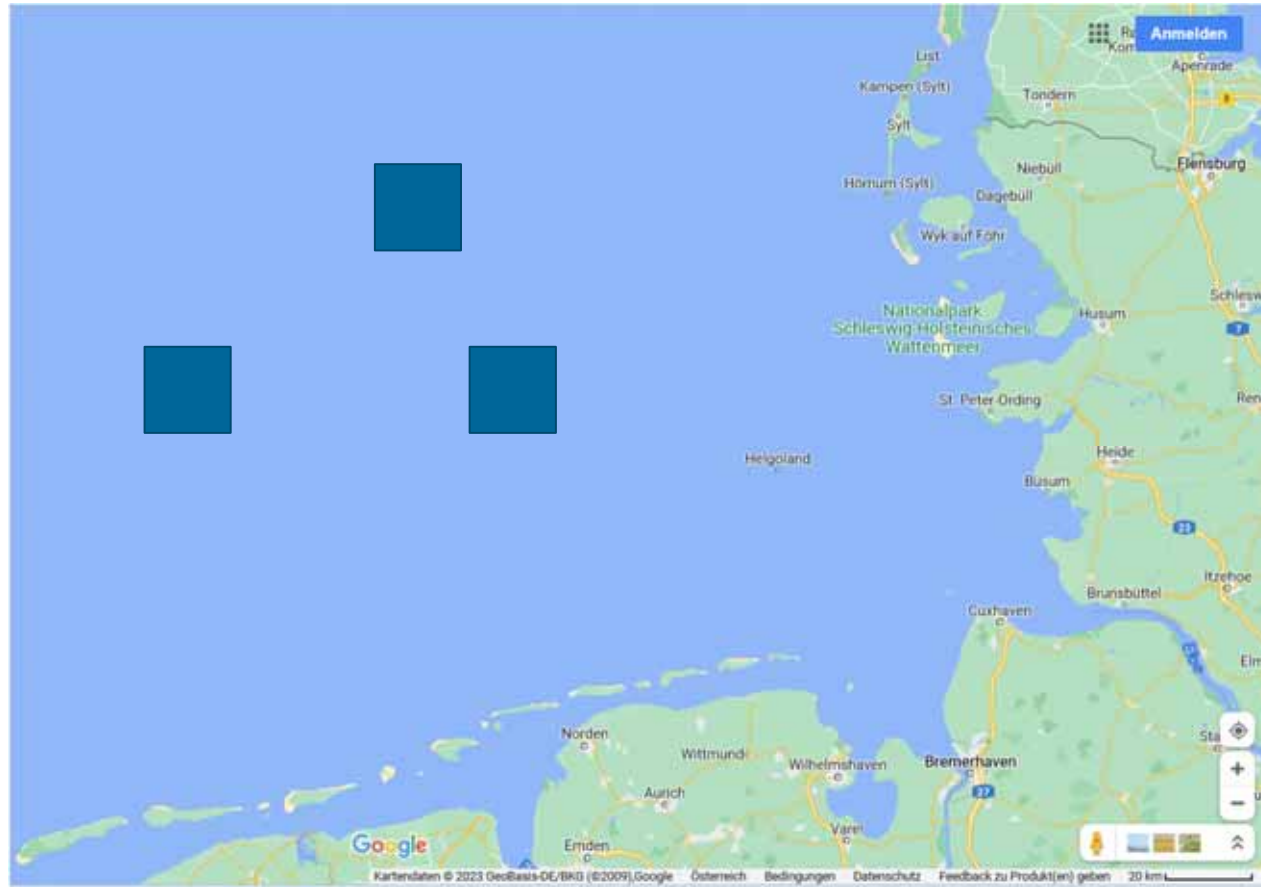
	Investition		Ausbau		Stromverbrauch 2100	
Gesamt	247.326	EU				
Transfer	8.748	EU				
Wind	756	EU				
PV	5.879	EU				
Wasser	kein invest					
Speicher	231.943	EUR/Kopf				

Strom-Erzeugungskosten 0,4 EUR/kWh.
 Transfer über 80 Jahre 109 EUR/Kopf und Jahr



20 TWh
 3 TWh Pumpspeicher
 1 TWh Batterie in E-Autos

Wochendaten aus 2022/2023 hochskaliert auf Strommengen in 2060



11 MW

200m Durchmesser

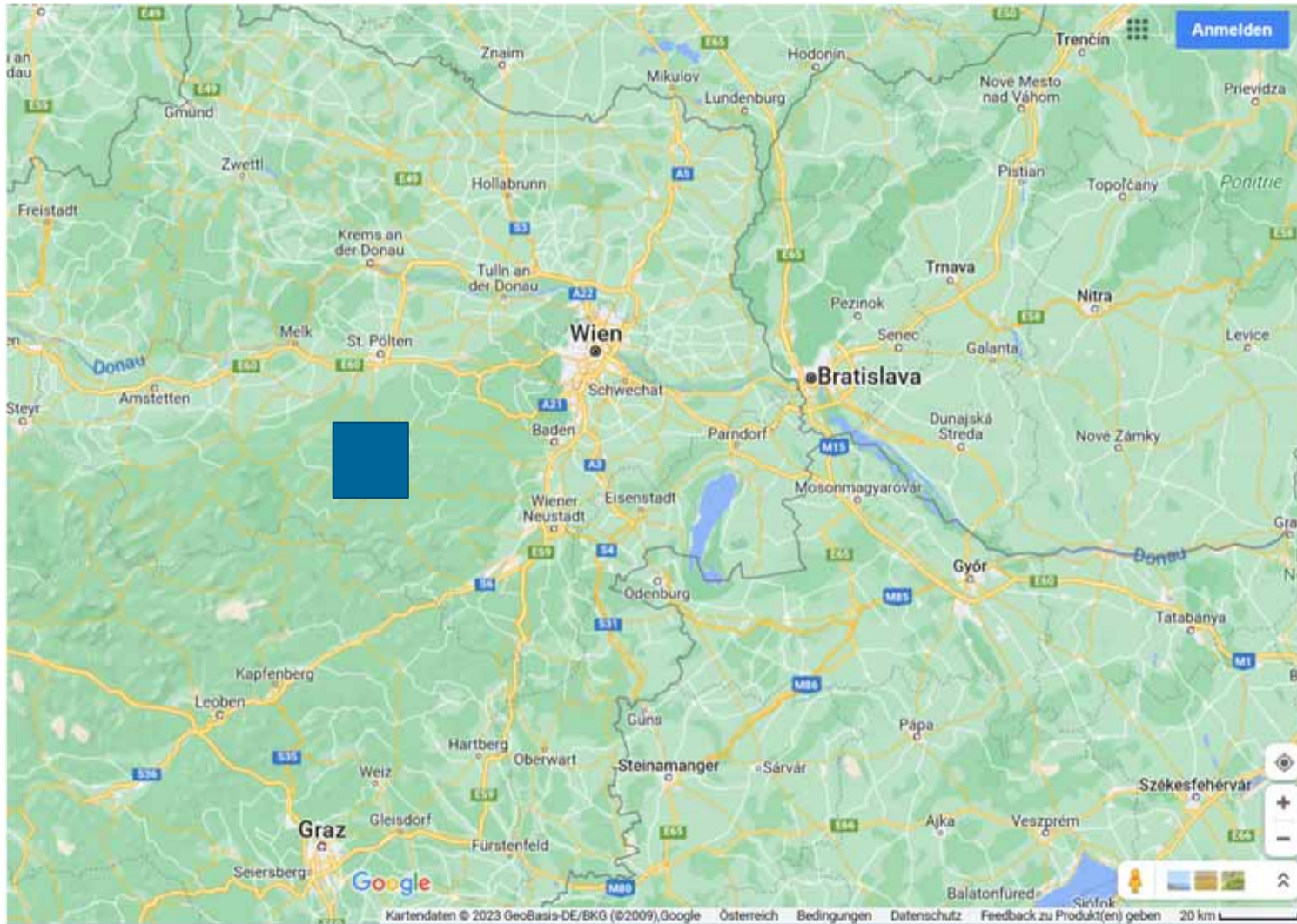
1 km Abstand

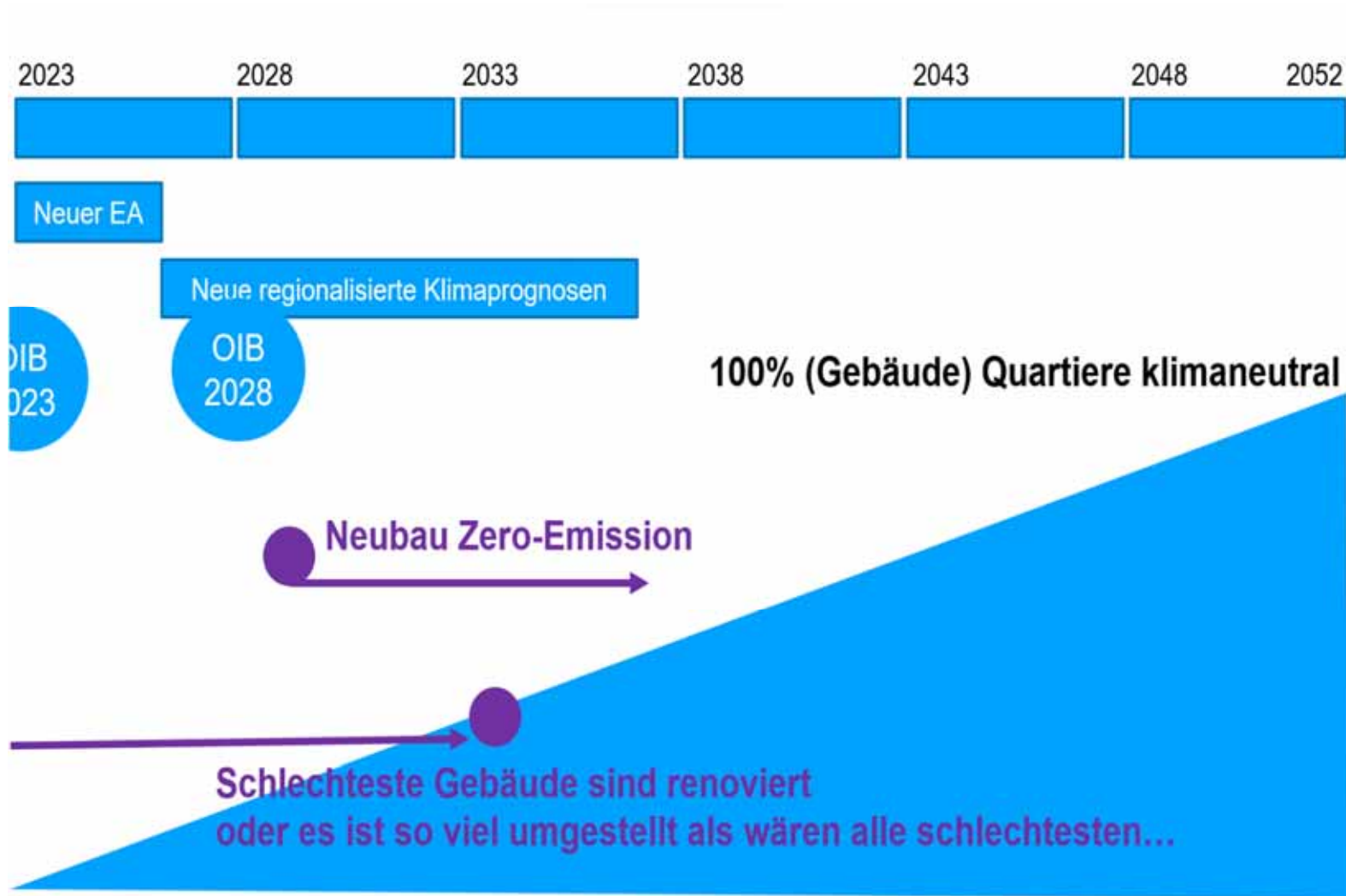
$20 \times 20 \text{ km}^2 =$



400 Anlagen

15 TWh





Erfasster Energieverbrauch

Reales Wetter

Reale Nutzung



Gemessener Energieverbrauch

Typisches Wetter

Typische Nutzung

Differenz klein

Berechneter Energieverbrauch

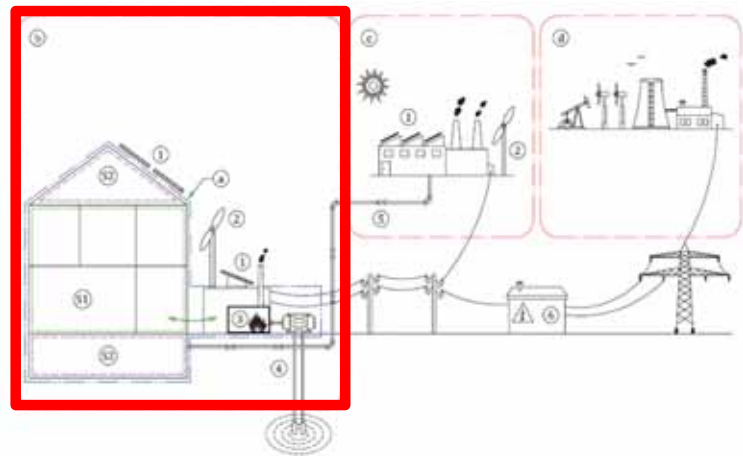
Typisches Wetter

Typische Nutzung

=> Berechnung/Simulation mit einem Zeitschritt unter einer Stunde

=> Automation, Taktverhalten von Anlagen, Luftbehandlung
Speichervorgänge, Flexibilität, Nutzverhalten,

Niedrigstenergiegebäude



Key	
a	assessment boundary (use energy balance)
b	perimeter: on-site
c	perimeter: nearby
d	perimeter: distant
S1	thermally conditioned space
S2	space outside thermal envelope
1	PV, solar
2	wind
3	boiler room
4	heat pump
5	district heating/cooling
6	substation (low/medium voltage and possible storage)

Nullemissionsgebäude



Key	
a	assessment boundary (use energy balance)
b	perimeter: on-site
c	perimeter: nearby
d	perimeter: distant
S1	thermally conditioned space
S2	space outside thermal envelope
1	PV, solar
2	wind
3	boiler room
4	heat pump
5	district heating/cooling
6	substation (low/medium voltage and possible storage)

Windkraftanlagen
PV Anlagen
Ökostrom

Nullemissionsgebäude



Key			
a	assessment boundary (use energy balance)	1	PV, solar
b	perimeter: on-site	2	wind
c	perimeter: nearby	3	boiler room
d	perimeter: distant	4	heat pump
51	thermally conditioned space	5	district heating/cooling
52	space outside thermal envelope	6	substation (low/medium voltage and possible storage)

Keine Emissionen für

Lüftung
 Beleuchtung
 Heizen
 Kühlen
 Warmwasser
 Transport

Export- kann Import kompensieren

Haushalts- und Betriebsstrom nicht betrachtet

Nullemissionsgebäude



Key

a	assessment boundary (use energy balance)	1	PV, solar
b	perimeter: on-site	2	wind
c	perimeter: nearby	3	boiler room
d	perimeter: distant	4	heat pump
51	thermally conditioned space	5	district heating/cooling
52	space outside thermal envelope	6	substation (low/medium voltage and possible storage)

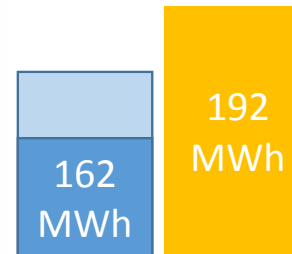


Tabelle 3. Übersicht über die Energieverbräuche und die Energieversorgung im Plus-Energie-Bürohochhaus – Gegenüberstellung des technologischen Potenzials gemäß Planung und den Ergebnissen aus dem Energiemonitoring der Jahre 2015 bis 2018

Energieform	Verbraucherkategorie/Energiequelle		Endenergie [MWh]					geschätzter Fehler
			Planung	2015	2016	2017	2018	
Strom	Verbrauch	Sozialräume & Teeküchen	8,95	8,72 ¹⁾	8,72	9,04	8,90	±15,0 %
		weitere Geräte (Kopierer, Beamer...)	4,28	10,98 ²⁾	9,82	7,09	5,70	± 3,4 %
		EDV-Arbeitsplätze	13,27	69,83 ²⁾	62,40	54,25	48,11	±10,3 %
		Kommunikation (Telefone, Switches)	10,54	23,57 ¹⁾	23,57	23,65	23,81	
		Server & USV	40,30	41,70 ¹⁾	41,70	42,23	41,40	
		restliche elektrische Komponenten	1,35	0,94 ¹⁾	0,94	1,05	1,03	±13,2 %
		MSRT	14,32	18,19 ¹⁾	18,19	21,41	19,50	
		Aufzug	9,69	5,04 ¹⁾	5,04	4,31	4,37	
		Beleuchtung	33,40	39,84 ¹⁾	39,84	38,00	35,89	±15,0 %
		Lüftung	9,00	30,96 ¹⁾	30,96	30,51	30,80	
		Warmwasser & Trinkwasser	8,57	7,11 ¹⁾	7,11	7,11	7,14	
		Kühlung & Serverkühlung	13,68	34,74 ¹⁾	34,74	31,31	39,48	
		Heizung	2,09	1,94 ¹⁾	1,94	1,98	1,72	
		Versorgung	Photovoltaik	196,04	163,32 ²⁾	189,88	196,50	192,10
Bezug aus dem elektrischen Netz	-26,62		130,23 ¹⁾	95,08	75,44	75,74		
Wärme	Verbrauch	Heizwärmeverbrauch	48,62	117,40 ¹⁾	117,40	114,68	105,45	
		Versorgung	Energierückgewinnung Serverabwärme	29,33	3,92 ¹⁾	3,92	2,78	4,58
	Bezug aus dem Fernwärmenetz	19,29	113,48 ¹⁾	113,48	111,90	100,87		

1) Wert von 2016 übernommen

2) Wert aus vorhandenen Monitoringdaten hochgerechnet

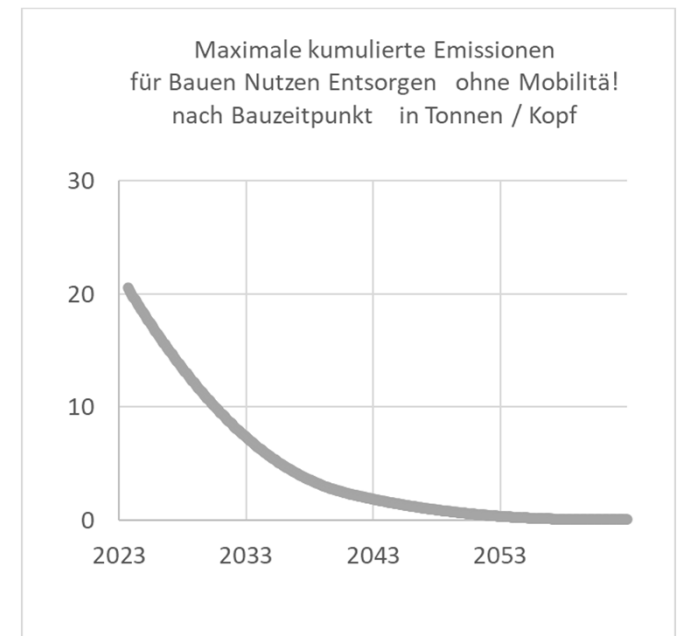
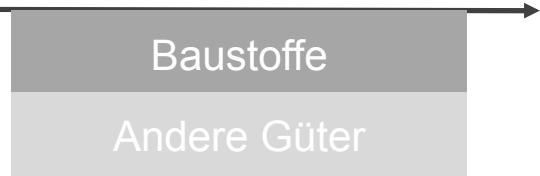
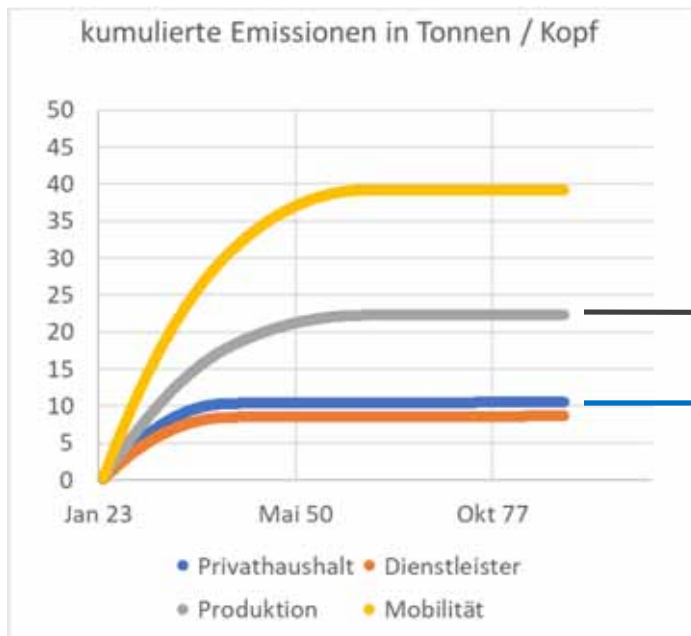


<https://onlinelibrary.wiley.com/doi/abs/10.1002/9783433611289.ch16>

Planung, Ausführung und Betriebserfahrung eines Plus-Energie-Bürohochhauses
Alexander David, Thomas Bednar, Markus Leeb und Helmut Schöberl

Lebenszyklus Treibhausgasemissionen

Anforderung oder nur Ausgeben?



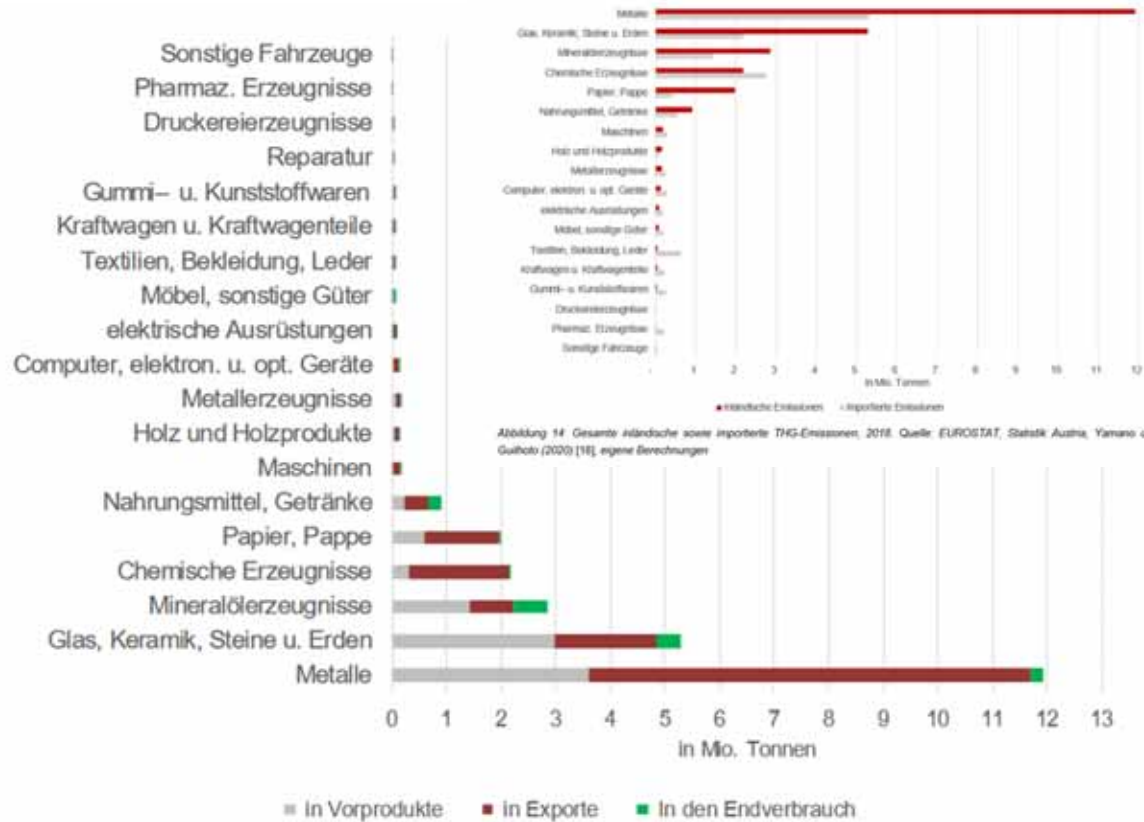


Abbildung 8: THG-Emissionen nach Verwendungszweck der Güter pro Sektor, 2018. Eigene Darstellung nach [3], [16], sowie eigenen Berechnungen

26 Mio Tonnen / Jahr

studie
**KLIMANEUTRALITÄT
 ÖSTERREICHS BIS 2040**
 BEITRAG DER ÖSTERREICHISCHEN
 INDUSTRIE



Christian Ebenhofer, Bernhard Galitsch, Bernhard Dachs (AIT)
 Thomas Kerschinger, Peter Heggenhuber (EVT)
 Peter Böhm, Stefan Mauer (E-AGU)
 Gergely Thomas, Katalin Kócsa (IFA)

September 2021

				Grenze entsprechend Baubeginn		
				19,9	14,1	21,1
					Tonnen/Kopf	Tonnen/Kopf
						Grenze
						kgCO2/m ²
			1 Ziegel	0,8	Tonnen/Kopf	12,3
			1 Beton	8,3	Tonnen/Kopf	13,0
			1 Haustechnik	4,4	Tonnen/Kopf	
			Dicke	0,30	m	
	OK		1 EPS	0,6	Tonnen/Kopf	
		Fläche in m ²	Erdgas	-	Tonnen/Kopf	11,3
Bauen/ThermRen	01.01.2024		Strom	6,9	Tonnen/Kopf	6,9
Umstellung WP	01.01.2024	0	davon Haushaltsstrom	3,45	Tonnen/Kopf	
PV	01.01.2024	-				
Instandhaltung TGA	01.01.2049	25				
Abbruch	01.01.2074	50	Gebäude	17,60	Tonnen/Kopf	
			Gesamt	21,05	Tonnen/Kopf	
			SummeBetriebDämm	7,5	Tonnen/Kopf	

Grobe Abschätzung – zahlreiche Komponenten fehlen

				Grenze entsprechend Baubeginn					
				6,4 Tonnen/Kopf			15,9		
							Tonnen/Kopf	Grenze	kgCO2/m ²
				1 Ziegel	0,8	Tonnen/Kopf	14,1	4,6	12,3
				1 Beton	8,3	Tonnen/Kopf			
				1 Haustechnik	4,4	Tonnen/Kopf			
				Dicke	0,30	m			
	OK			1 EPS	0,6	Tonnen/Kopf			
		Fläche in m ²	Anzahl an Jahren nach Bau	Erdgas	-	Tonnen/Kopf	1,8		4,0
Bauen/ThermRen	01.01.2034			Strom	1,8	Tonnen/Kopf			
Umstellung WP	01.01.2034		0	davon Haushaltsstrom	0,90	Tonnen/Kopf			
PV	01.01.2034	-							
Instandhaltung TGA	01.01.2059		25						
Abbruch	01.01.2084		50	Gebäude	15,02	Tonnen/Kopf			
				Gesamt	15,92	Tonnen/Kopf			
				SummeBetriebDämm	2,4	Tonnen/Kopf			

Grobe Abschätzung – zahlreiche Komponenten fehlen

Serienfehler vermeiden

Ein großes Problem entsteht

wenn der Schaden länger braucht bis er sichtbar wird

und die Behebung sehr teuer wird.

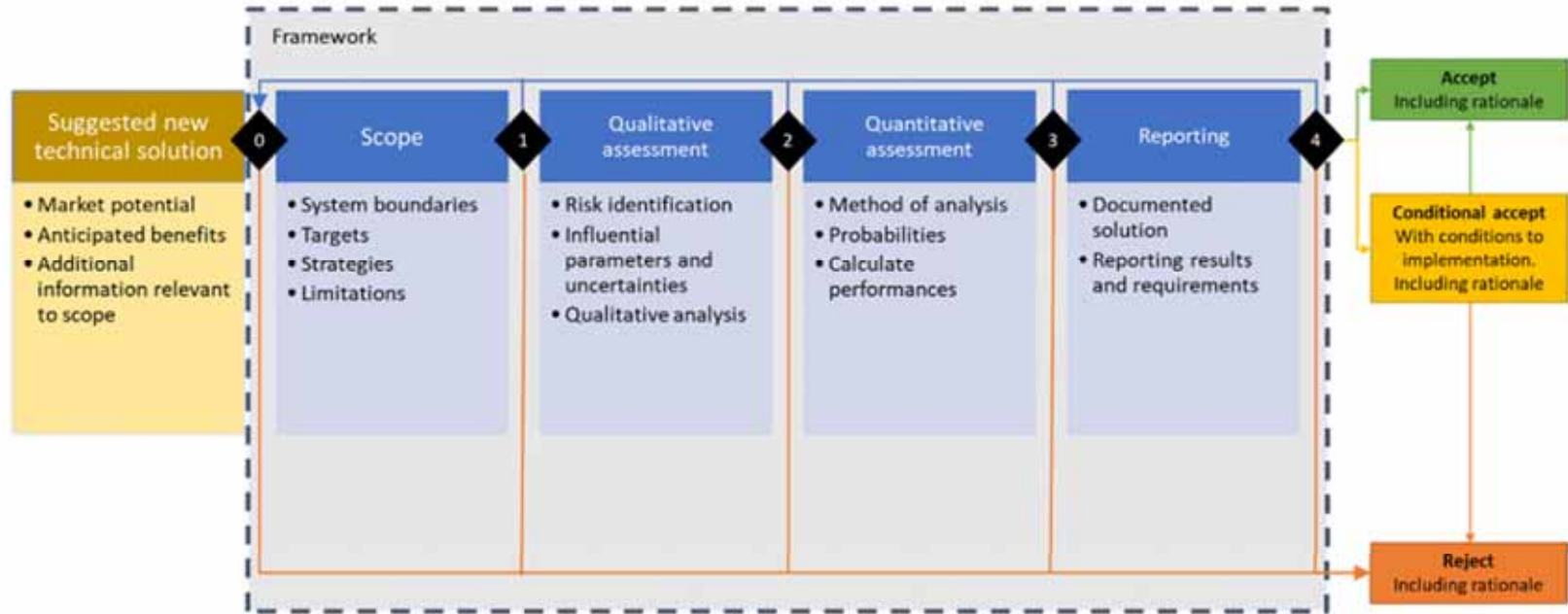
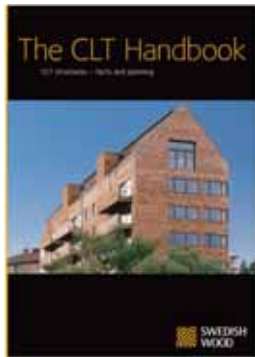


Figure 1. Workflow, adapted from IEA Annex 55 [21]. Steps in framework can be iterated as work proceeds. Suggested toll gates are 0: decision to initiate assessment; 1: decision to accept scope; 2: decision to proceed with assessment; 3: decision to proceed with assessment, and 4: decision to proceed to implementation. Each tollgate corresponds to a steering group decision to proceed, revise, or to not proceed.

Svensson Tengberg, C., Hagentoft, C. (2021). Risk assessment framework to avoid serial failure for new technical solutions applied to the construction of a clt structure resilient to climate. Buildings, 11(6). <http://dx.doi.org/10.3390/buildings11060247>



2019

10.3 Protecting the structure during construction

The anchors should normally should be pre-tensioned to a certain extent to compensate for the long-term deformations that occur over the course of construction. The anchors are usually fixed every 100 mm to the structural frame as built up. As the building is raised up and more and more material is fixed in place, the anchors can lose their tension due to vertical drifting. Once all the stories are in place, it is therefore essential to check that the anchors are under tension and not loose. If the anchors are loose, they must be tightened up. For safety and sound issues create certain demands in the assembly plant, particularly in multi-story buildings, which require high amounts and fire safety standards. Once again, it is important that the construction documents are followed carefully.

10.3 Protecting the structure during construction

10.3.1 Weather protection during construction

The benefits of working under the cover of a full temporary shelter are clear, but some cases require such protection more than others, depending on the nature of the building and the construction method. Depending on the production method and degree of prefabrication, there are different ways to achieve a moisture-proof construction process that takes account of the quality requirements demanded by the client and the authorities to the most effective way. If a building has a high degree of prefabrication and sensitive details, a full temporary shelter is the best alternative overall. On another project with a low degree of prefabrication, a simpler shelter or better use of tarpaulins may be preferable for financial reasons.



Photograph: Peter Wille, www.peterwille.no

Building without weather protection

If the CLT frame is erected without weather protection, the structure must be temporarily protected with tarpaulins or some other temporary rain cover. This method is best suited to CLT that is built without any form of shoring, so this allows any drying in action. It also requires good planning concerning drainage, protection of end-grain wood, methods for drying out during surfaces and follow-up to the form of inspection plans and other documentation.

If the building comprises both floor structures and load-bearing walls or CLT, the walls should be protected as quickly as possible. This forms a volume that is easier to protect with a plastic or tarpaulin roof until the next floor structure is in place. The top edge of the CLT walls must be protected particularly carefully, since end-grain wood will otherwise be exposed to moisture. In some cases, the finished roof can be used to provide temporary shelter, lifting it off and on. This is mainly applicable if the building is not too large or tall. A construction crane will also usually have to be on site to make this a cost-effective method. The exception is a single-family house, where a hoist will usually suffice. Bear in mind that the roof must be temporarily anchored down to avoid the risk of it blowing off.

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10.3 Protecting the structure during construction

Building with weather protection

There are various different systems for weather protection that cover the facade and roof, depending on the situation.

Weather protection on facade scaffolding

Weather protection is achieved by attaching plastic sheeting to the outside of the scaffolding, which is anchored to the structural frame of the building. This solution is suitable for frames with a low degree of prefabrication and frames with more prefabrication, as the weather protection follows the building upwards and can be combined with a roof cover or just a simple temporary floor cover. This falls outside the Swedish Work Environment Authority's definition of weather protection, but it is still widely used. The sheeting creates considerable windage and it is critical to fully check that the scaffolding is properly anchored in place. When designing fixing points, account must be taken of how the sheeting is attached to the scaffolding. A common method is to attach the sheeting using straps that are designed to give way under a certain load.



Shelter with no weather protection, Høvedskjøl, Nordland, Norway

Fixed or wheeled temporary roofing

Fixed temporary roofing usually comprises aluminium lattice beams stabilised with struts. The dimensions and load-bearing capacity are critical to determining how the solution works under wind and snow loads. The frame is covered with PVC sheeting or alternately with plastic or metal panels. A wheeled temporary roof is similar to the fixed version, but can be moved on wheels that run on tracks or rails. The weather protection can be split up into sections that can be fully or partly wheeled along the same rails, or that sit on parallel rails, with the sections overlapping one another. The fact that the weather protection can be opened up makes this solution good for taking in materials.



Fixed with struts

Climbing weather protection

Climbing weather protection is based on steel structures that follow the building upwards, story by story. Climbing weather protection can include suspended working platforms, and also an internal overhead crane to transport materials from the gable ends, replacing the need for an external crane. This type of weather protection has been used on several wood construction projects in Sweden.



Example of climbing weather protection for sky construction with a high degree of prefabrication

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10.3.2 Controls and monitoring

Buildings must be designed so that moisture does not cause damage, rot or mould growth that might affect health and hygiene. This is a responsibility that the developer and the property owner have towards those who use the building, under Sweden's Building Regulations (BRB). To meet this requirement, it is important to conduct regular moisture controls on delivered and assembled construction products. This is usually taken care of by the contractor in the form of on-site inspections.

The on-site inspections should be preceded by a moisture proofing proposal that states what needs to be checked and what moisture levels may be considered acceptable. This proposal should then be submitted to the person responsible for the inspections, and so

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Moisture safety in CLT construction without weather protection – Case studies, literature review and interviews

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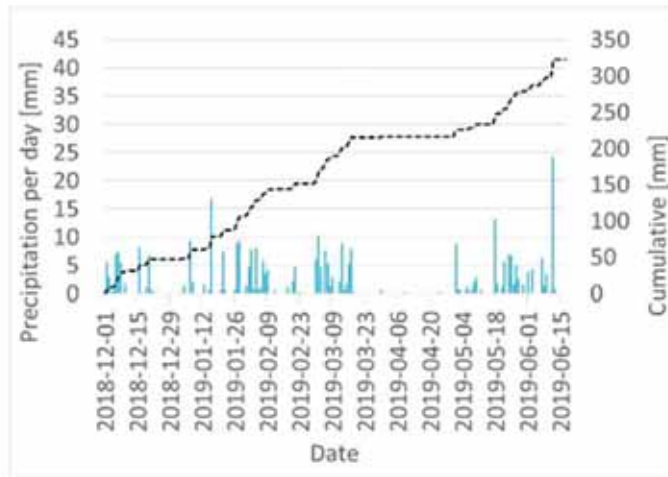


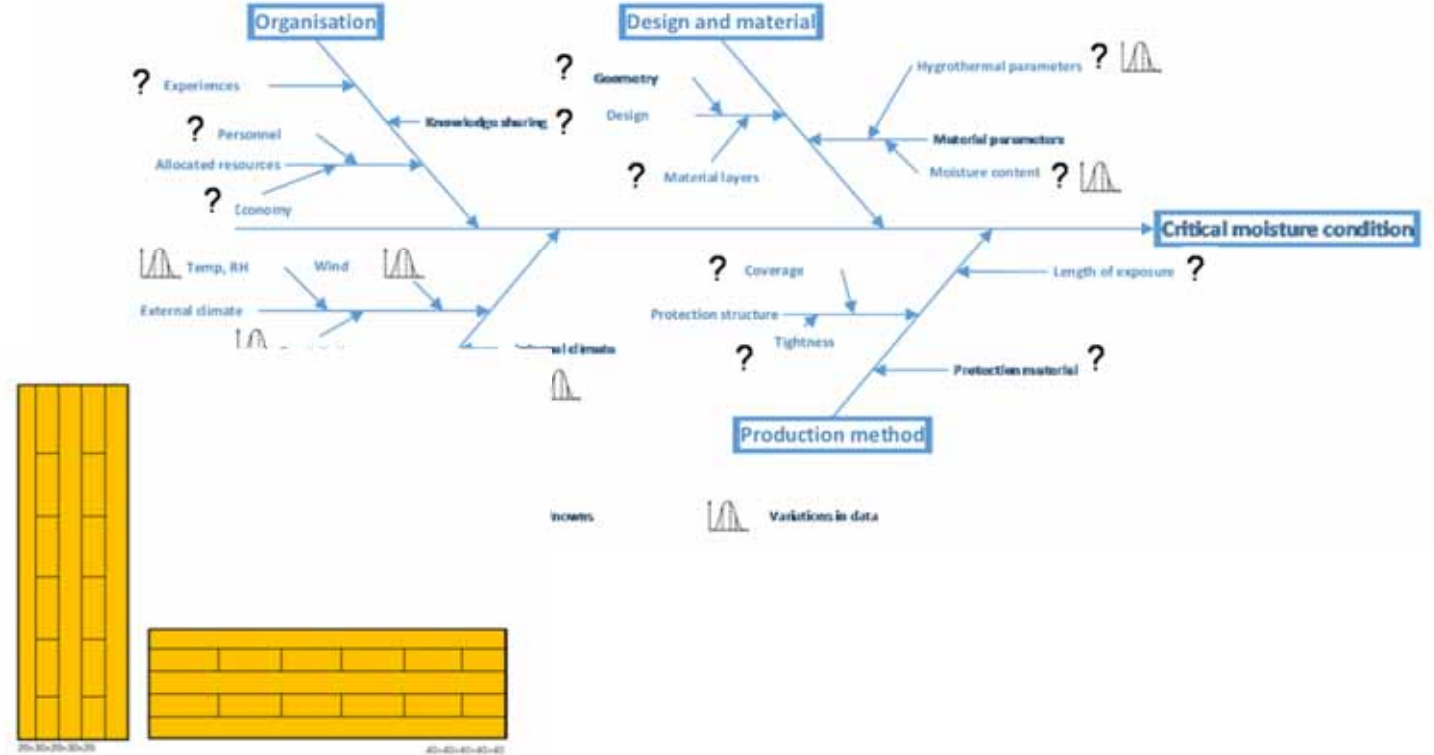
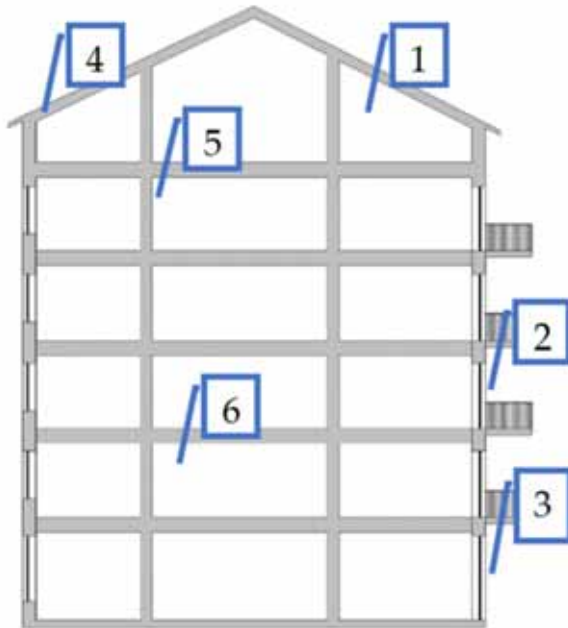
Fig. 7. Precipitation in mm rain per day and cumulative in mm rain during construction stage in central Sweden.



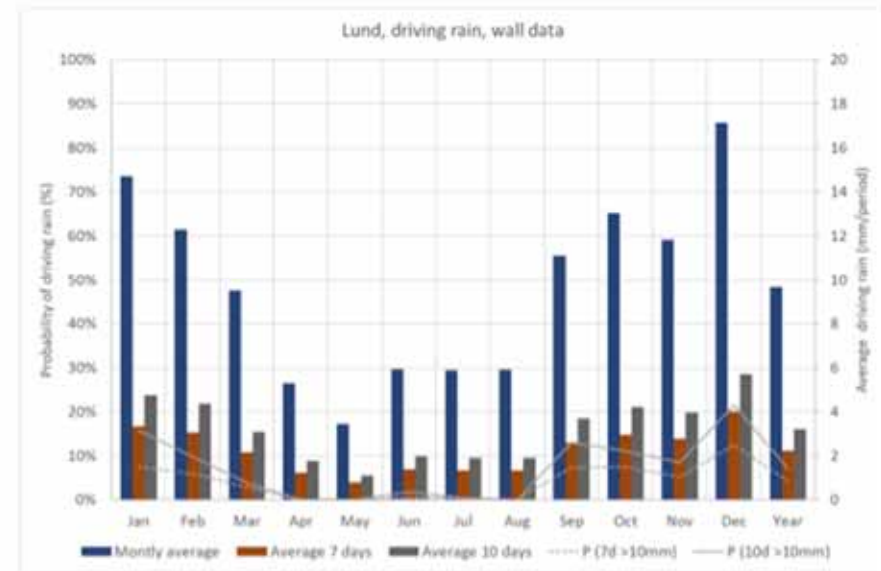
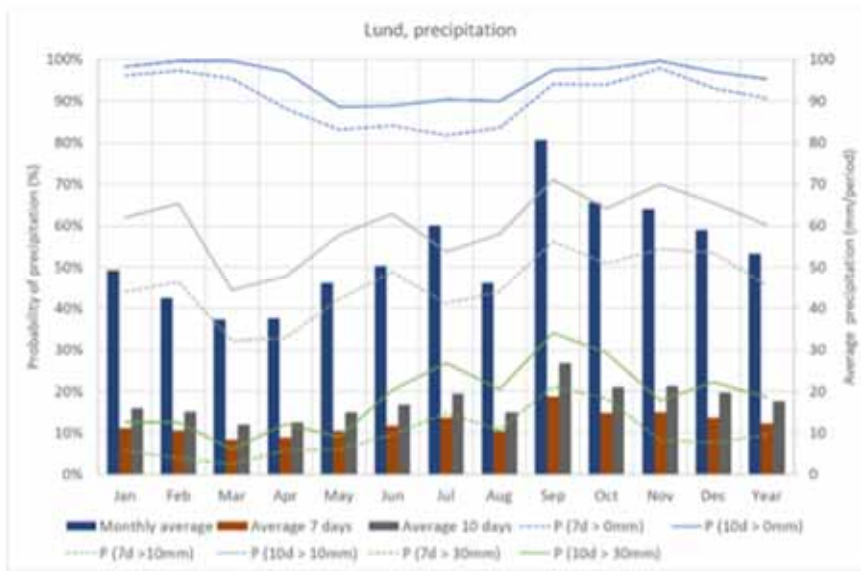
Fig. 5. On several occasions, water pooled on the floor structure. Precipitation ran down primarily from the above floor structures.



Fig. 8. Sample taken from the top side of the floor structure (CLT) under the sound and vibration pads and inner walls (CLT). The surfaces have been stained primarily by discoloured water.



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Table 4. Summary of assessment concerning moisture target for structure exposed respectively protected by weather protection. Color assessment of risk related to moisture target, as defined in Section 3.1. Scope (green = low, yellow = medium, orange = high, red = very high).

Start	Normal Construction Time				Short Construction Time			
	Jan	April	July	Oct	Jan	April	July	Oct
Exposed summary	Red	Red	Red	Red	Red	Red	Red	Red
Exterior wall	Green	Yellow	Red	Red	Red	Green	Yellow	Red
Intermediate floor	Green	Yellow	Red	Red	Red	Green	Yellow	Red
Shafts / leakages	Green	Yellow	Red	Red	Red	Green	Yellow	Red
Water trapping	Red	Red	Red	Red	Red	Red	Red	Red
Protected summary	Green	Green	Orange	Green	Green	Green	Green	Orange
Exterior wall	Green	Green	Orange	Green	Green	Green	Green	Orange
Intermediate floor	Green	Green	Orange	Green	Green	Green	Green	Orange

Table 5. Summary of assessment concerning mold target for structure exposed respectively protected by weather protection. Colors: assessment risk related to mold target defined in Section 3.1. Scope (green = low, yellow = medium, orange = high, red = very high).

Start	Normal Construction Time				Short Construction Time			
	Jan	April	July	Oct	Jan	April	July	Oct
Exposed summary	Red	Red	Red	Red	Red	Red	Red	Red
Exterior wall *	Yellow	Red	Red	Red	Yellow	Yellow	Red	Red
Intermediate floor	Green	Yellow	Yellow	Yellow	Green	Green	Yellow	Yellow
Shafts / leakages	Yellow	Red	Red	Red	Yellow	Red	Red	Red
Water trapping	Red	Red	Red	Red	Red	Red	Red	Red
Protected summary	Green	Yellow	Yellow	Yellow	Green	Green	Yellow	Orange
Exterior wall	Green	Yellow	Yellow	Yellow	Green	Green	Yellow	Orange
Intermediate floor	Green	Yellow	Yellow	Yellow	Green	Green	Yellow	Orange

* Values estimated as VTT model are not applicable to exposed conditions.

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