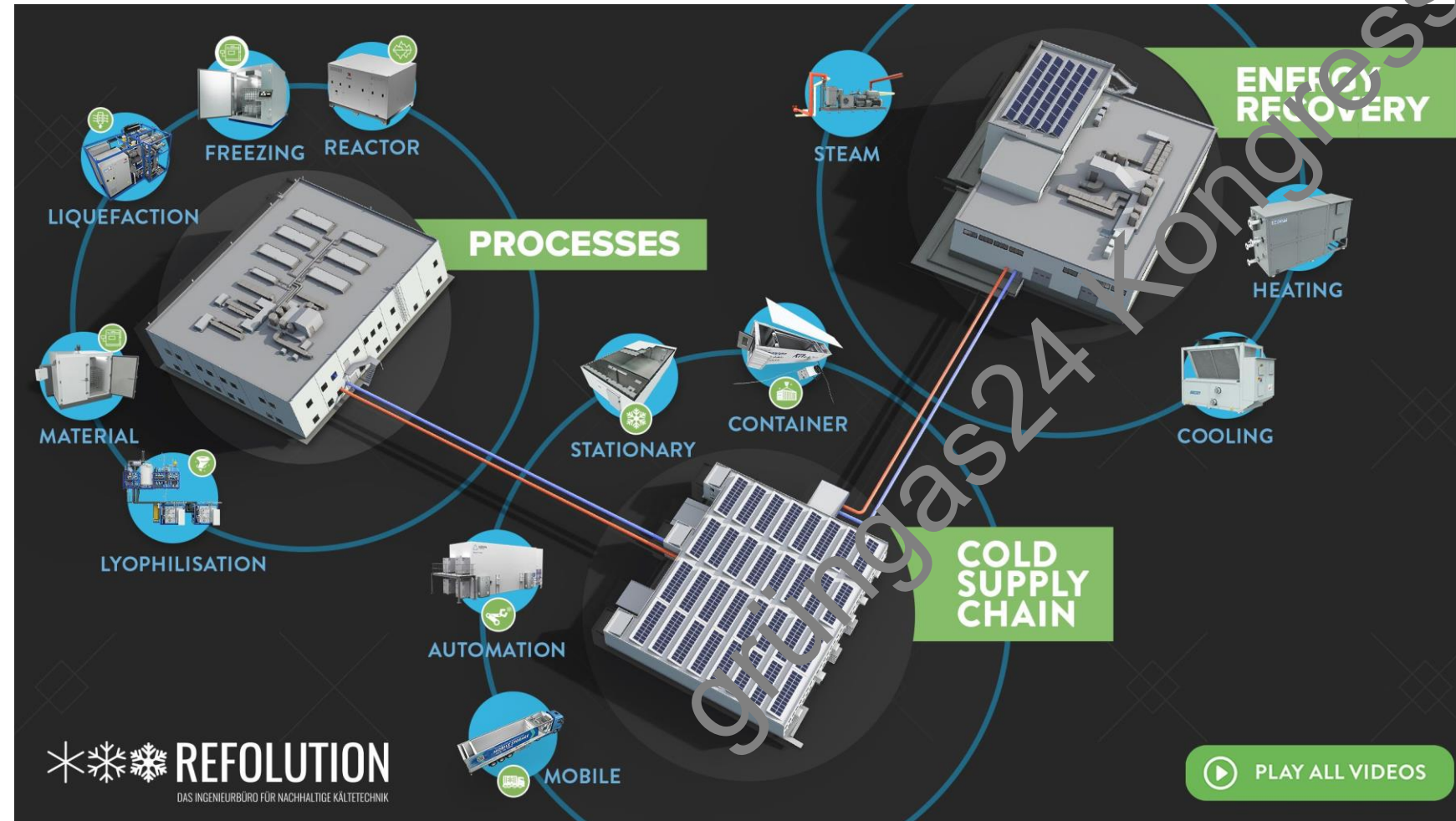




# Nachhaltige Verflüssigung von Biomethan und CO2 zur Erhöhung der Wertschöpfung



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Grüingas-Kongress  
2024



# Impact of refrigeration

Indirect CO2 emissions:

In Germany about 14% to 19% of total electrical power is used in a refrigeration process

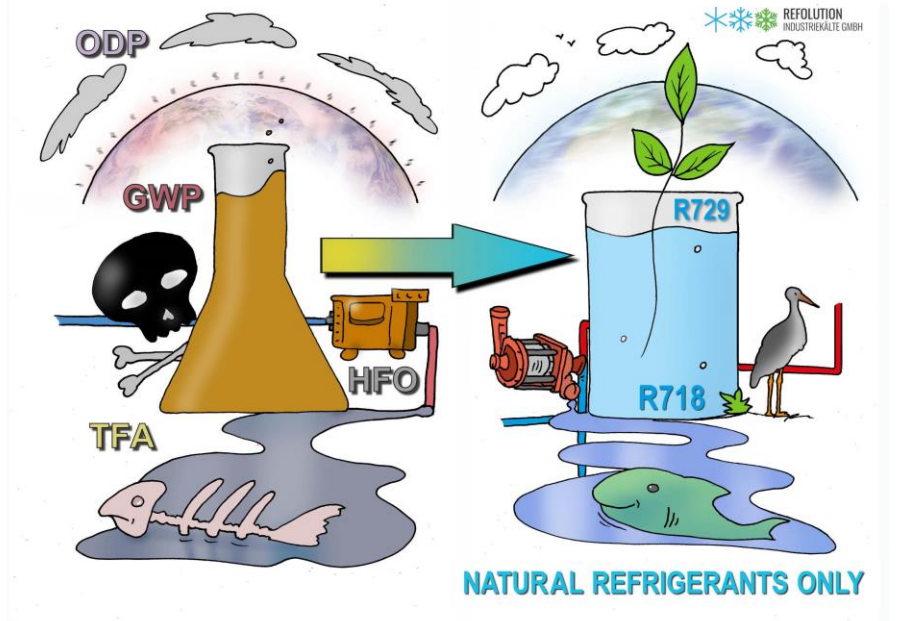
Average life cycle is 15 years and life cycle cost is not counted

➤ Need for efficient and long-lasting solutions

Direct emissions of refrigerants:

- ODP – Ozone Depletion Potential
  - GWP – Global Warming Potential
  - PFAS/TFA – persistent pollution of the environment
- Use of natural refrigerants

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# Laws on refrigeration equipment

1. F-Gas-Regulation (EU) 2024/573

→ 2024

2. PFAS draft for REACH

→ Maybe 2027

3. Energieeffizienzgesetz - EnEfG

→ 2023



2024/573

20.2.2024

VERORDNUNG (EU) 2024/573 DES EUROPÄISCHEN PARLAMENTS UND DES RATES  
vom 7. Februar 2024  
über fluorierte Treibhausgase, zur Änderung der Richtlinie (EU) 2019/1937 und zur Aufhebung der  
Verordnung (EU) Nr. 517/2014



ANNEX XV RESTRICTION REPORT

PROPOSAL FOR A RESTRICTION

SUBSTANCE NAME(S): Per- and polyfluoroalkyl substances (PFASs)



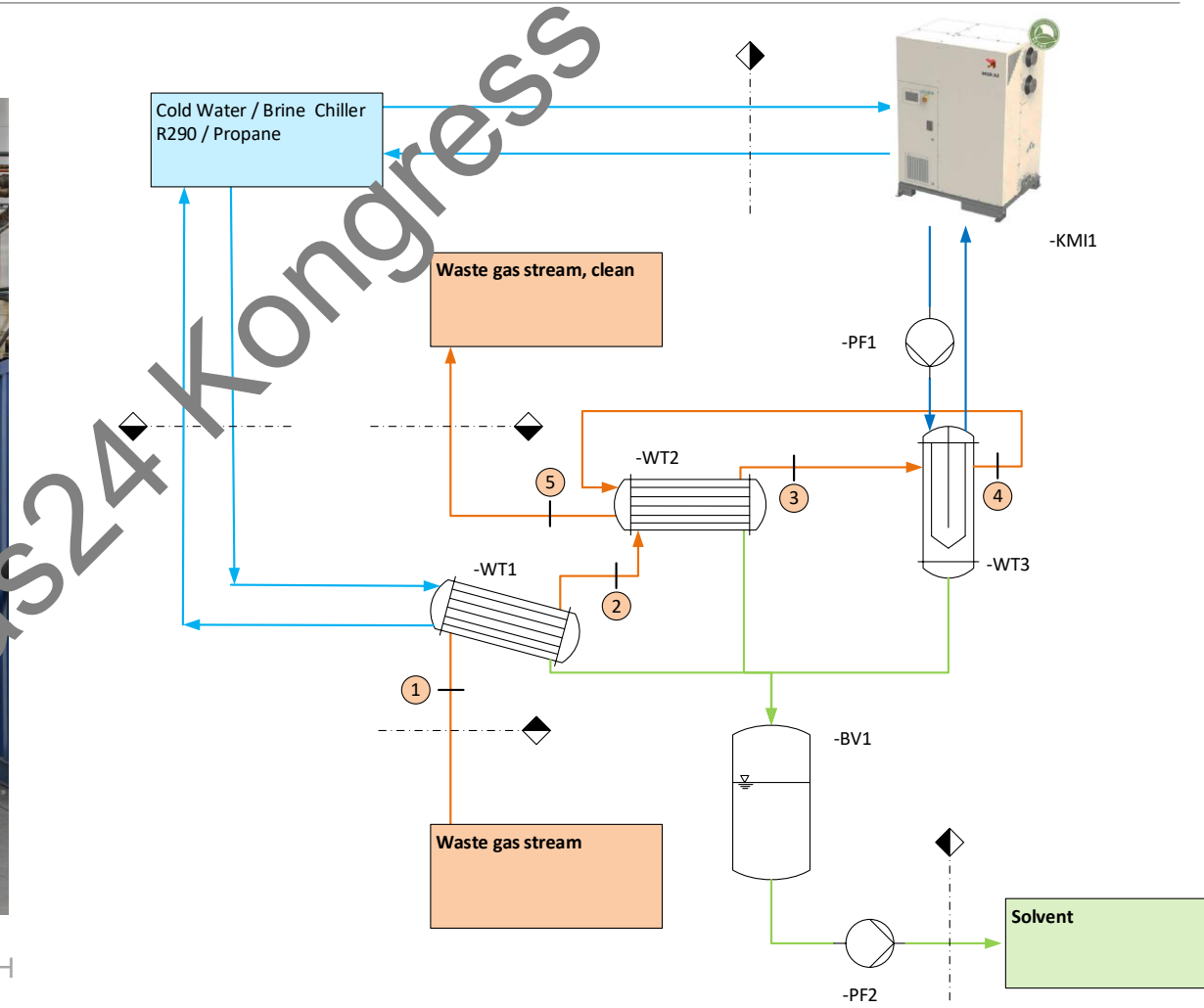
Gesetz zur Steigerung der Energieeffizienz in Deutschland  
(Energieeffizienzgesetz - EnEfG)



# Refolution in Liquefaction

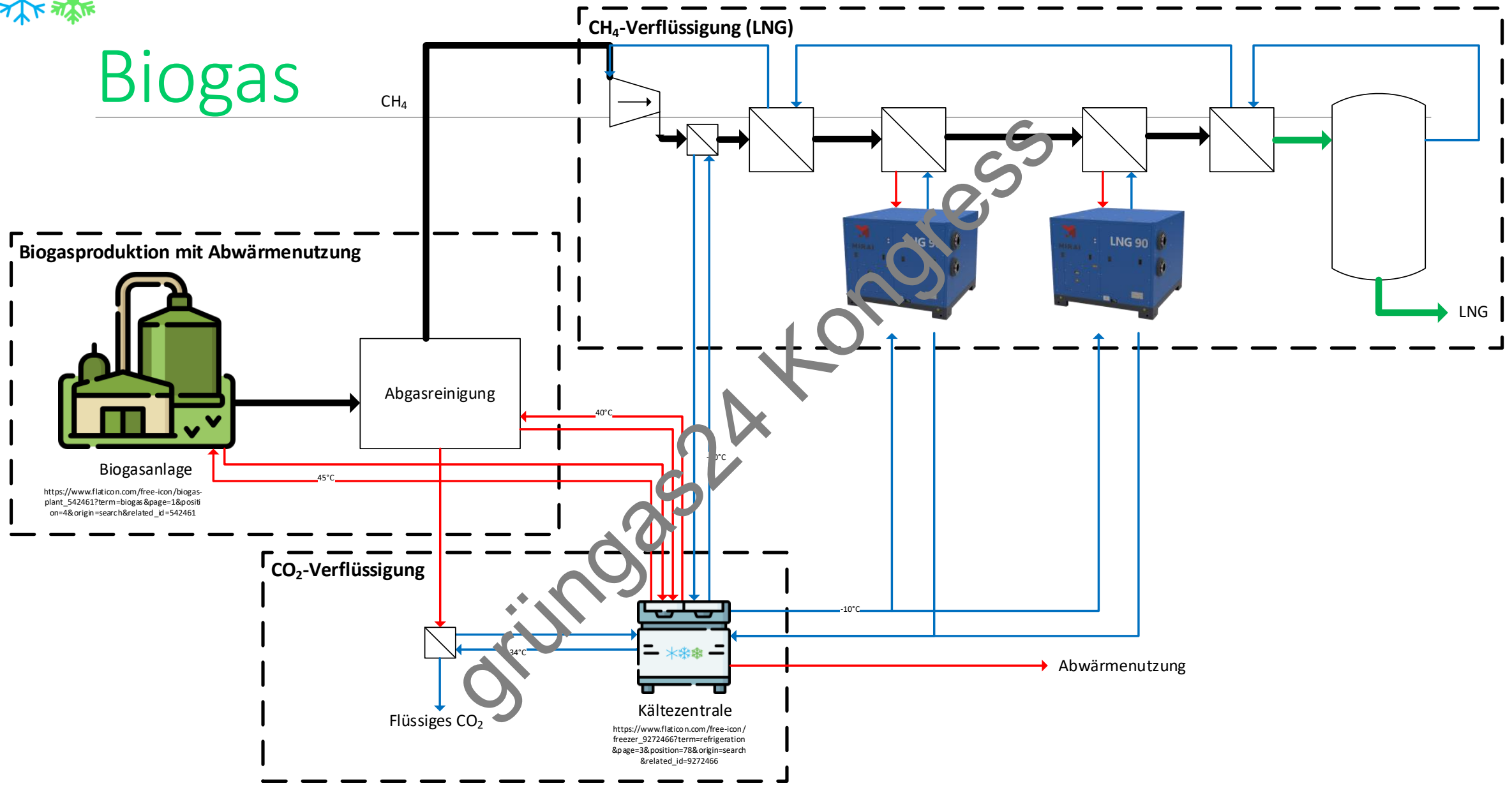


© HOF-Sonderanlagenbau GmbH



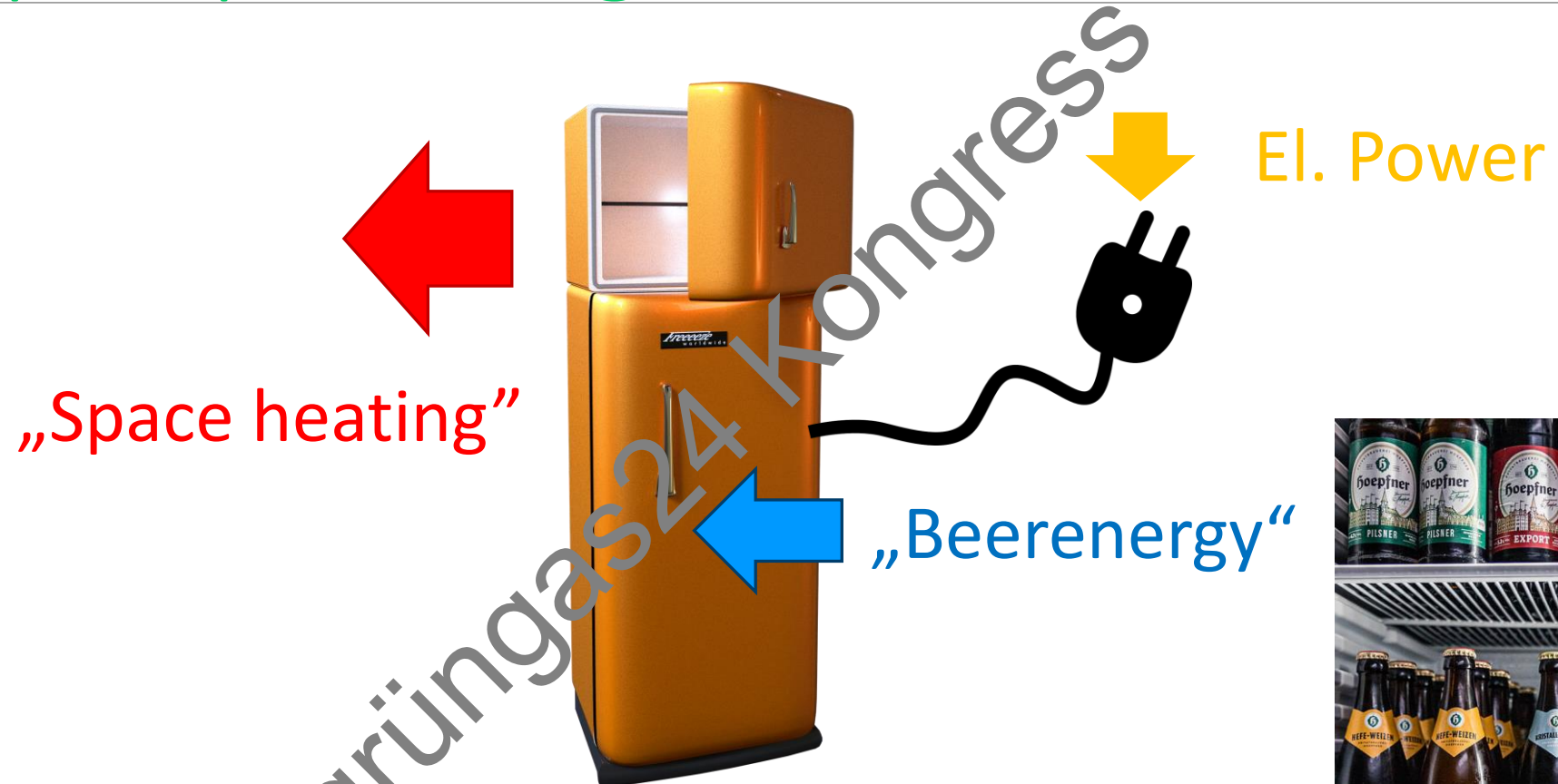


# Biogas





# Heatpump = Refrigerator

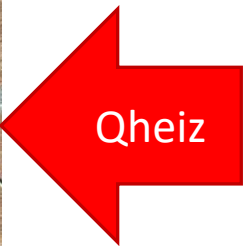


$$\text{COP} = \frac{\textit{benefit}}{\textit{effort}} = \frac{Q_{\text{heat}}}{P_{\text{el}}}$$





# How to recover energy?





# Beispiel aus der Praxis

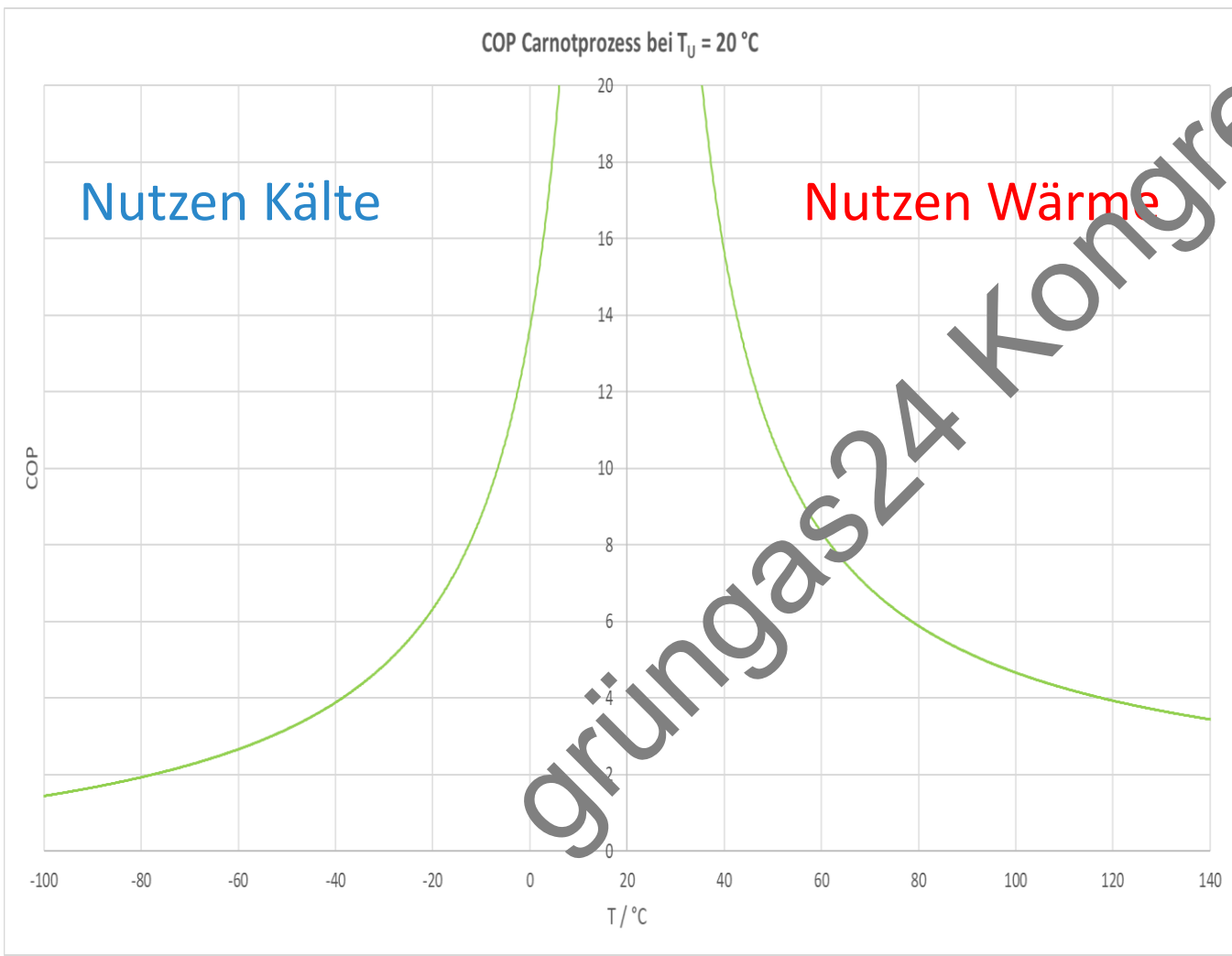
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# Idealer Vergleichsprozess Carnot



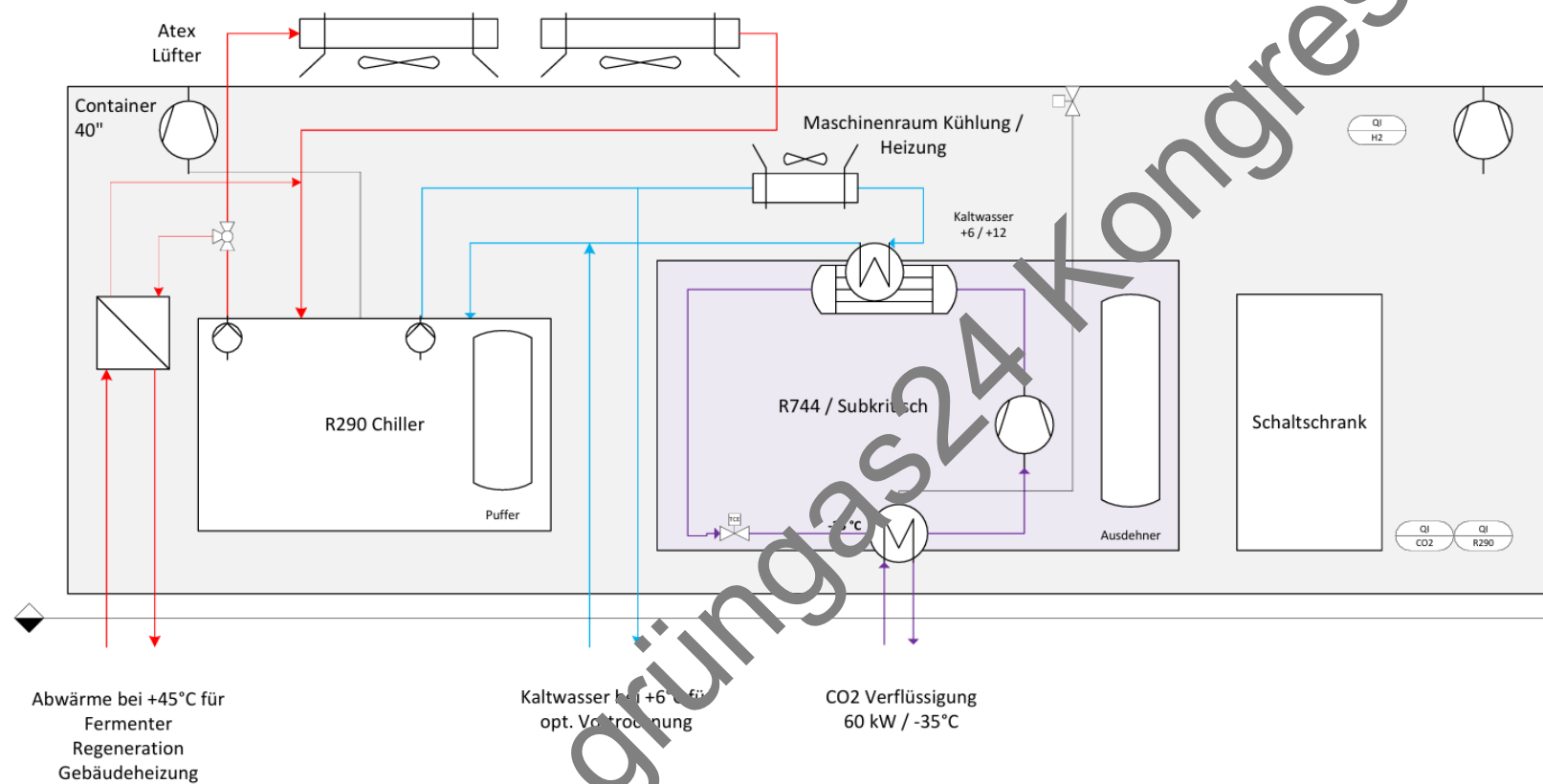
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Für positive Amortisation:

$$\text{COP} > \frac{\text{€ Strom}}{\text{€ Gas}}$$



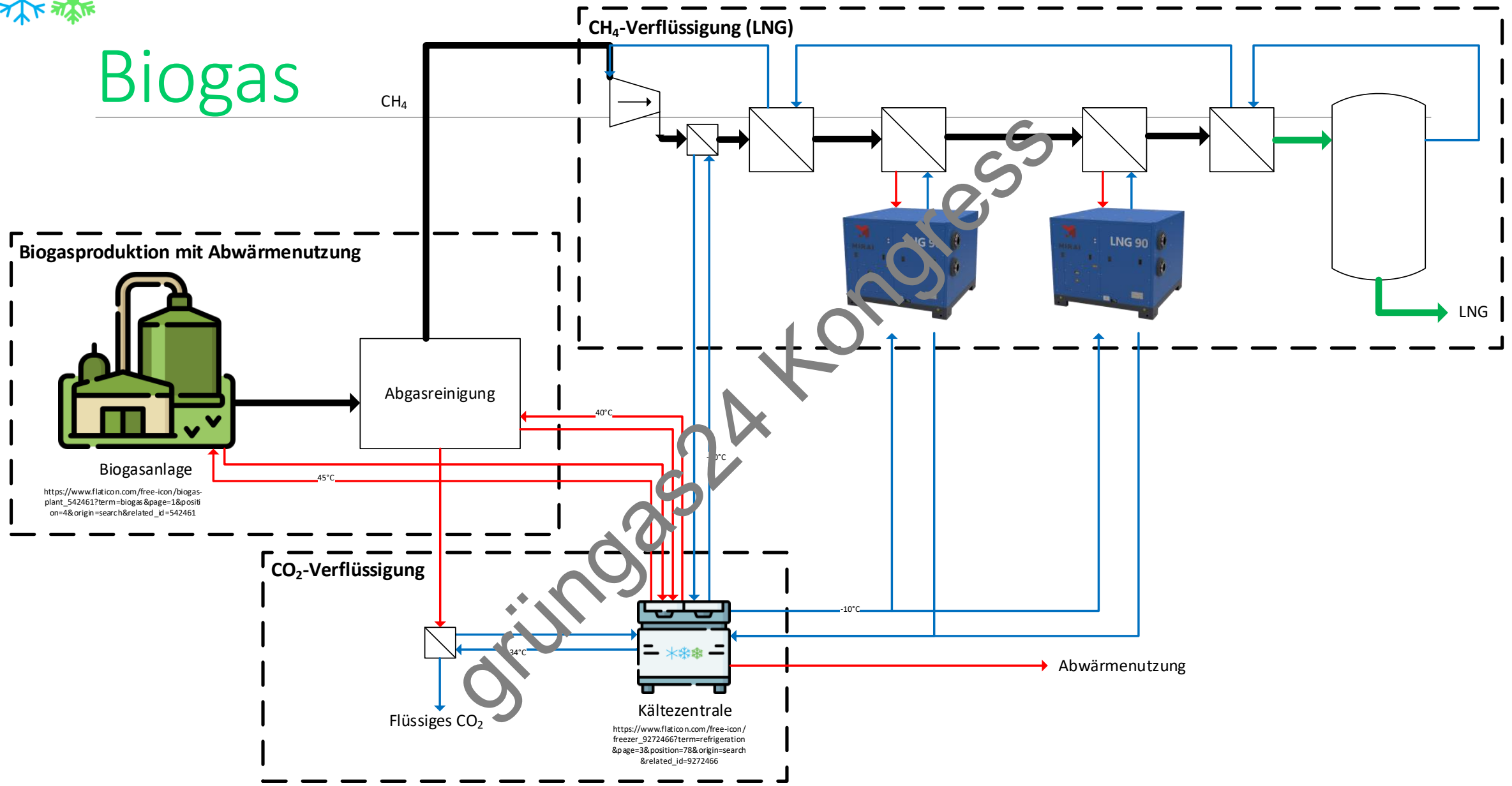
# R&I-Schema der Verflüssigungsanlage von CO2



- Kühlmittel: Propan R290 für Kaltwasser und R744 für CO2-Verflüssigung
- CO2 Verflüssigung: 60 kW / -35°C
- Abwärme: 45°C für Fermenter, Regeneration, Gebäudeheizung



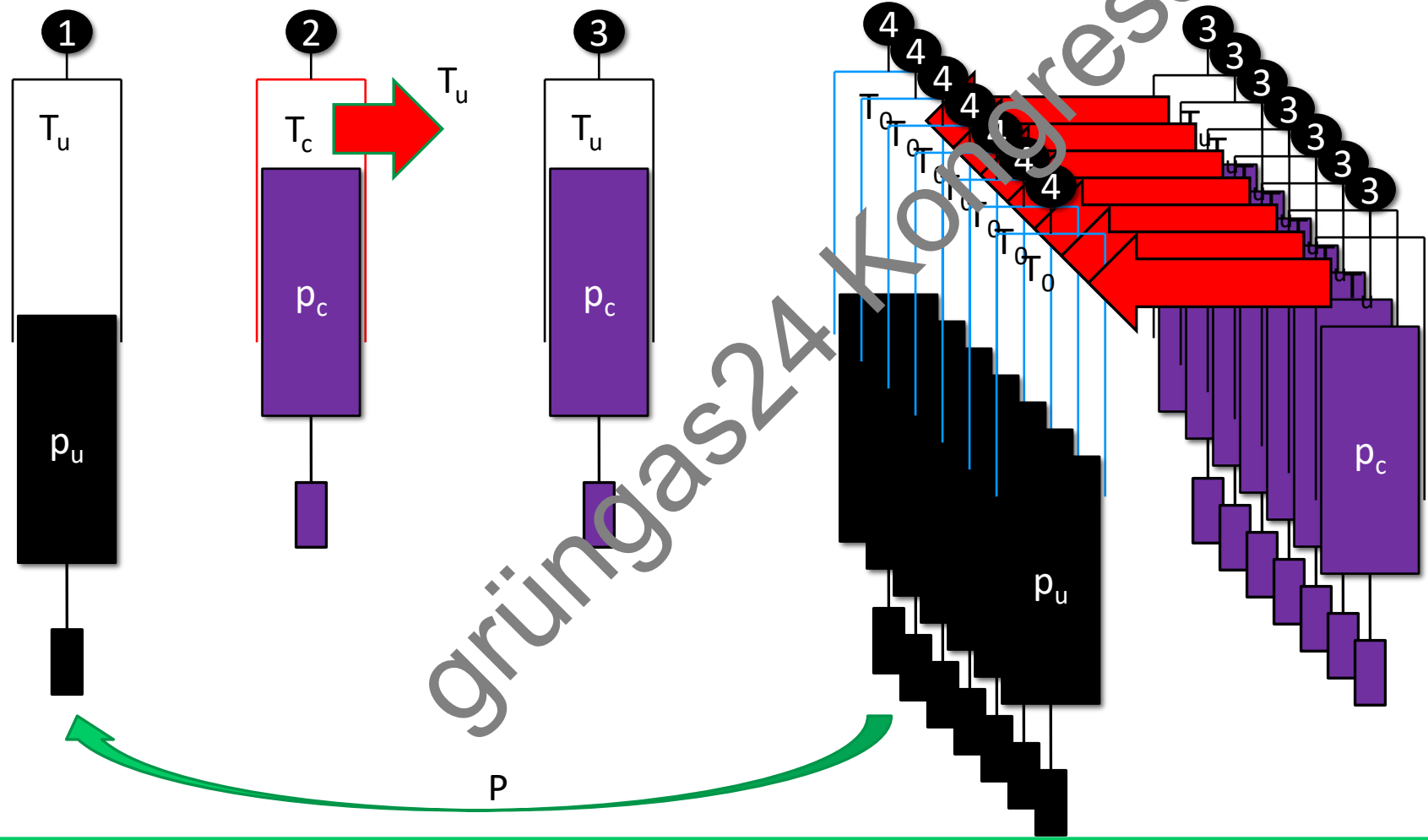
# Biogas





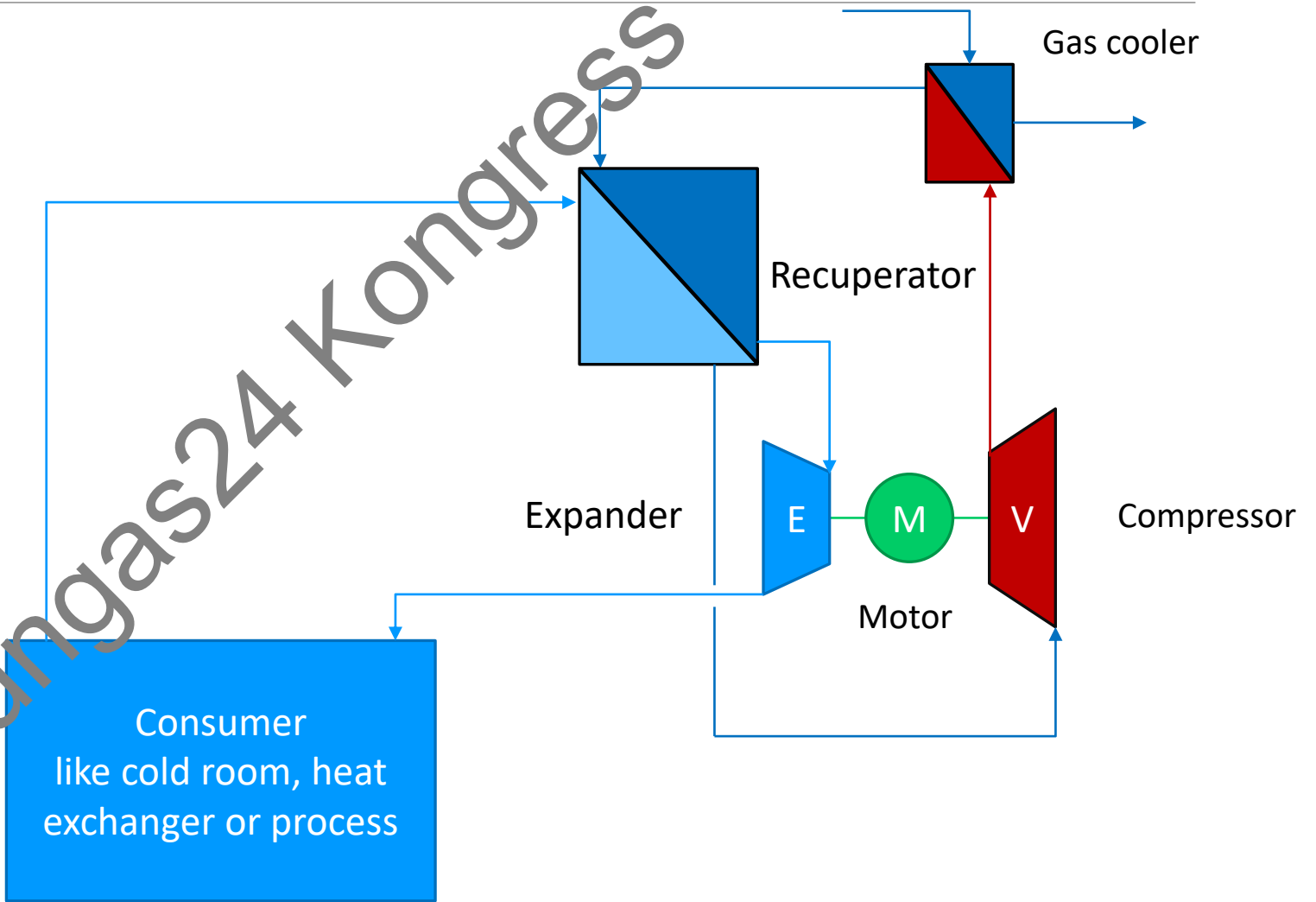
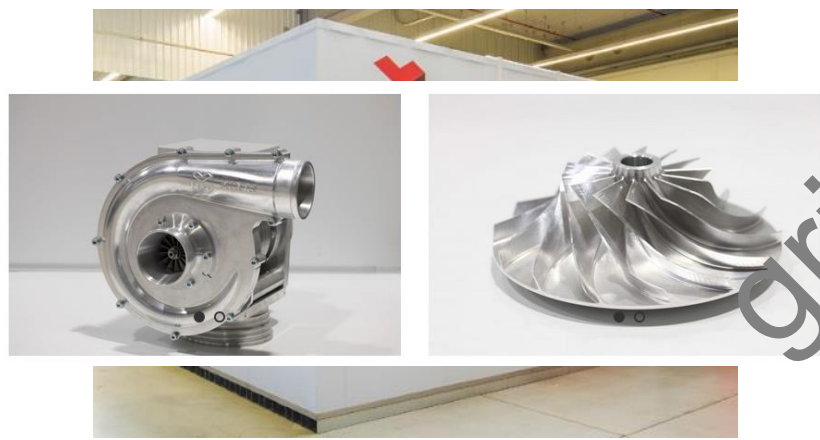
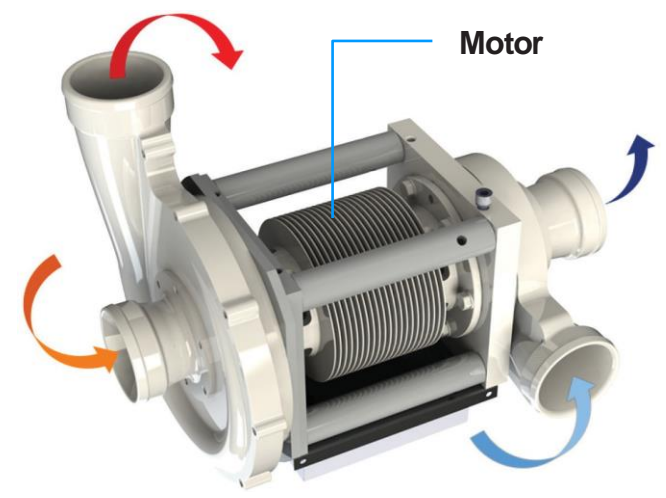
# Thought Experiment

Air pump





# Air refrigeration – Mirai Intex machine





# MIRAI LNG

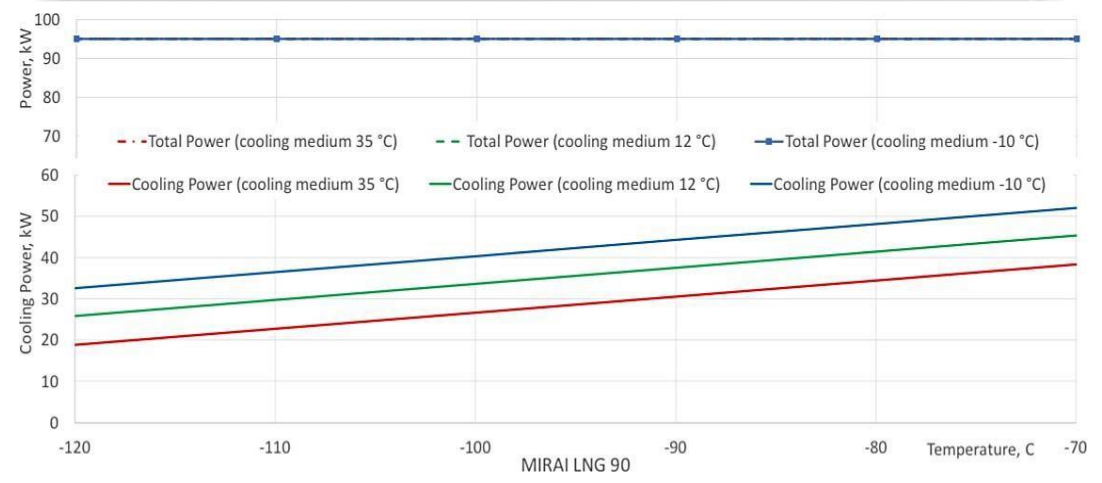
LNG 50

LNG 90

LNG 150



MODEL NAME	MIRAI LNG 90
Refrigerant	Nitrogen (R728)
Temperature range	From -40°C to -150°C
Rated motor power	90 Kw
Power supply	~3 PE+N, 400 V, 50 Hz
Noise level	75 dB
System cooling	Water-cooled
Dimensions (L*W*H)	238 X 232 X 219 Cm
Weight of the machine	3800 Kg
Weight of the electrical cabinet	300 Kg



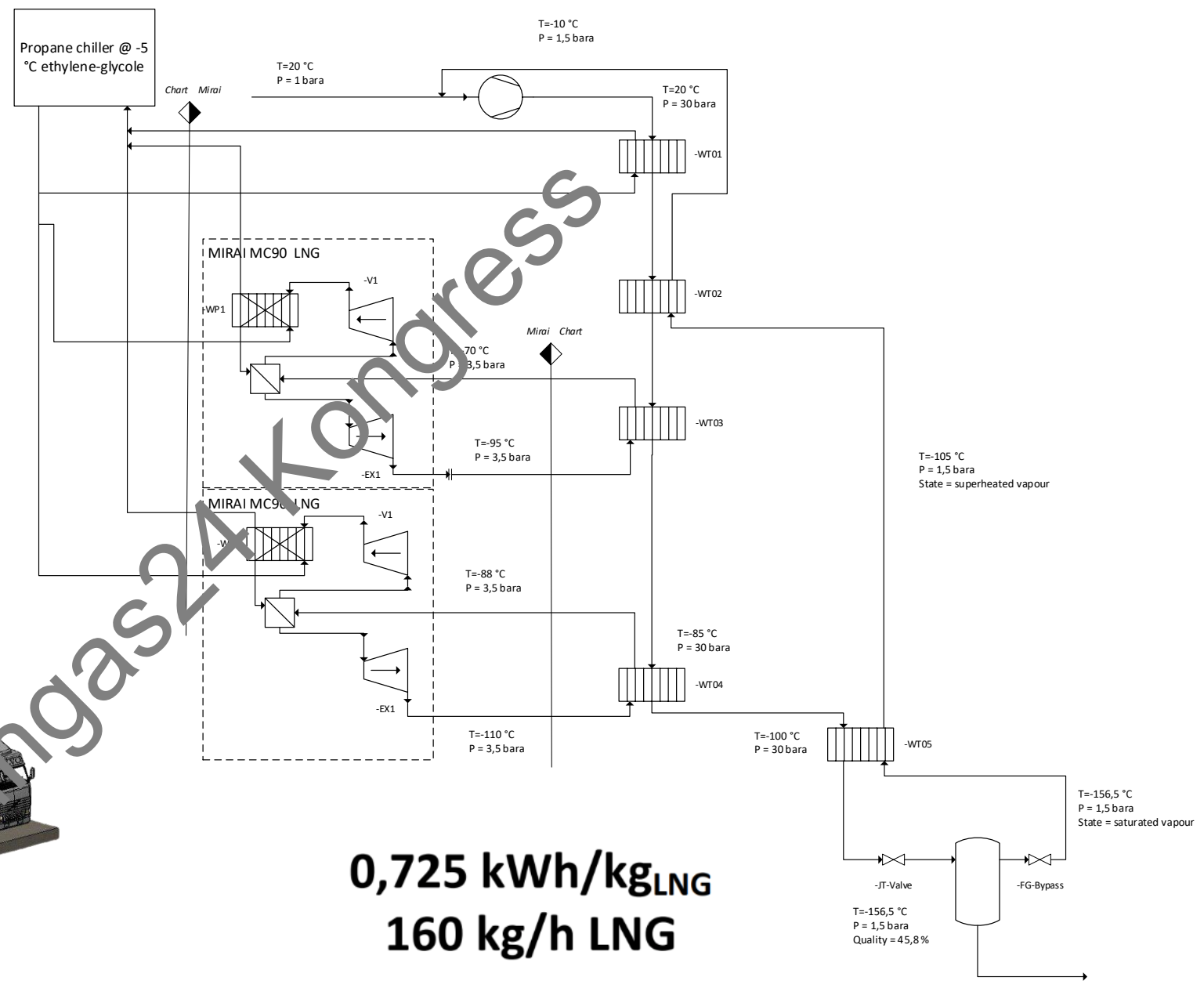
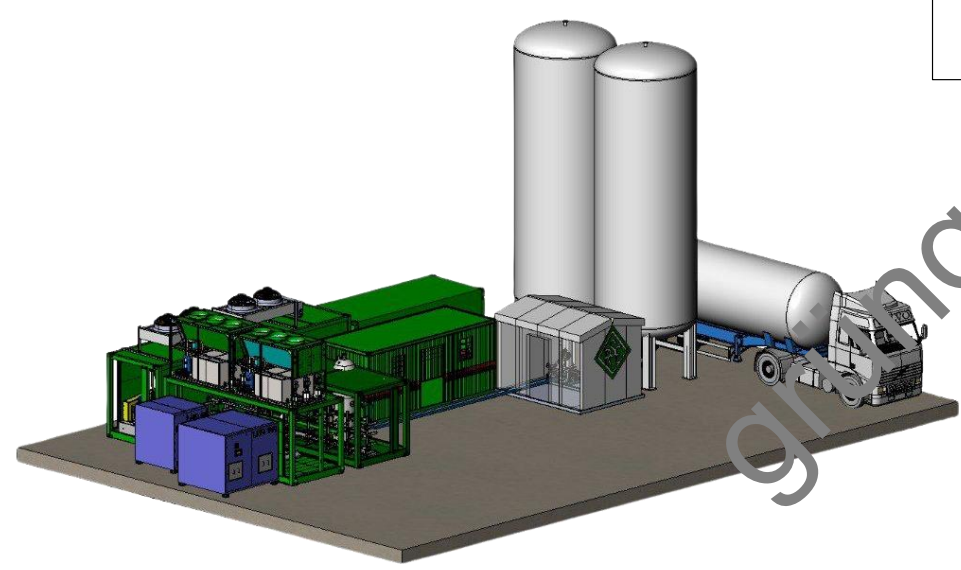


# MC90 LNG90





# Example of process integration

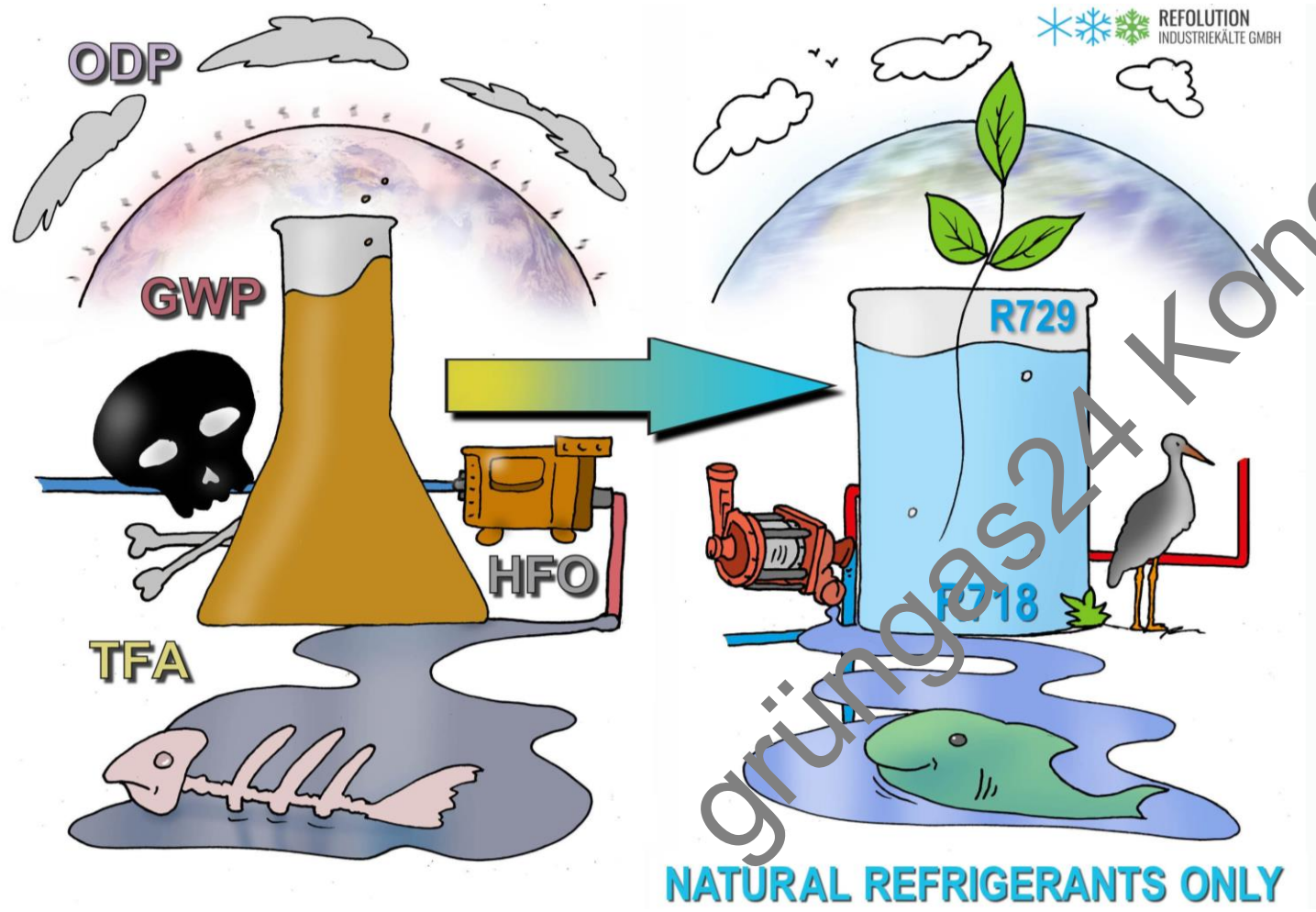


**0,725 kWh/kg<sub>LNG</sub>**  
**160 kg/h LNG**





# It's time for your questions



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