



# CO<sub>2</sub>-freie Mobilität: mehr als elektrisch?

**Christian Bach**

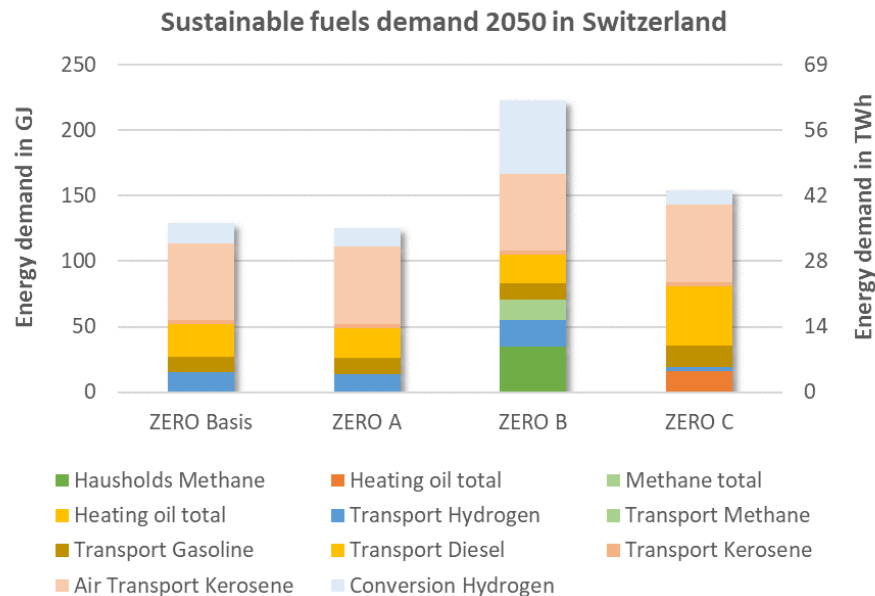
Abteilungsleiter Chemische Energieträger und Fahrzeugsysteme  
Co-Koordinator SWEET-Konsortium reFuel.ch

# Bedarf an nachhaltigen Brenn- und Treibstoffen

Der Bedarf an nachhaltigen Brenn- und Treibstoffen wird in den Energieperspektiven 2050+ des Bundesamtes für Energie (BFE) bis 2050 je nach Szenario auf 110 bis 220 GJ bzw. **30 bis 60 TWh/Jahr** geschätzt.

ZERO Basis: intensive Elektrifizierung  
ZERO A: intensive Elektrifizierung  
ZERO B: inkl. erneuerbare Gase (PtH<sub>2</sub>/PtG)  
ZERO C: inkl. erneuerbare flüssige Brenn-/Treibstoffe (PtL)

Es wird davon ausgegangen, dass **>90 % davon importiert** werden müssen.



# Oman Projektinitiative: Policy support

## Memorandum of Understanding

Unterzeichnet im November 2023

## Collaboration letter

Unterzeichnet im November 2023

## Implementation programme

Unterzeichnet im Mai 2025

## Letter of Intent

Unterzeichnet im Dezember 2025

MEMORANDUM OF UNDERSTANDING  
BETWEEN  
THE FEDERAL OFFICE OF ENERGY OF THE SWISS CONFEDERATION  
AND  
THE MINISTRY OF ENERGY AND MINERALS  
OF THE SULTANATE OF OMAN  
IN THE FIELDS OF SUSTAINABLE AND RENEWABLE ENERGY AND  
RENEWABLE ENERGY TECHNOLOGIES

Stemming from the distinguished relations between the Swiss Confederation and the Sultanate of Oman, and the desire of both countries to continue promoting and developing cooperation between them in the fields of sustainable and renewable energy, and in light of the discussions held between Swiss and Omani sides, the Federal Office of Energy of the Swiss Confederation and the Ministry of Energy and Minerals of the Sultanate of Oman, (hereinafter referred to jointly as the "Partners") have agreed to the following:

### Paragraph 1

This Memorandum aims to develop a bilateral cooperation in the fields of sustainable and renewable energy and sustainable and renewable energy technologies for the purpose of achieving the following objectives:

1. Promote autonomous initiative in the private sector of both countries to encourage scientific and technical assistance and joint transport, storage and distribution.
2. Facilitating the interaction for the implementation of knowledge and best practices in sustainable and renewable energy, efficiency, and decarbonization.



## IMPLEMENTATION PROGRAMME OF THE MEMORANDUM OF UNDERSTANDING BETWEEN THE MINISTRY OF ENERGY AND MINERALS OF THE SULTANATE OF OMAN AND THE FEDERAL OFFICE OF ENERGY OF THE SWISS CONFEDERATION IN THE FIELDS OF SUSTAINABLE ENERGY AND SUSTAINABLE ENERGY TECHNOLOGIES

Driven by the desire to strengthen the friendly relations, promote cooperation in the fields of sustainable and renewable energy, as well as its technologies, the Ministry of Energy and Minerals of the Sultanate of Oman and the Federal Office of Energy of the Swiss Confederation, agreed in Muscat on 30 November 2023.

As the "Omni Party" and the Federal Office of Energy of the Swiss Confederation referred to (hereinafter referred to as the "Swiss Party"), hereinafter referred to together as the "Partners", have agreed to facilitate the following Implementation Programme (the "Programme") by Omani and Swiss Implementing Partners (the "Partners"). Partners can be government entities, state-owned companies, private sector companies, business associations, academia & research institutions.

### ARTICLE (1) OBJECTIVE

The objective of this Programme is to activate the bilateral MoU in the fields of sustainable energy and sustainable energy technologies of 30 November 2023 for the coming two years, and to support the concretization of activities between the Partners of the Parties.

### ARTICLE (2) PROGRAMM SCOPE OF WORK

As part of fulfilling the Objectives, Parties agree to facilitate the implementation of the following points:

1. **FX-synthesis processes (e.g. methanation)**
  - Share experience and knowledge in methanation process, research and pilot studies conducted by;
  - Share local experiences and efforts to realize methanation projects locally.
2. Conduct joint academic research in the field of methanation by organizing at least once a year academic workshop
3. Organize at least two knowledge sharing sessions

Embassy of  
The Sultanate of Oman  
Bern

Mr. Christian Bach  
Head of Automotive Powertrain  
Technologies Laboratory  
EMPA  
Lindenstrasse 129  
8600 Dübendorf - Switzerland  
Bern, 6th of November, 2023

Subject: **Agreement for collaboration**

Dear Mr. Bach,

Further to my last visit, along with Dr. Anika Kastner from the Oman-Swiss Friendship Association (OSFA), on last April, to your Federal Laboratory for Materials Science and Technology (EMPA), for discussing possible cooperation, the Embassy is delighted to kindly inform you that the Ministry of Energy and Minerals of the Sultanate of Oman has given officially its approval to collaborate with your Laboratory in the field of information exchange.

The focal point person responsible of the cooperation in this field is:  
Mrs. Sultana Bina HANADOO AL HASANI, Engineer in charge of electrical energy at the Department of Renewable Energy and Hydrogen Studies.  
Email: sultana.b.alhasani@mem.gov.om

The Embassy hopes that this will lead to open the perspectives of promising fruitful cooperation and will be pleased to bring any assistance in the future in this regard.

Please, accept Dear Mr. Bach, the expression of our best consideration.

The Ambassador  
rahmadood AL HASANI



LETTER OF INTENT

Sulphur Port and Freezone  
Port and Freezone  
Sulphur 127 (Oman)  
(hereinafter referred to as "Sulphur Port and Freezone")

and

Empa  
Head of refuel.ch Consortium and coordinator Switzerland-Oman Cooperation  
Chemical Energy Carriers and Vehicles Systems Laboratory  
Lindenstrasse 137  
8600 Dübendorf (Switzerland)  
(hereinafter referred to as "Empa")

In the following, the above-mentioned signatures may be referred to individually as "Party" or collectively as "Parties".

1. **Preamble**

Port of Sulphur and Freezone is a fully integrated industrial along global trade routes between Europe and Asia. Operated by the ADNOC Group and the Port of Rotterdam, it is a long-term partnership, designed to stimulate investment in key technologies, designed to stimulate investment in key technologies and a member of the T10 Cluster, comprising research institutions across Switzerland, along with the research institution (see [www.refuel.ch/en/empa](https://www.refuel.ch/en/empa)) as the lead institution (see [www.refuel.ch/en/empa](https://www.refuel.ch/en/empa)) in the six-year period (2024-2030), the consortium aims to develop platform chemicals for Switzerland. Empa represents the platform chemicals for Switzerland. Empa represents the platform chemicals for Switzerland.

Within the refuel.ch consortium, an initiative was born to develop a project for H<sub>2</sub>CO<sub>2</sub> Renewable Fuels of Net-zero synthetic drop-in fuels, such as methane, a gas with Swiss regulatory frameworks for CO<sub>2</sub> reduction obligations.

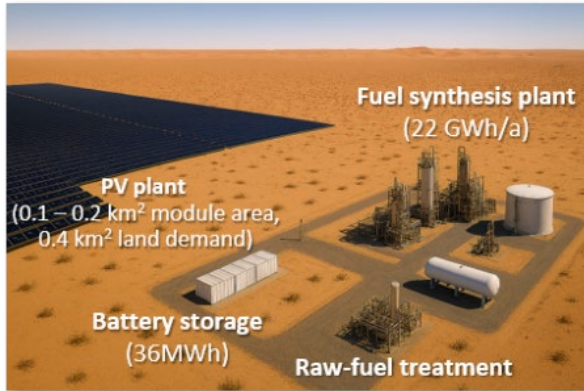


# Oman Projektinitiative – Review/Diskussionspartner



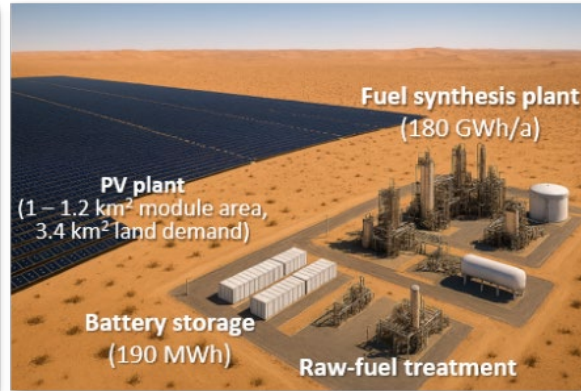
# Skalierungsansatz

**Stufe 1 (25 MW<sub>el</sub>)**  
Port of Sohar and Freezone



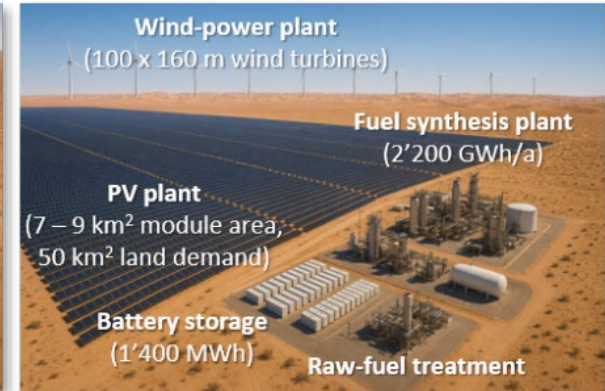
Invest: 74 Mio CHF  
Betrieb: 2030 - 2040

**Stufe 2 (200 MW<sub>el</sub>)**  
Duqm (Hydrom auction)



Invest: 310 Mio CHF  
Betrieb: 2035 - 2055

**Stufe 3 (2'000 MW<sub>el</sub>)**  
Duqm (Hydrom auction)

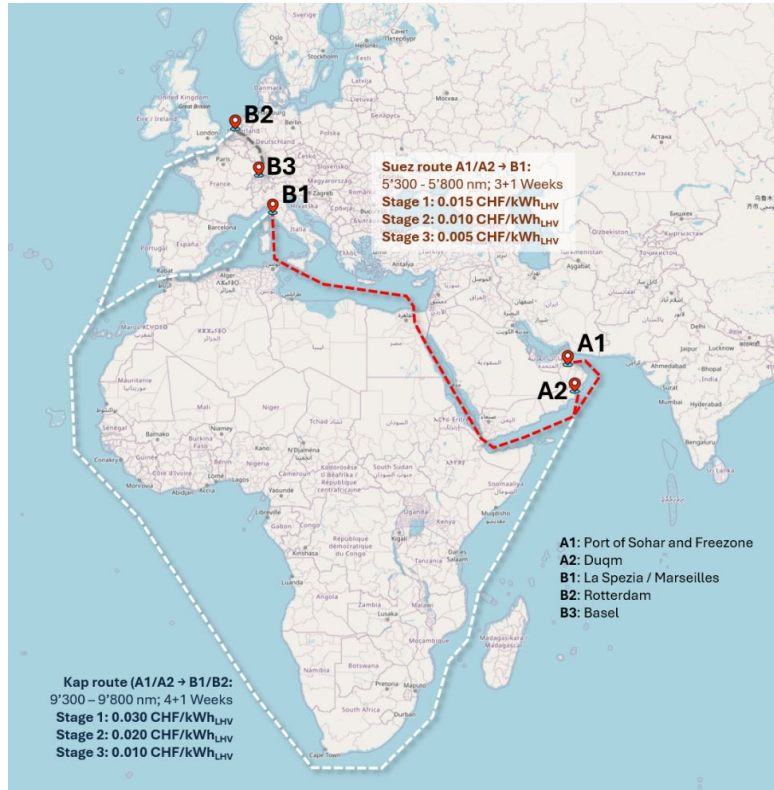


Invest: 2'100 Mio CHF  
Betrieb: 2040 - 2060

- Herstellung von erneuerbaren Kraftstoffen nicht-biogenen Ursprungs (RFNBO)
- Zertifiziert nach der ISCC-EU-Richtlinie für erneuerbare Energien III (RED-III)
- Massensilanzierter Transport nach Europa/Schweiz

# Transport nach Europa/Schweiz

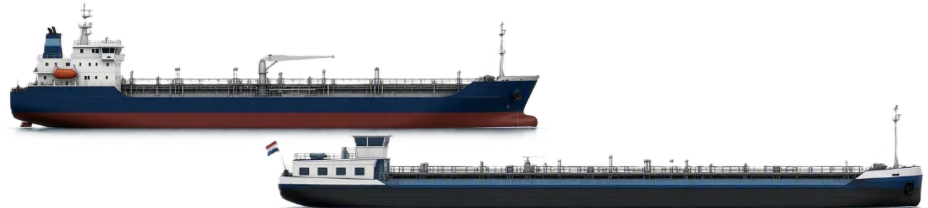
preliminary results



Stufe 1-Anlage: 1 x monatlich 20 ISO-Container nach Basel



Stufe 2-Anlage: 1 x monatlich 4'000 m<sup>3</sup> Produkttanker nach Rotterdam mit Umladen auf Rheinschiff und Transport nach Basel



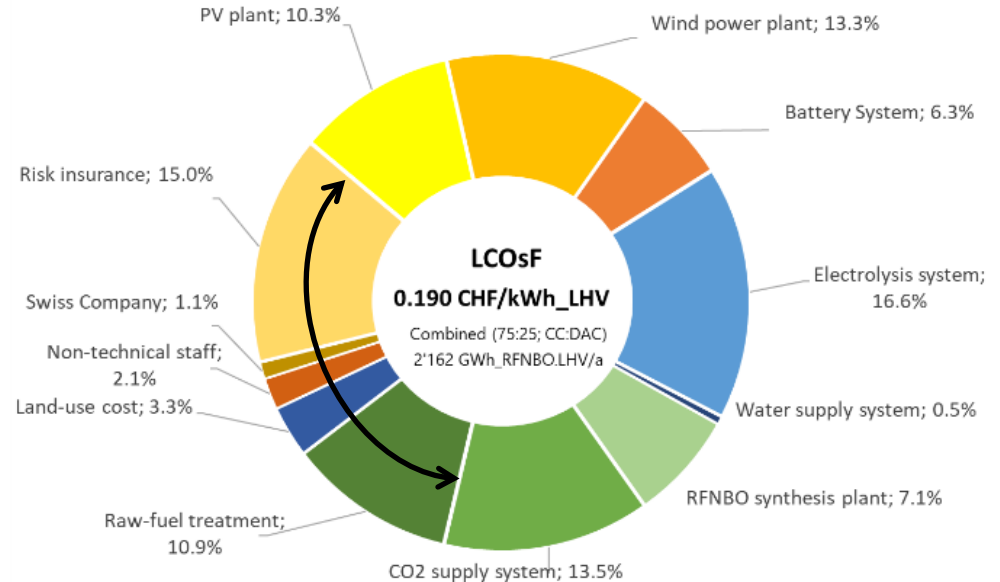
Stufe 3-Anlage: 1 x monatlich 50'000 m<sup>3</sup> Tanker nach Marseille/Fos-sur-Mer und Einspeisung in Pipeline



# Gestehungskosten Stage 3-Anlage

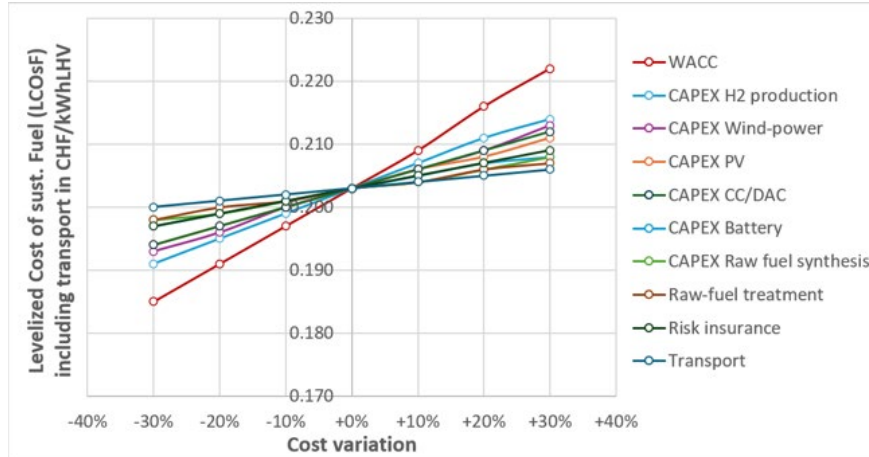
preliminary results

Die Gestehungskosten strombasierter nachhaltiger Brenn- und Treibstoffe setzen sich aus verschiedenen Positionen zusammen, die im Rahmen der Pre-Feasibility Studie analysiert wurden. Zusätzlich zu den Kostenpositionen des Global PtX Atlas (Fraunhofer Institut IEE) wurden weitere Kostenpositionen berücksichtigt (schwarzer Pfeil).

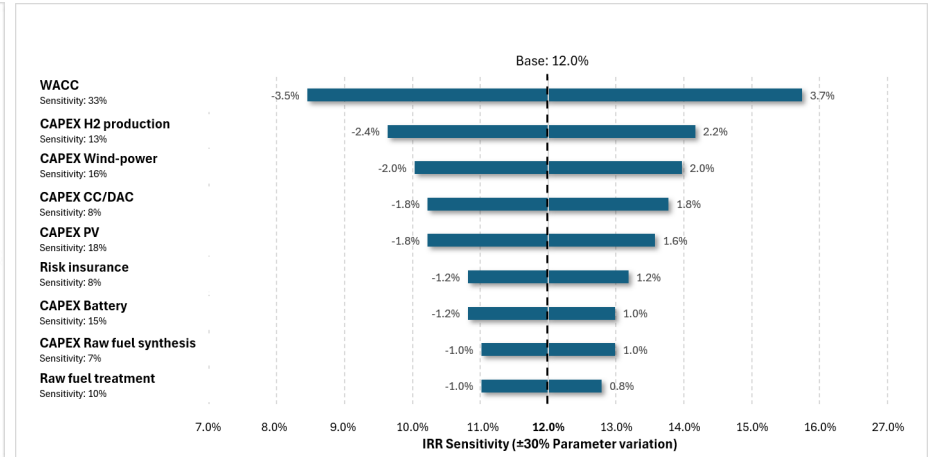


# Sensitivitäten Stage 3-Anlage

preliminary results



Gestehungskosten

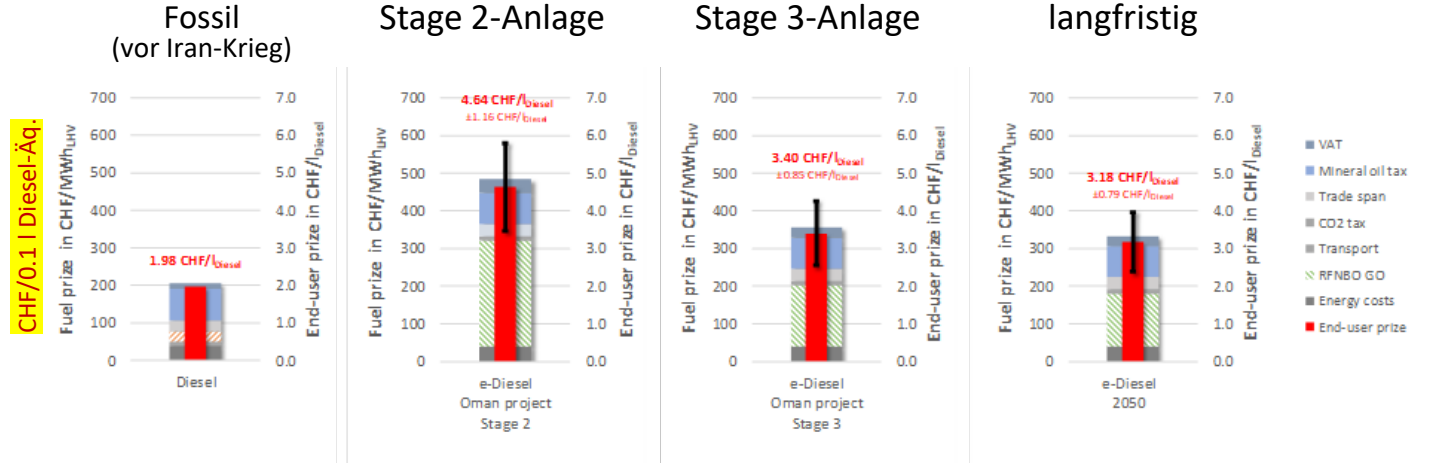


Internal Return Rate  
(WACC 8%)

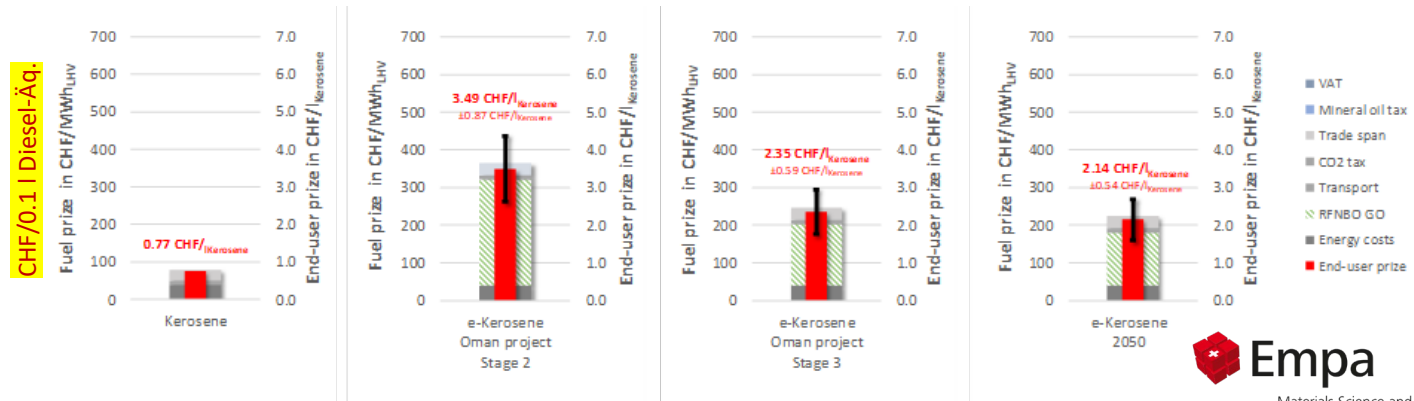
# Marktintegration

preliminary results

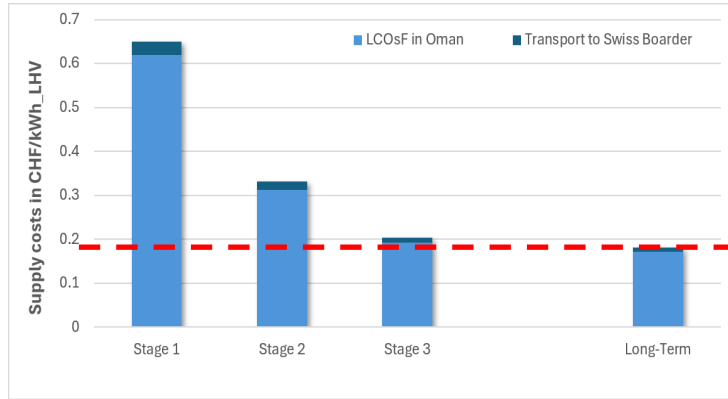
Diesel:  
(inkl. MinÖSt)



Kerosin:

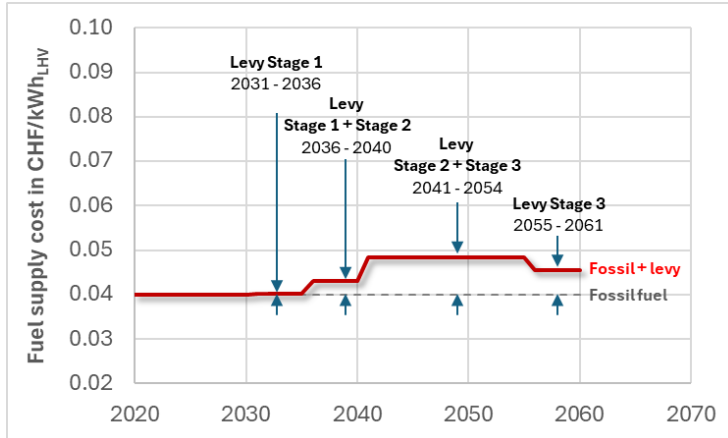


# Umlagemodell



Umlage

Offtake-Preis (long-term-orientiert)



## Umlage für Offtaker mit 1 TWh Marktvolumen

- Offtake: 10% Stage 1 (2 GWh<sub>LHV</sub>/a)  
10% Stage 2 (18 GWh<sub>LHV</sub>/a)  
10% Stage 3 (216 GWh<sub>LHV</sub>/a)
- Umlage auf verbleibende fossile Energie im Bereich im Mittel 0.005 CHF/kWh<sub>LHV</sub>

# Vielen Dank für die Aufmerksamkeit

Verdankung: Dr. Patrik Soltic  
Dr. Nikolaus Thumm

Kontakt:  
[christian.bach@empa.ch](mailto:christian.bach@empa.ch)