SAREP

Sahara Renaissance Project

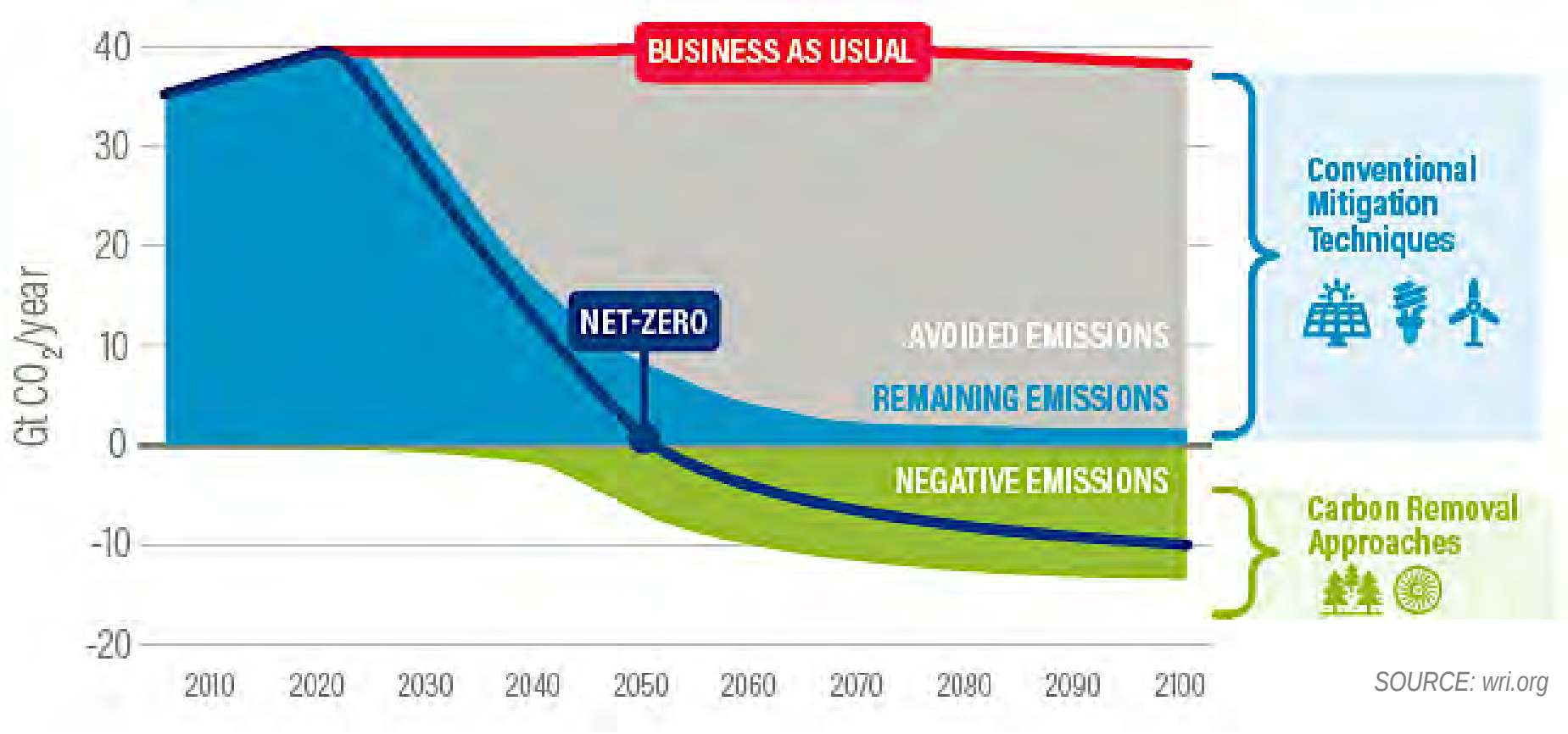
Prof. Dr. Peter Heck
CEO SAREP, CEO IfaS

ICEW 6.11.2024

IfaS

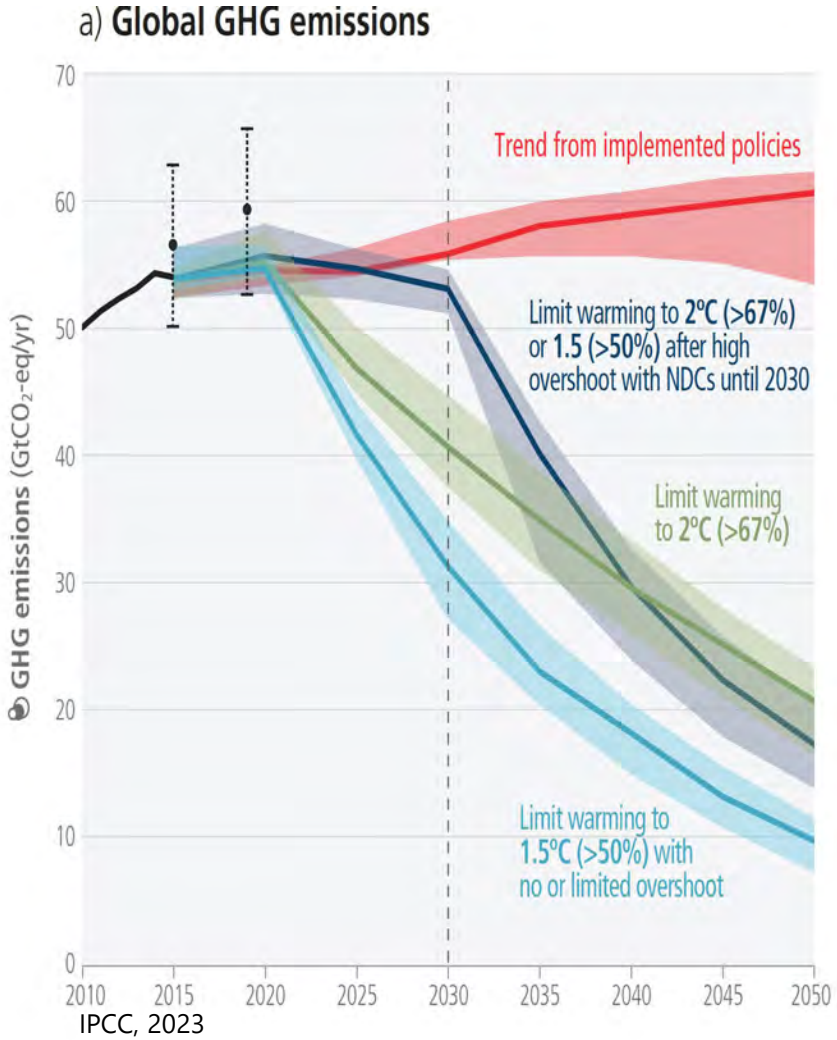
SYNLIFT
industrial products

The international relevance of Carbon removal



SOURCE: wri.org

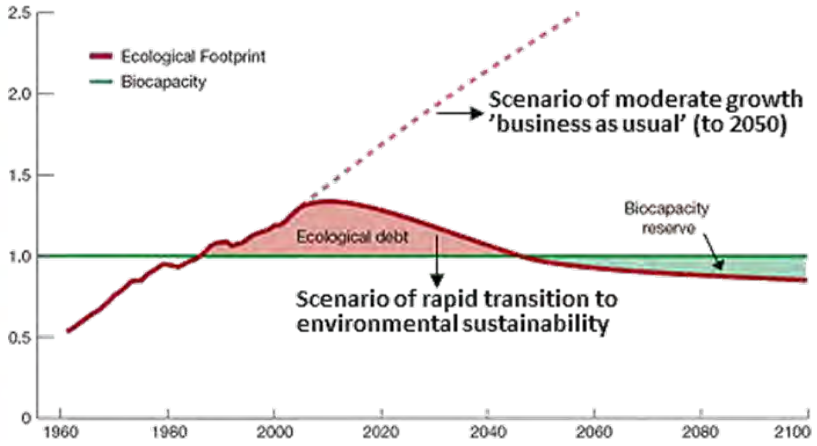
Global Challenges: insufficient policy but room for private investment



IPCC, 2023

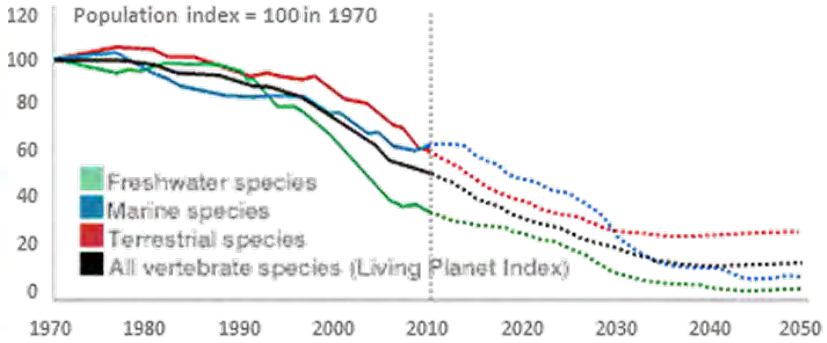
Global Biocapacity and Ecological Footprint

By scenarios of ecological footprints, in number of Earths needed



Global Biodiversity and Species Loss

By groups of species, in percentage change in species population

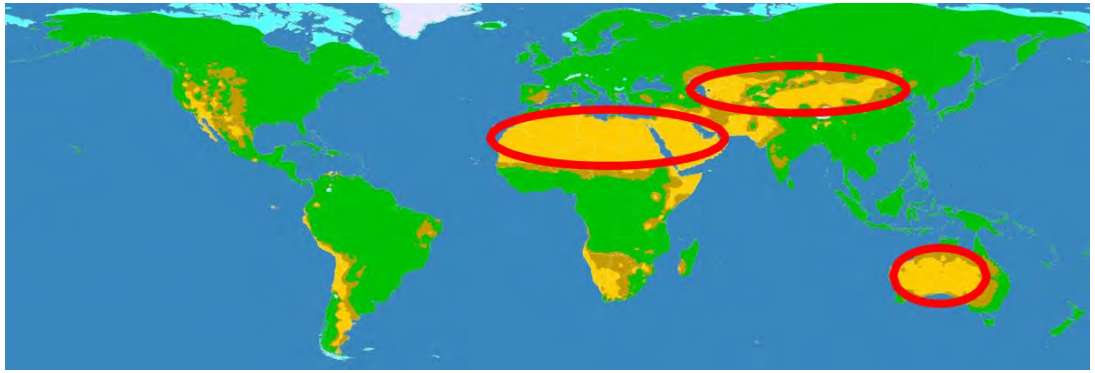


Global Poverty and Migration Crisis

- Trade GHG emissions
- Merge biodiversity & ecotourism
- Supply biogenic materials

Sources: Institute for Atmospheric and Climate Science (IACETH), World Wide Fund for Nature (WWF), Zoological Society of London (ZSL), United Nations Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC), Global Footprint Network (GFN).

Soil carbon sequestration



- Soil carbon sequestration (SCS) describes methods of soil cultivation which increases the organic carbon content of soil, by capturing atmospheric CO_2
- Soils contain approx. 2,600 billion tonnes of carbon. This is roughly ***three times more than in the atmosphere***
- Small changes in carbon storage in soil can have a massive impact on CO_2 concentration in the atmosphere

Desert soils as carbon storage can be a game changer!

THIS AREA COULD BE A GREEN CARBON STORAGE AND BIOMASS PRODUCING LAND

- **Storing up to 160 t CO_2/ha/year**
- **Producing approx. 2,000 litre biofuel/ha/year**
- **Producing up to 80 t dry matter woody biomass/year/ha**
- **Generating 2,000 jobs per 10,000 ha**

Solution Overview | Greening the Desert

Input

Desalinated Seawater
(Use of renewable energies)
Drip Irrigation/Fertigation

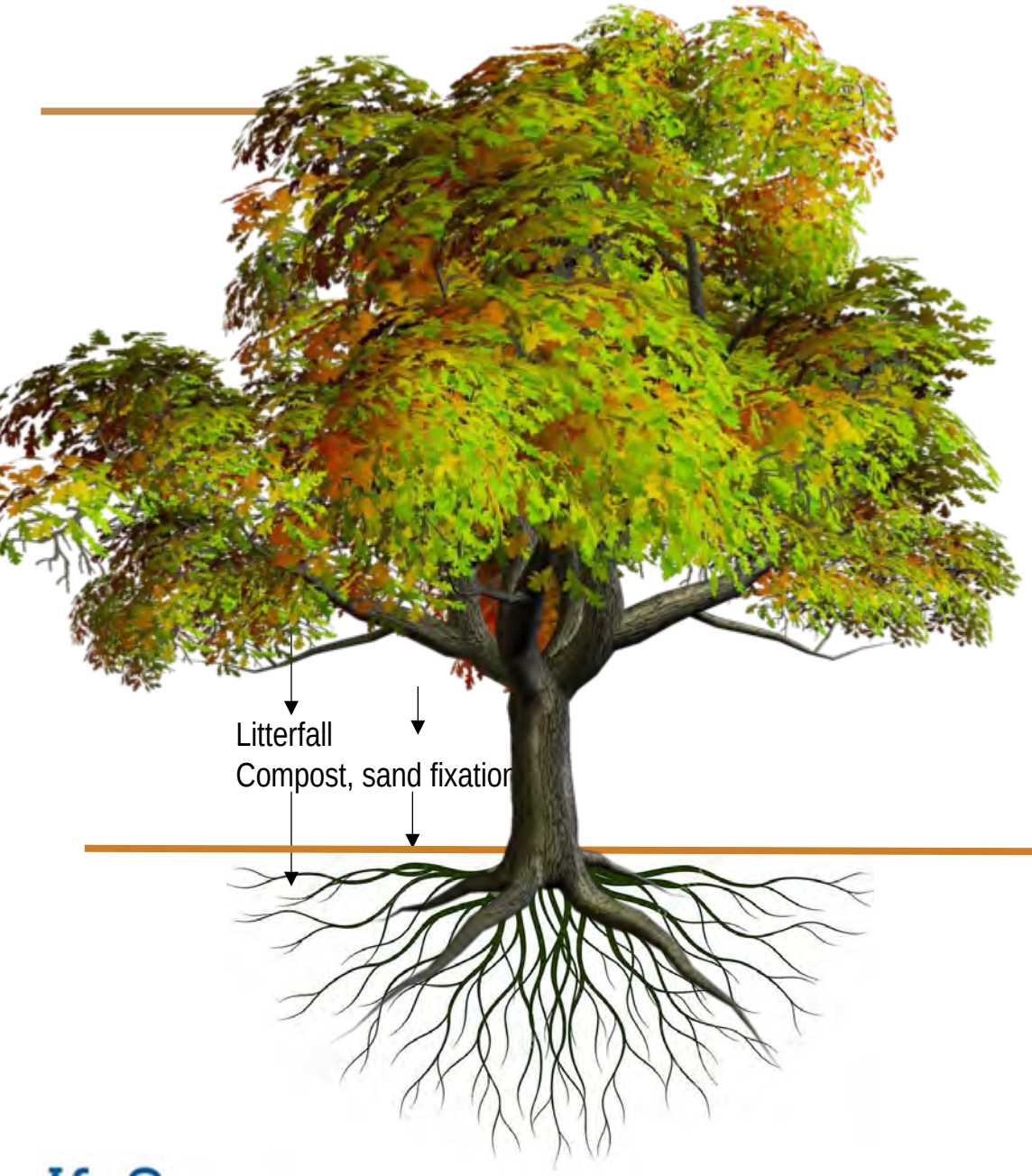
Nutrients (N, P, K)

Plant Growth

Output

Carbon sequestration

Biomass (biofuel, plant oil, feed and food, timber, wood pellets, biochar etc.)



DM

75 %

25 %

60 % timber

40 % slabs, crown, branches, bark

charcoal

Soil fertility

Longterm C-sink

SOC

Biocoenosis
Organic life
around charcoal

IfaS Institut für angewandtes Stoffstrommanagement

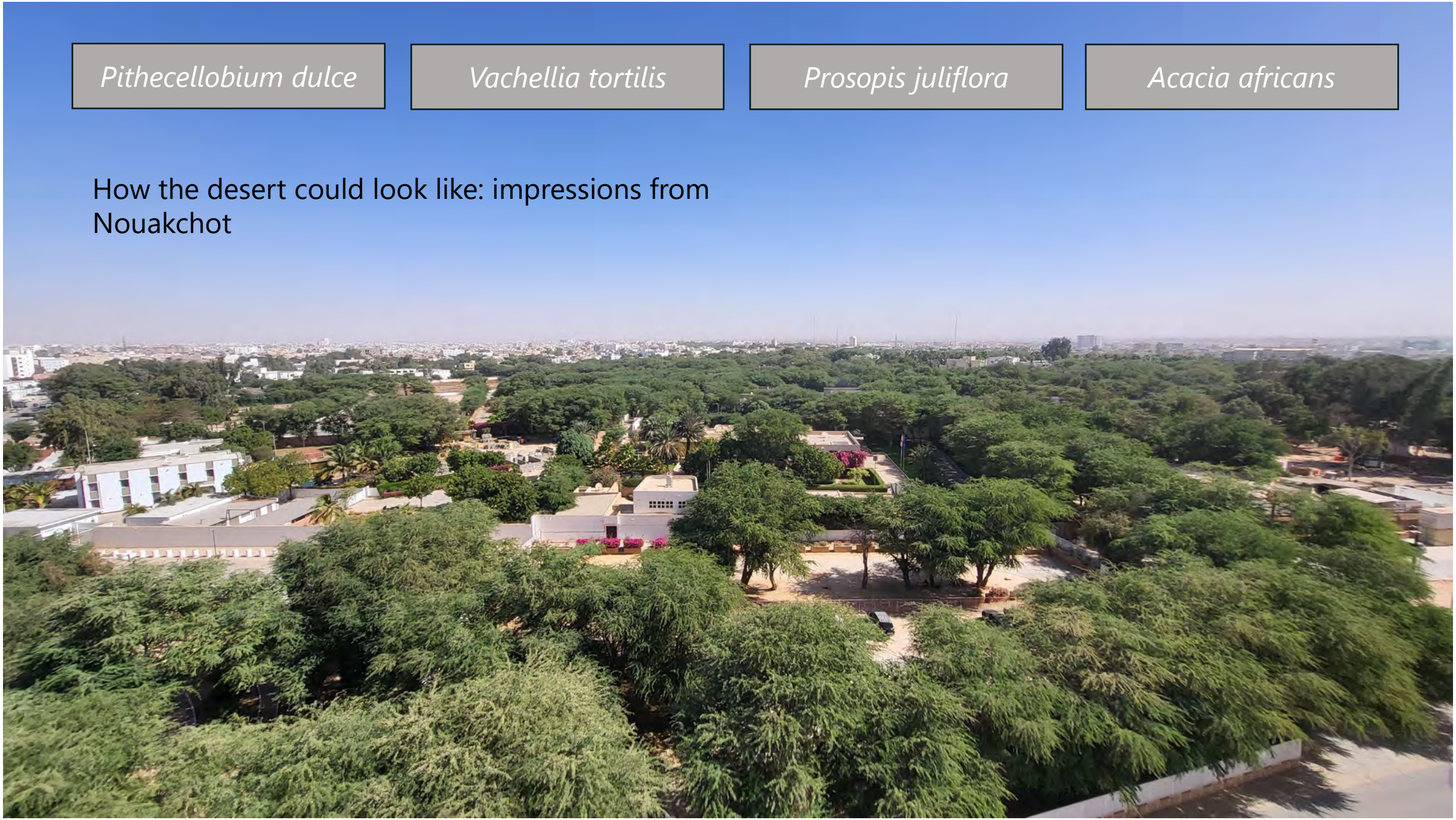
Pithecellobium dulce

Vachellia tortilis

Prosopis juliflora

Acacia africans

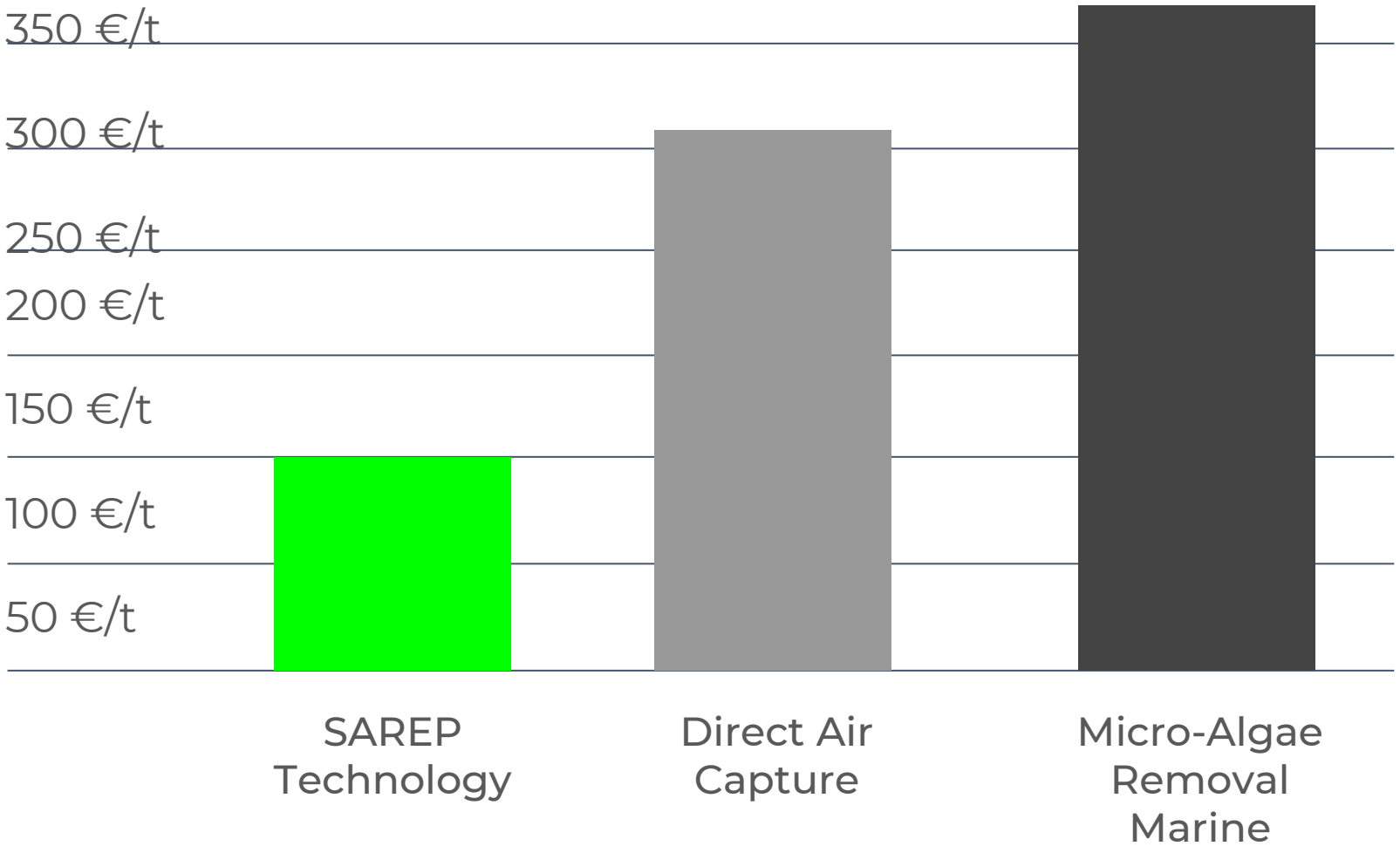
How the desert could look like: impressions from Nouakchot




Acacia africans

SAREP Technology is 3x less expensive then existing solutions

Carbon Offset Price €/t CO2 in 2023

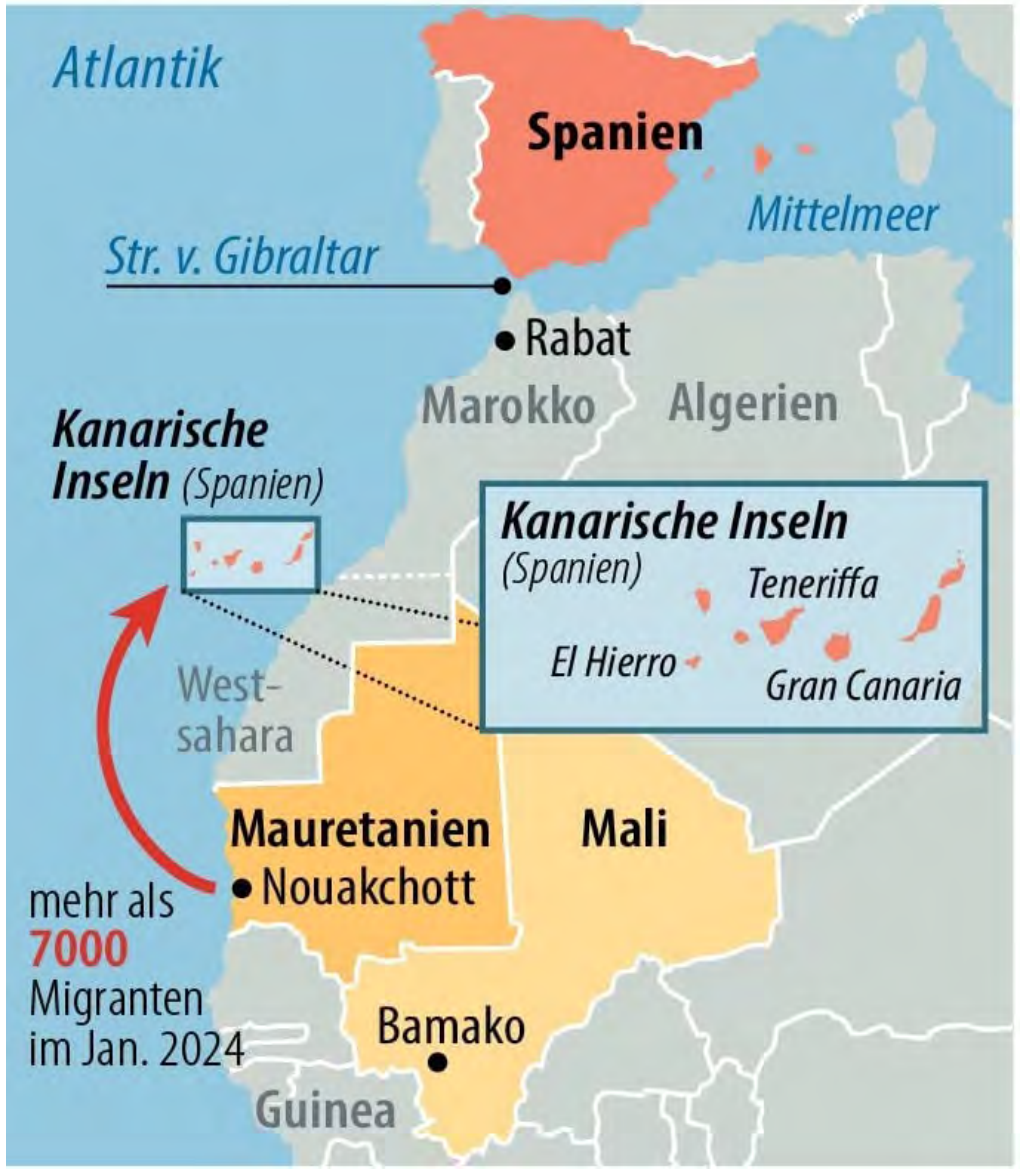


SAREP Technology is:

- 3x less expensive than existing solutions
- is highly scalable, due to little to non proprietary technology
- thus presents the most efficient way to capture CO2 on scale

Why Mauretania?

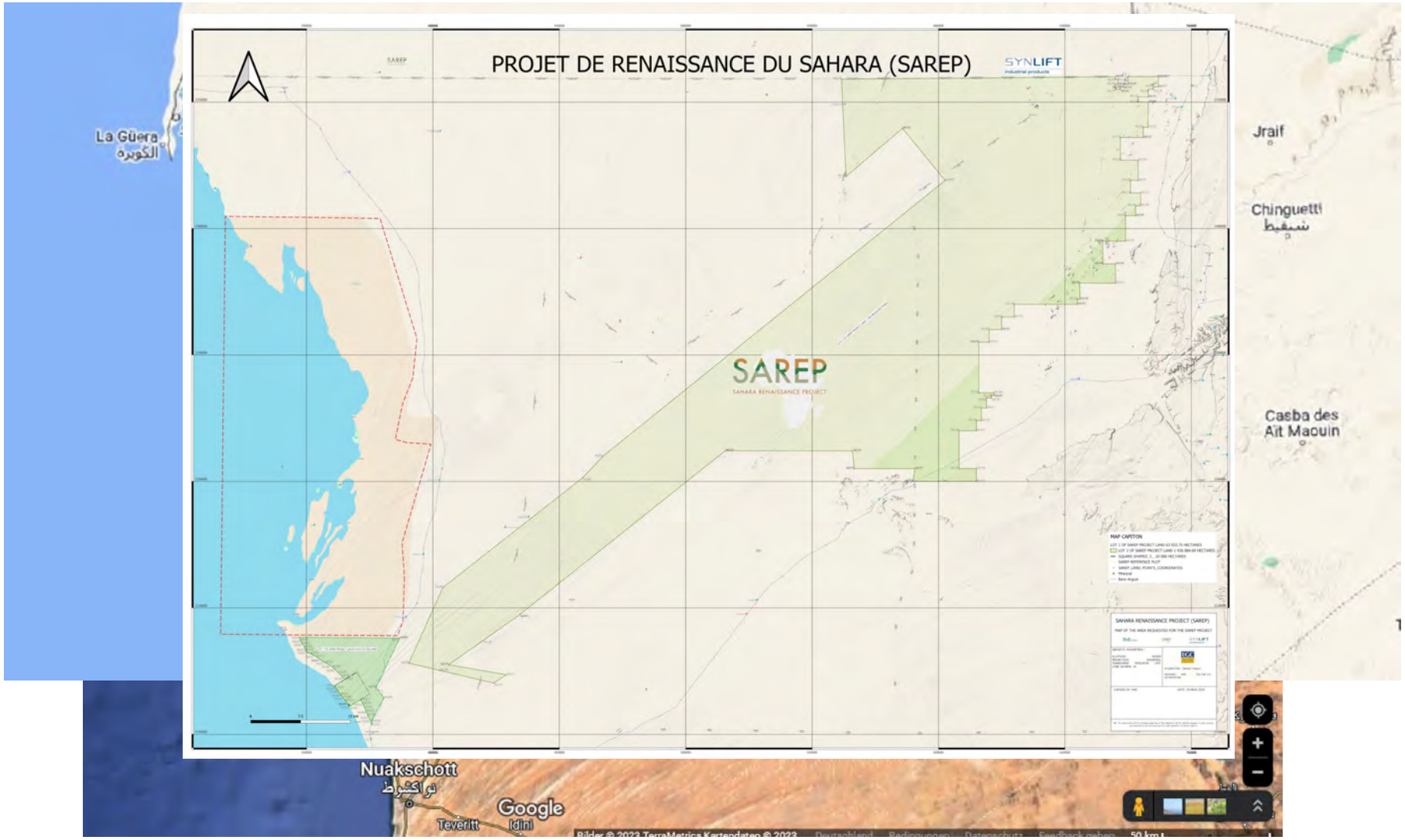
- Mauretania one of the most seriously affected countries by climate change
- Mauretania suffering from refugee crisis
- Mauretania as a starting point for illegal migration to Europe
- Mauretania with logistical options for mineral resources, hydrogen and biogenic commodities
- Mauretania with a huge potential in water, renewable energies and land



Zone du projet

Côte de la Mauritanie (2,000,000 ha)

Initial Project Region




TA

Example: Jatropha curcas | High yield through fertigation

https://www.exot-nutz-zier.de/images/prod_images/Jatropha_curcas2.jpg
Prof. Klaus Becker, Universität Hohenheim

Up to 6t of nuts per ha = up to 2,000 liter of oil and 4t of presscake

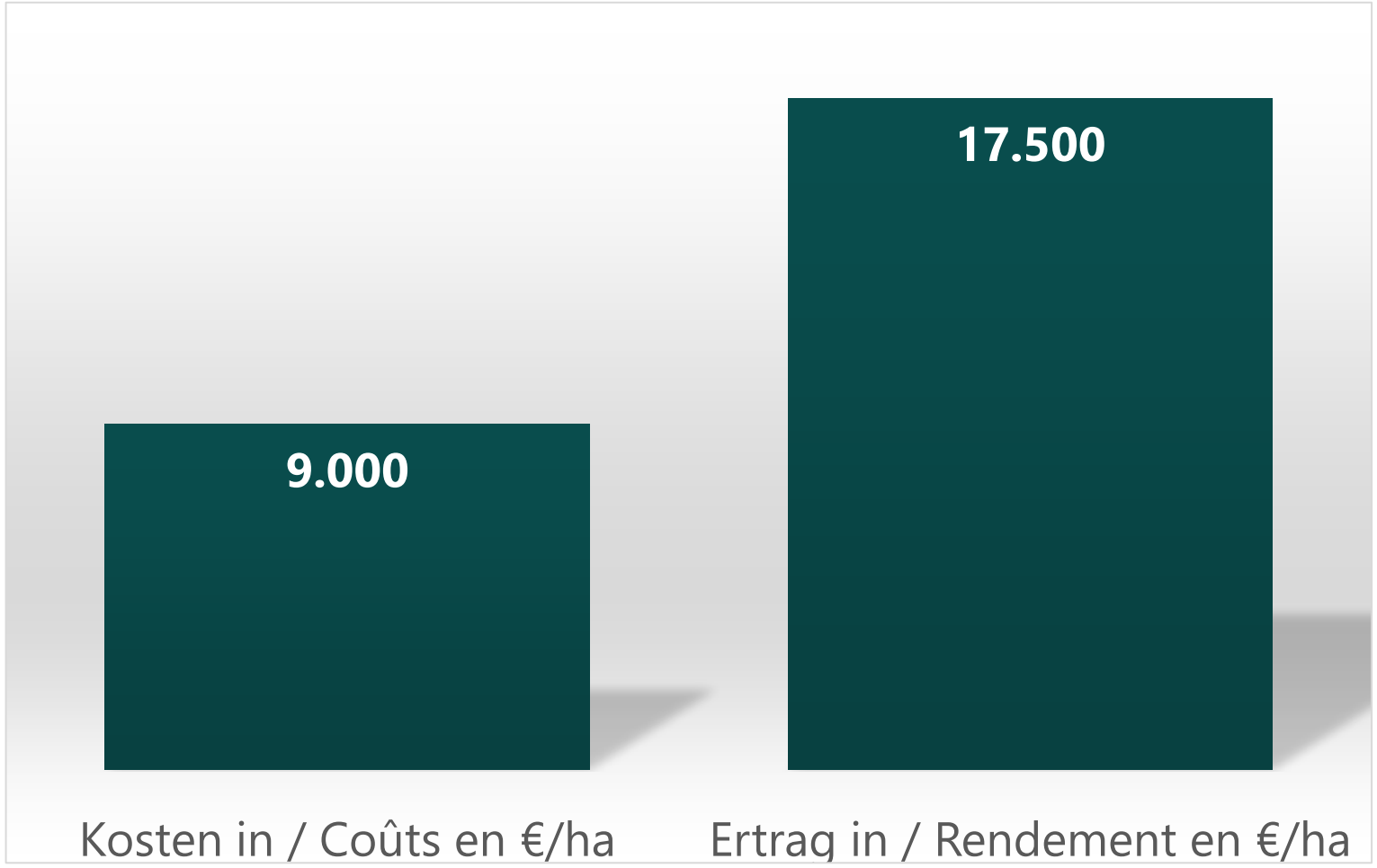
Plus carbon removal potential of approx. 25 t CO_2/ha/year

10,000 ha yield →

- 20,000 t oil/year
- 250,000 t CO_2/year
- 20,000 t protein /year
- 6,000 t biochar/year

Onion farming: growing demand in Africa approx. 40 kg/cap/year

SAREP onion business case



Phase 1 „Reference plot“ LCoW 1,60 €/m³

10 Mio. € Investment

Key facts:

- 1,000 m³/d desalinated water
- 25 ha Prosopis juliflora etc.
- 5 ha onions and staple food for local demand
- 5 ha parc with showroom, boarding house, education center
- 20 trainees, 2 managers
- EIA and social impact study

Phase 2 „Pilot“: LCoW 0,69 €/m³

90 Mio. € Investment

Key facts:

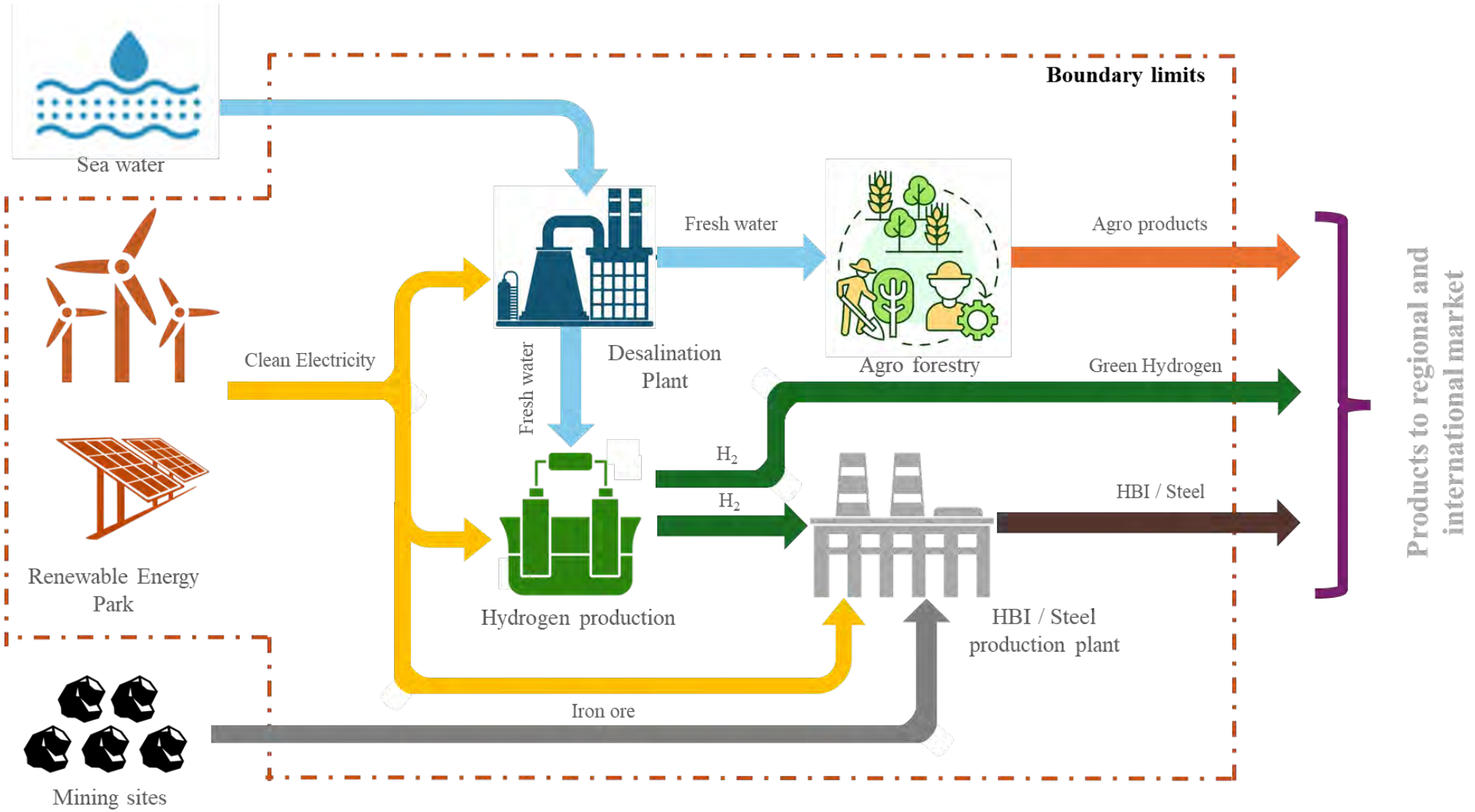
- 20,000 m³/d desalinated water
- 10,000 m³ sold to Nouakchot *(0,85€/m³)*
- 300 ha Prosopis juliflora etc.
- 40 ha onions and staple food for local demand
- 10 ha Jatropha curcas / Moringa oleifera

Phase 3 „1st Standard Plot“ – 65,000 ha; LCOW 0,40€/m^3

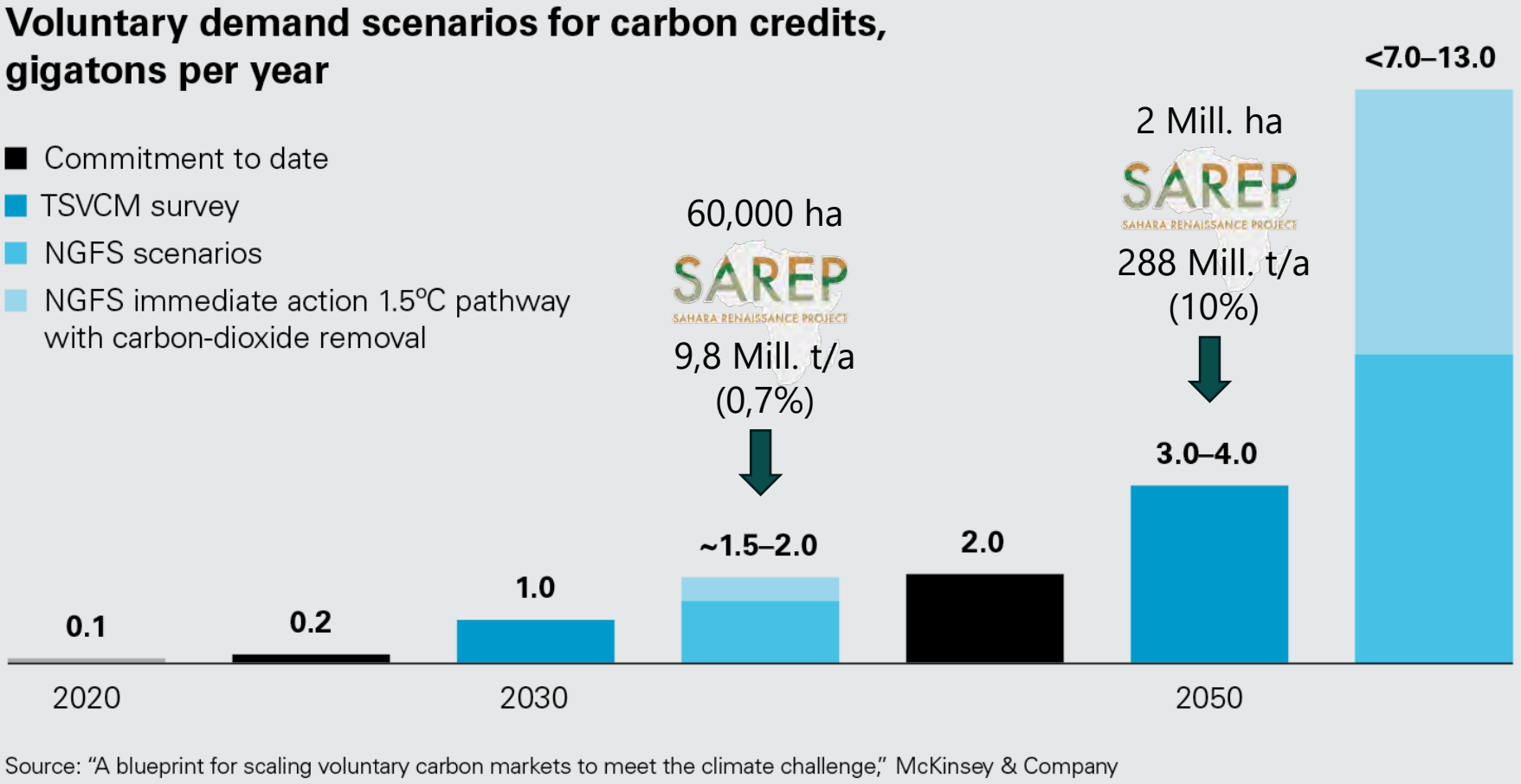
Industrial Commercialisation up to 2 Mio. ha

SAREP harbour – Potential for Mauritania

Business Model – Unfolding Synergies



Carbon Removal Certificates Demand in billion tons



Source: "A blueprint for scaling voluntary carbon markets to meet the climate challenge," McKinsey & Company

EIB predicts*:
183 USD/tCO in 2025
277 USD/tCO in 2030

Whitecase predicts:
50 USD/tCO in 2030
300 USD/tCO in 2050

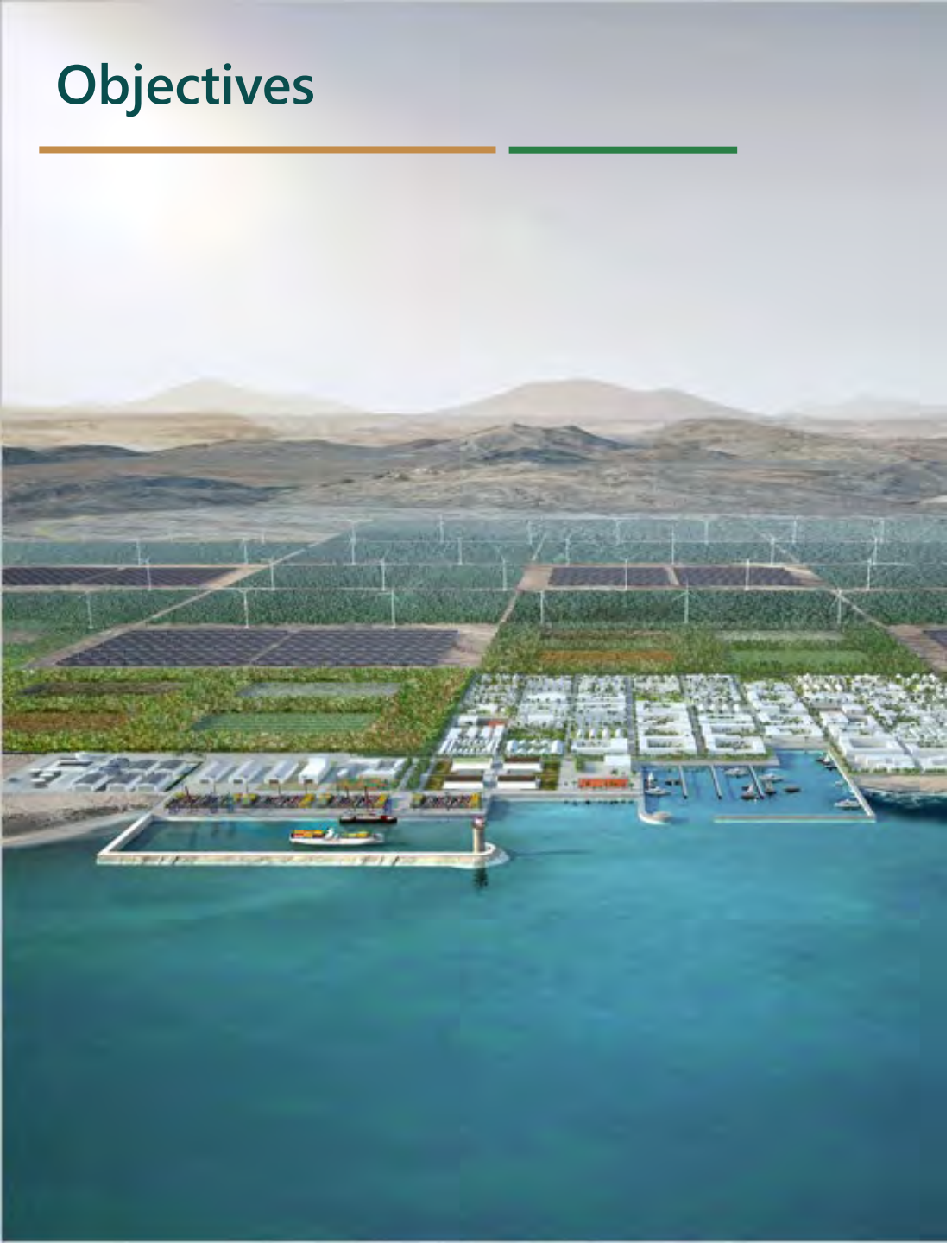
*Source: World Bank (2021), State and Trends of Carbon Pricing / European Investment Bank (2020), EIB Group Climate Bank Roadmap 2021-2025

CO_2 Price Development

Source	Issuance 2020 (million t CO_2/a)	Demand 2030 (million t CO_2/a)	Demand 2050 (million t CO_2/a)	Price 2030 ($/t$CO_2$)	Market Volume 2030 (billion $/a)
Credit Suisse	282	1,000	5,000<	50-100	50-100
TSVCM	282	1,000-2,000	7,000-13,000	5-100	30-180
MSCI Trove Research	282	500-1,500	-	20-50	10-40
Bloomberg NEF	282	1,000	5,000<	47-224	190
McKinsey	282	1,000-2,000	6,000-10,000	40-80	40-80
BCG	282	500 -1,500	-	20-40	10-40
SwissRe	-	-	-	200	-
World Bank	-	-	-	61-122	-
EIB	-	-	-	250	-

Sources: Credit Suisse (2022), TSVCM (2021), Trove Research (2021), Bloomberg NEF (2022), McKinsey & Company (2023), (BCG & Shell, 2023), SwissRe (2023), World Bank (2023), EIB (2020)

Objectives



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Green Business Opportunities

- Mobilizing Private Investments
- Offering a Competitive Product Portfolio

Climate Change Mitigation & Adaptation

- Initiating Large-Scale Carbon Sequestration
- Industry-Scale Biomass Production
- Industry Scale Hydrogen for local use and export

Regional Development

- Enhancing Food, Water, Energy Security
- Creating Jobs and Life Perspectives
- Migration Mitigation

Biomass products for industry

- Biofuel, Pellets, Timber, Protein,
  Biochar, Cash crops

Economic analysis

			budget figues	extrapolated
Parameter	**Unit**	**Pilot plot**	**Standard plot**	**Target dimension**
Construction time	a	4	4	10
Water capacity	m^3/d	20,000	2,000,000	54,000,000
Water supply to Nouakchot	m^3/d	10,000	200,000	200,000
Levelized Cost of Water	**€/m³**	**0.69**	**0.38**	**0.26**
Water Sales Price	€/m³	0.85	0.85	0.85
Afforestation	ha	339	70,000	1,960,000
Land use cost	€/ha	0.0	0.0	0.0
CO_2 removal	tCO_2/a	48,000	9,590,000	268,520,000
CAPEX	**k€**	**76,000**	**5,789,000**	**153,987,400**
Renewable Energy (PV+Wind)	k€	18,903	1,439,861	38,300,313
Reverse Osmosis	k€	39,000	2,970,671	79,019,850
Irrigation System	k€	6,945	529,036	14,072,353
Afforestation	k€	5,055	385,037	10,241,980
Training Center / SAREP Headquarter	k€	6,185	471,131	12,532,094
Working Capital	k€	8,981	170,000	4,522,000
Trade Working Capital	k€	1,200	22,715	604,222
Development Cost	k€	7,781	147,285	3,917,778
CO_2 start price	$€/tCO_2$	65	85	85
CO_2 price inflation	p.a.	5%	5%	5%
EBITDA-Margin		33.7%	54.2%	>60%
WACC		3.9%	8.4%	12.0%
IRR		4.4%	9.2%	>12%
PBP	a	29	27	<25

- SAREP <u>at scale</u> constitutes a profitable investment option!
- SAREPs financial result oscillates from rather low (4%) to high (12%) IRR, depending on size (economy of scale) and the behaviour (development) of the most sensitive variables, with the top 3 being ranked:
  1. Yield expectation *(carbon removal performance)*
  2. Levelized Cost of Water *(and/or water consumption per ha/a)*
  3. Carbon certificate *(and/or commodity)* price

Objectives

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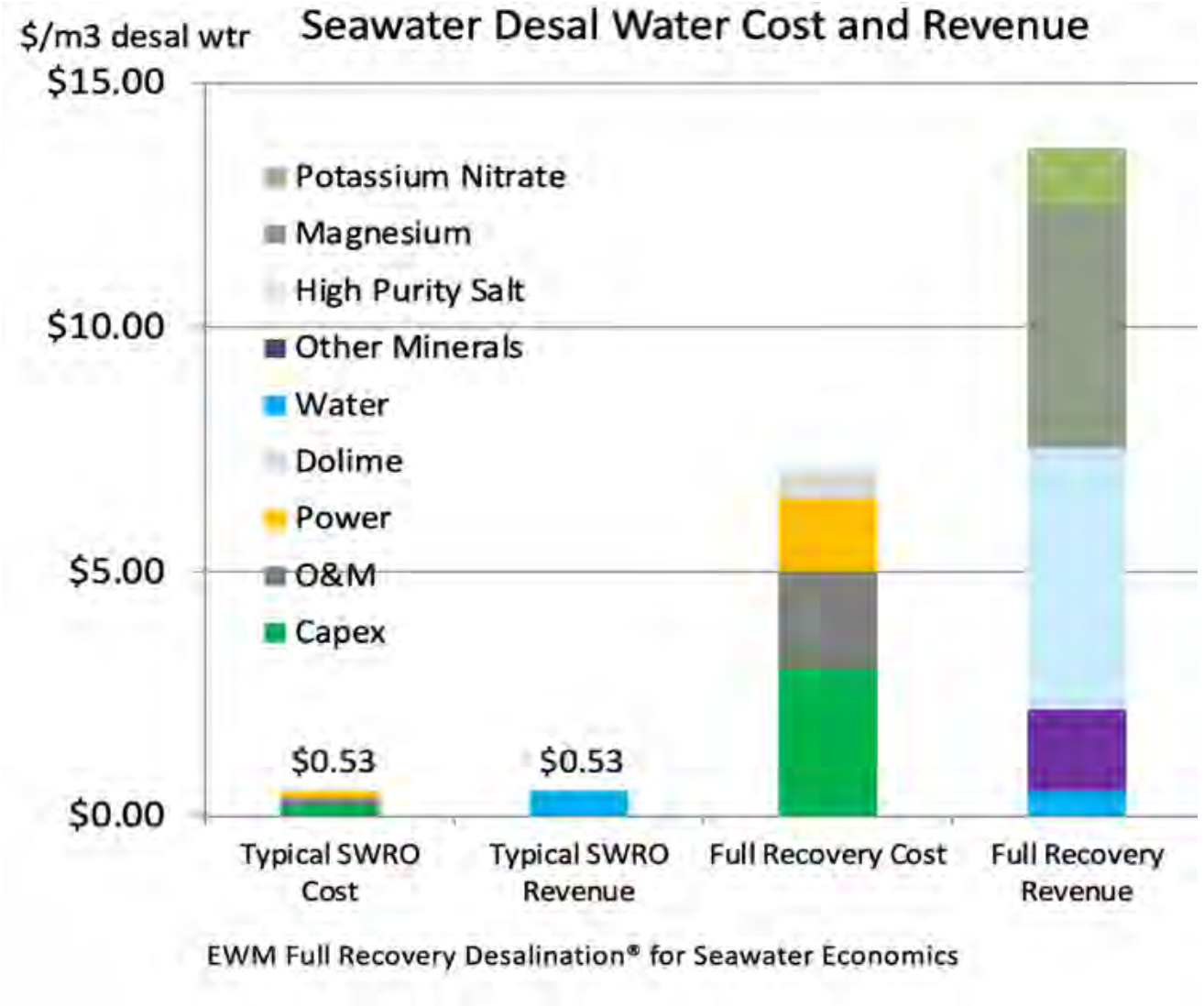
Food security and regional development through carbon removal, climate mitigation and adaptation

- Store carbon in soil
- Provide jobs and education to African society
- Organize food self-sufficiency for Africa
- Produce green Hydrogen for local use and export
- Produce green electricity and fuels for domestic consumption
- Offer technology opportunities and added value to the African continent
- Provide non fossil carbon for material use
- Provide plant oil substituting diesel and heavy fuel oil

There is more to brine....



Using brine in salt lake to cultivate Salicornia bigelovii

***Salicornia bigelovii* features**

- NaCl tolerance limit 100g/l
- Biomass - up to 16 t/ha/a
- Seeds – 2,000 kg/ha/a
- Whole plant is utile as fodder for camels

Source: http://www.queller.org/wuestenspargel/

COP28 Dubai - signing of MoU

Summary

- SAREP uses **state of the art technologies** to solve pressing worldwide problems
- SAREP offers **affordable potable water** and **food for local population**
- Solar and Wind powered desalinization creates **infinite** water resources at affordable costs
- The water – land – solar energy **nexus** creates carbon storage and green carbon production potentials in industrial dimensions
- SAREP offers large scale opportunities to produce „**sustainable“ steel** for local use (HBI) or export
- SAREP offers employment and education in for **local people and migrating refugees**

Green business model for climate mitigation, carbon storage, poverty alleviation, GHG neutral steel production and food security

Contact

IfaS

Institute for Applied Material Flow Management (IfaS)
Trier University of Applied Sciences / Environmental Campus Birkenfeld
P.O. Box 1380
55761 Birkenfeld
Germany

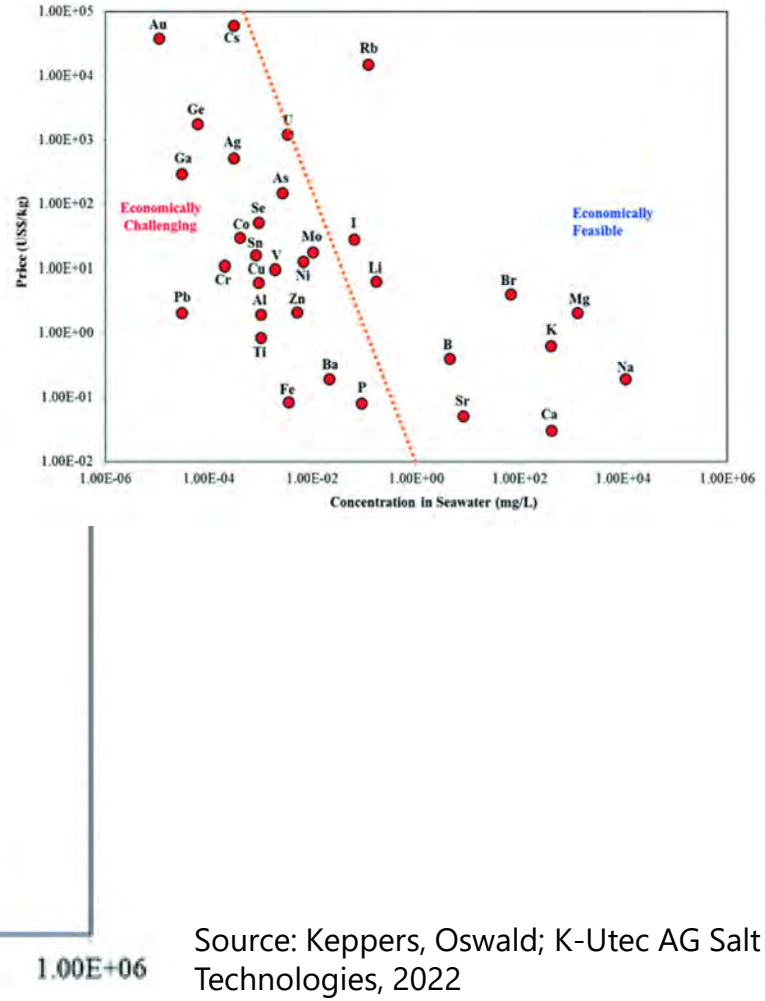
Prof. Dr. Peter Heck
Phone: +49 6782 17 - 12 21
e-mail: p.heck@umwelt-campus.de

Dr. Felix Flesch
Phone: +49 6782 17 – 26 23
e-mail: f.flesch@umwelt-campus.de

Website: https://sarep.de
www.stoffstrom.org

Solubilities of selected salts in brine

Compound	Solubility in g/100 ml H_2O at RT
$CaCO_3$	0.0015
$MgCO_3$	0.0139
$CaSO_4 \bullet 2H_2O$	0.26
K_2SO_4	11.1
$KMg(SO_4)Cl \bullet 3H_2O$, Kainite	20.0
$K_2Mg(SO_4)_2 \bullet 6H_2O$, Schoenite	25.0
KCl, Silvinite	35.5
NaCl	35.7
Na_2SO_4	44.0
$MgCl_2$	56.0
$KMgCl_3 \bullet 6H_2O$, Carnalite	64.5
$CaCl_2$	81.3
LiCl	84.5
$SrCl_2 \bullet 6H_2O$ (0°C)	106.0



Source: Keppers, Oswald; K-Utec AG Salt Technologies, 2022