SAREP | Sahara Renaissance Project

Prof. Dr. Peter Heck
CEO IfaS
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IfaS

SAREP
SAHARA RENAISSANCE PROJECT

SYNLIFT
industrial products

Zero Emission Campus – Concept

- **100%** renewable heat supply based on waste wood, biogas (co-generation) and solar thermal
- **100%** renewable electricity based on cogeneration & PV
- **100%** renewable cooling supply based on geothermal, biomass and solar adsorption
- **100%** Energy Efficiency

ECB – NO 1 in Germany

Trier University of Applied Sciences | HOCHSCHULE TRIER

- **Monitoring & Measuring: Green Metric 2023**
  - NO 3 globally and NO 1 in Germany (more than 1000 universities)
  - NO 1 in category „Energy and Climate Protection”
- Managing Sustainability
  - ISO-based Environmental Management System (not accredited)
  - Partner in various SDG networks
  - However – No Paris Statement - yet

Introduction of IfaS
One Team – plenty of Ideas and Visions...

„A clever man **solves** problems,
a wise man **avoids** them“

(Chinese proverb)

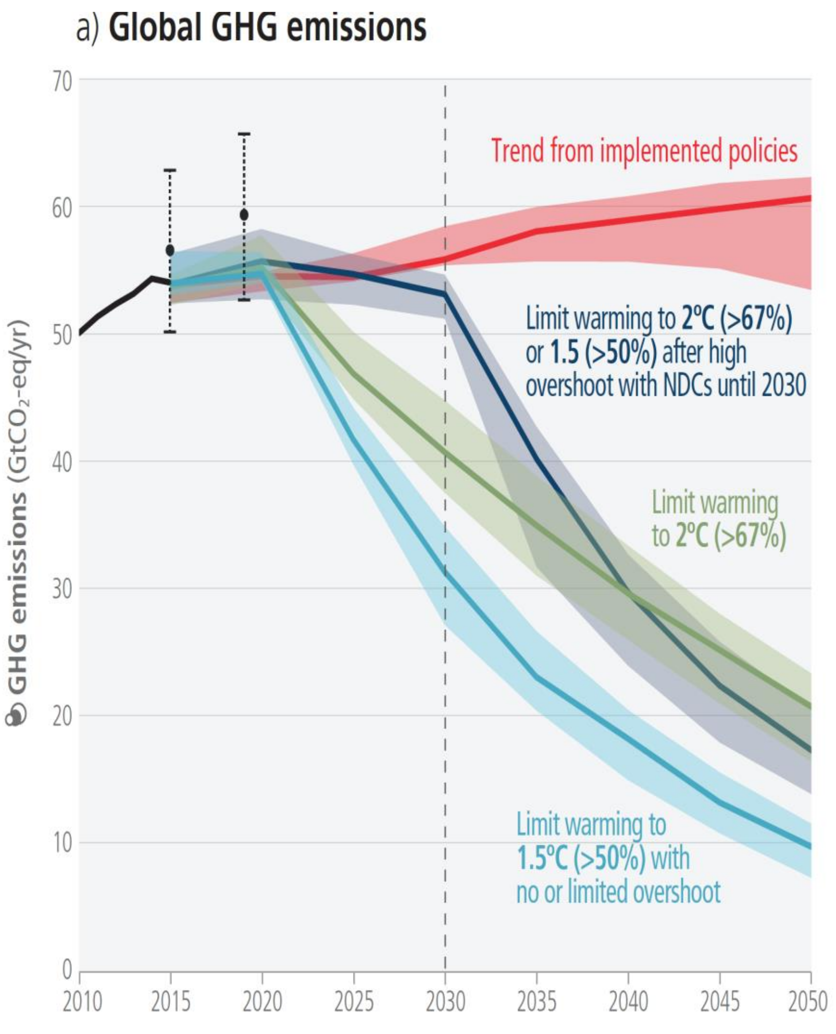
Non-Profit Research Institute at the University of applied Sciences Trier

Founded in 2001
- **9 Directors**

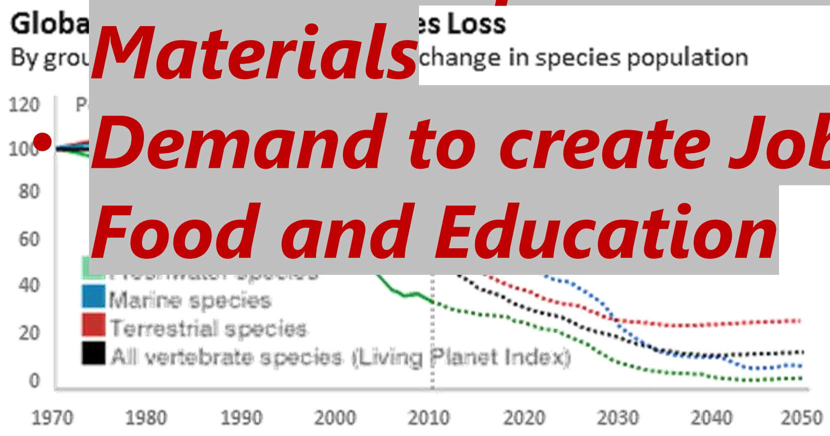
- **More than 80 researchers, project assistants and students**
- **8 Departments**

→ About 6 Mill. € turnover in 2023

Global Challenges: policy is insufficient



IPCC, 2023



Global Poverty and Migration Crisis

- ***Demand to reduce GHG emission***
- ***Demand to capture Carbon Dioxide***
- ***Demand to enhance Biodiversity***
- ***Demand to provision new, sustainable Materials***
- ***Demand to create Jobs, provide Shelter and Food and Education***

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).

The international relevance of Carbon Removal

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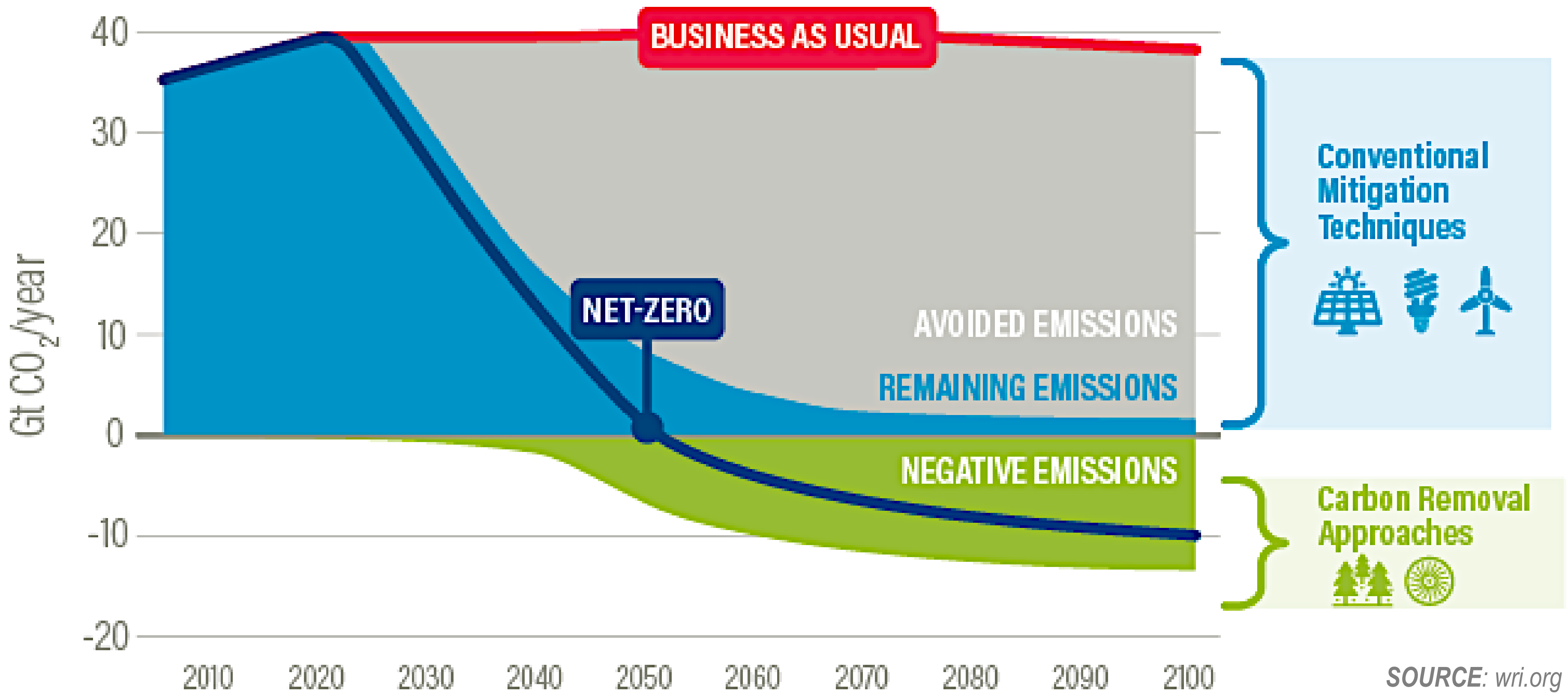
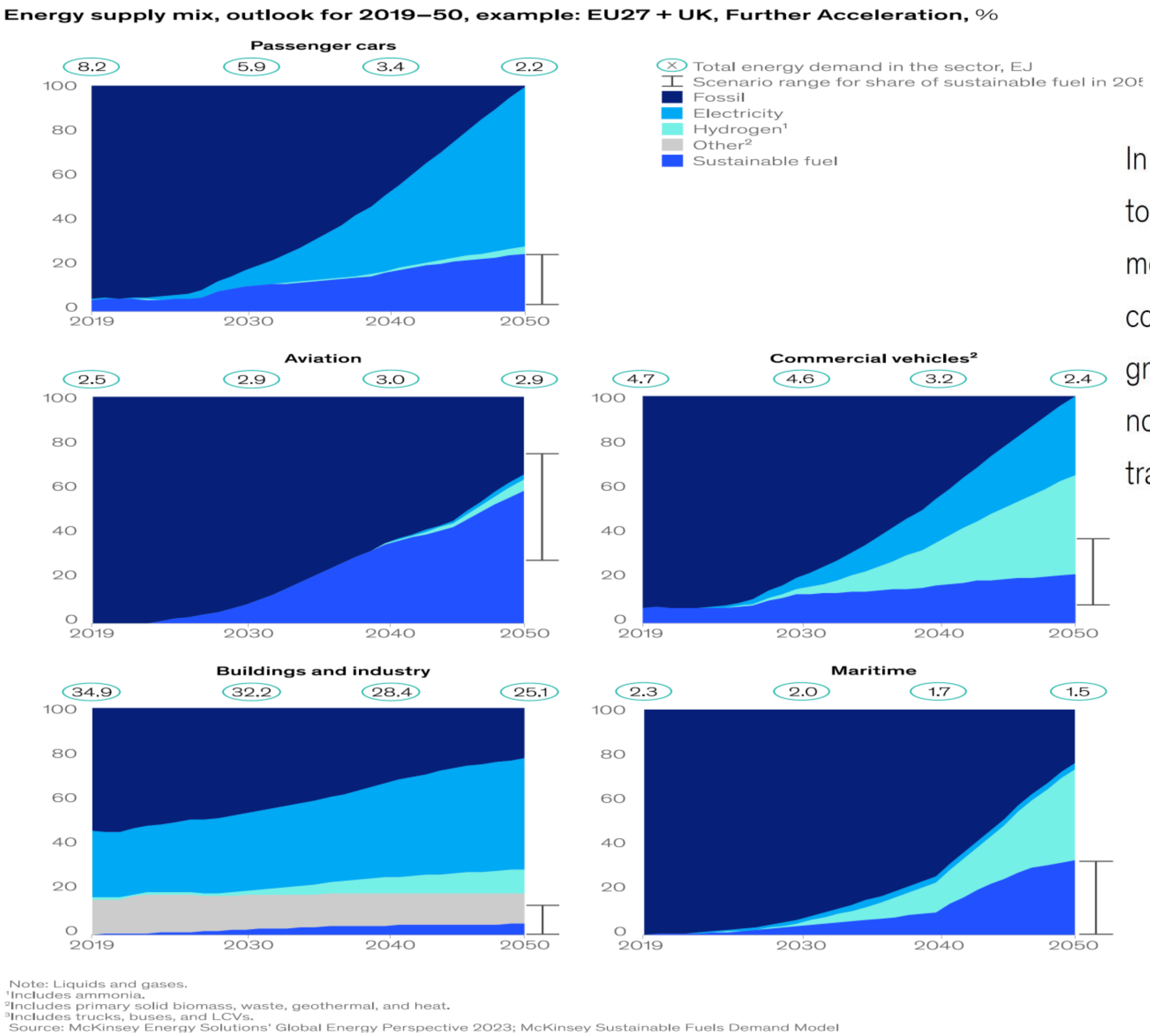


Increasing demand for sustainable fuels



In addition to accessing new sources of feedstock, producers may need to investigate ways to reduce the inherent lifecycle carbon intensity (CI) of the feedstock to make their fuels more attractive to customers. For example, opting for biogenic CO_2 instead of industrial CO_2 could reduce the CI of PtLs. Accessing harvested crops like corn, sugarcane, and oilseeds grown using sustainable farming practices could benefit HEFA and alcohol-to-jet. Focusing not only on the availability of feedstocks, but also on the CI of feedstocks and associated trade-offs is projected to be critical going forward.

- https://www.mckinsey.com/industries/oil-and-gas/our-insights/global-energy-perspective-2023-sustainable-fuels-outlook#/

Feedstock for sustainable fuel will be more and more important!

Overcoming the feedstock bottleneck could be crucial to the expansion of sustainable fuels

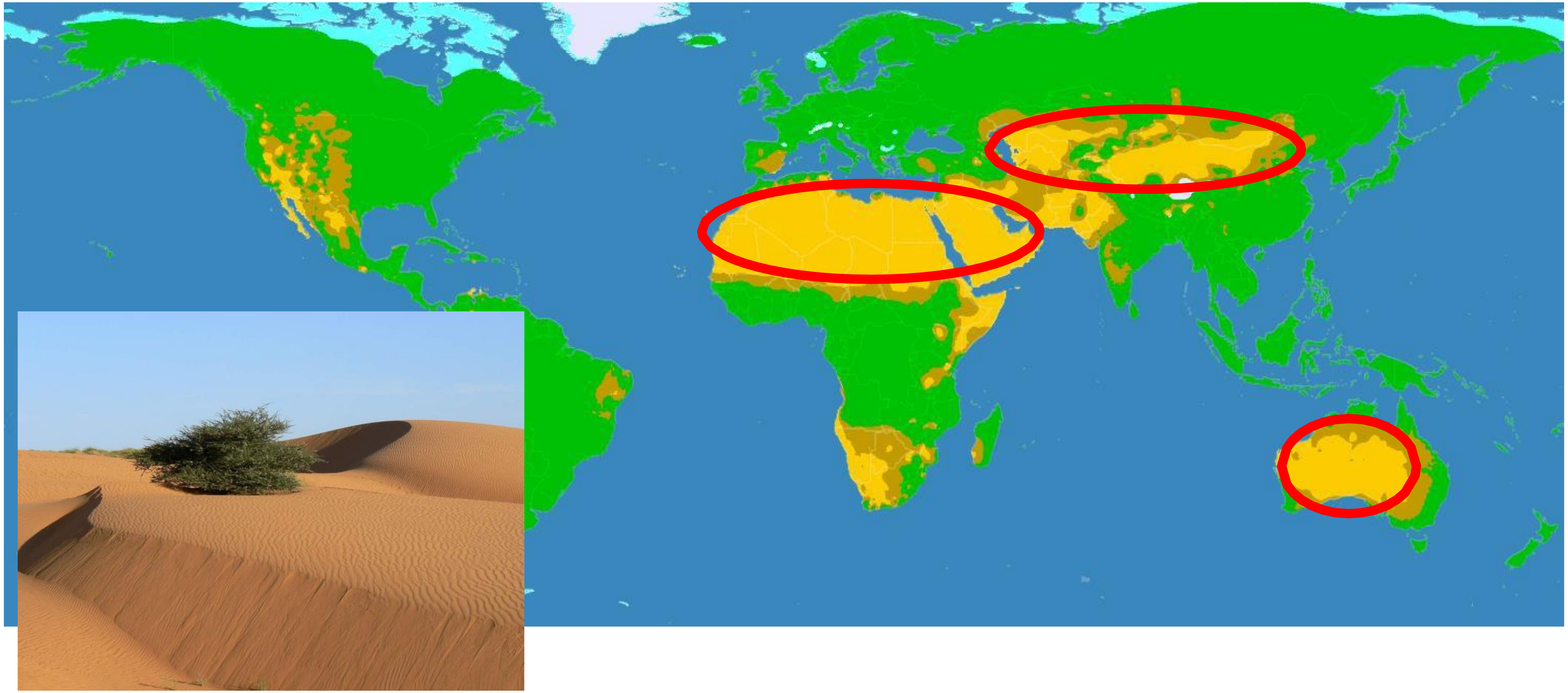
Comparison of feedstock types for sustainable fuels

Disadvantage Advantage

	Hydrotreated vegetable oils (HVO/HEFA) / renewable diesel	Gasification (+ Fischer-Tropsch or methanol route)	Alcohol-to-X	Power-to-liquid (e-fuel) (Fischer-Tropsch or methanol route)
Example feedstock	Typically waste (animal fat, used cooking oil, etc), also edible oils purposely-grown	Agricultural residues, forestry residues, municipal solid waste (MSW[1])	Ethanol (lignocellulosic biomass, sugar cane, corn)	CO_2 (CCUS[2] or DAC[3]), hydrogen
Typical sustainability considerations	Differences across waste categories under REDII, 1G use	Waste hierarchy, use of fossil components (such as plastics waste)	Food vs feed and land use (1G)	Source of electricity and carbon, double counting
Fuel blending scalability	Can be used as 100% diesel or 50% jet, chemicals	Versatile outputs as 100% diesel or gasoline, 50% jet, chemicals	Versatile outputs as 100% diesel or gasoline, 50% jet	Versatile outputs as 100% diesel or gasoline, 50% jet, chemicals
Feedstock scalability	Only ~30Mt fuel equivalent, upside from purposely-grown to ~100Mt fuel	>100Mt fuel but starting from a low base; MSW more transportable than residues	2G: theoretically >100Mt, practically challenging (fragmented)	>100Mt biogenic CO_2 fuel Theoretically unlimite DAC
Technology maturity	Mature	Pipeline toward 1Mt by 2025	No large-scale commercial production yet but mature technology	Might be mature for scale-up by 2030
LCA GHG reduction vs fossil fuel, %	Waste: 70–90+ 1G: 30–60	77–92[4]	A2G: 77–92[4] 1G: 30–80[4]	70–97

Note: Drop-in fuels only.
[1]MSW = municipal solid waste.
[2]CCUS = carbon capture and storage.
[3]DAC = direct air capture.
[4]Across selected technologies we could observe LCA GHG reductions exceeding 100%, if CCS and other abatement technologies are applied.
Source: McKinsey Energy Solutions' Global Energy Perspective 2023; McKinsey Sustainable Fuels Demand and Value Pools Model

Turning problems into opportunities: Greening the deserts as a natural carbon sink



→ greening the deserts could remove more CO_2 than men ever emitted !

Quelle: von Canstein 2020

Soil carbon sequestration

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- 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!

Solution Overview | Greening the Desert

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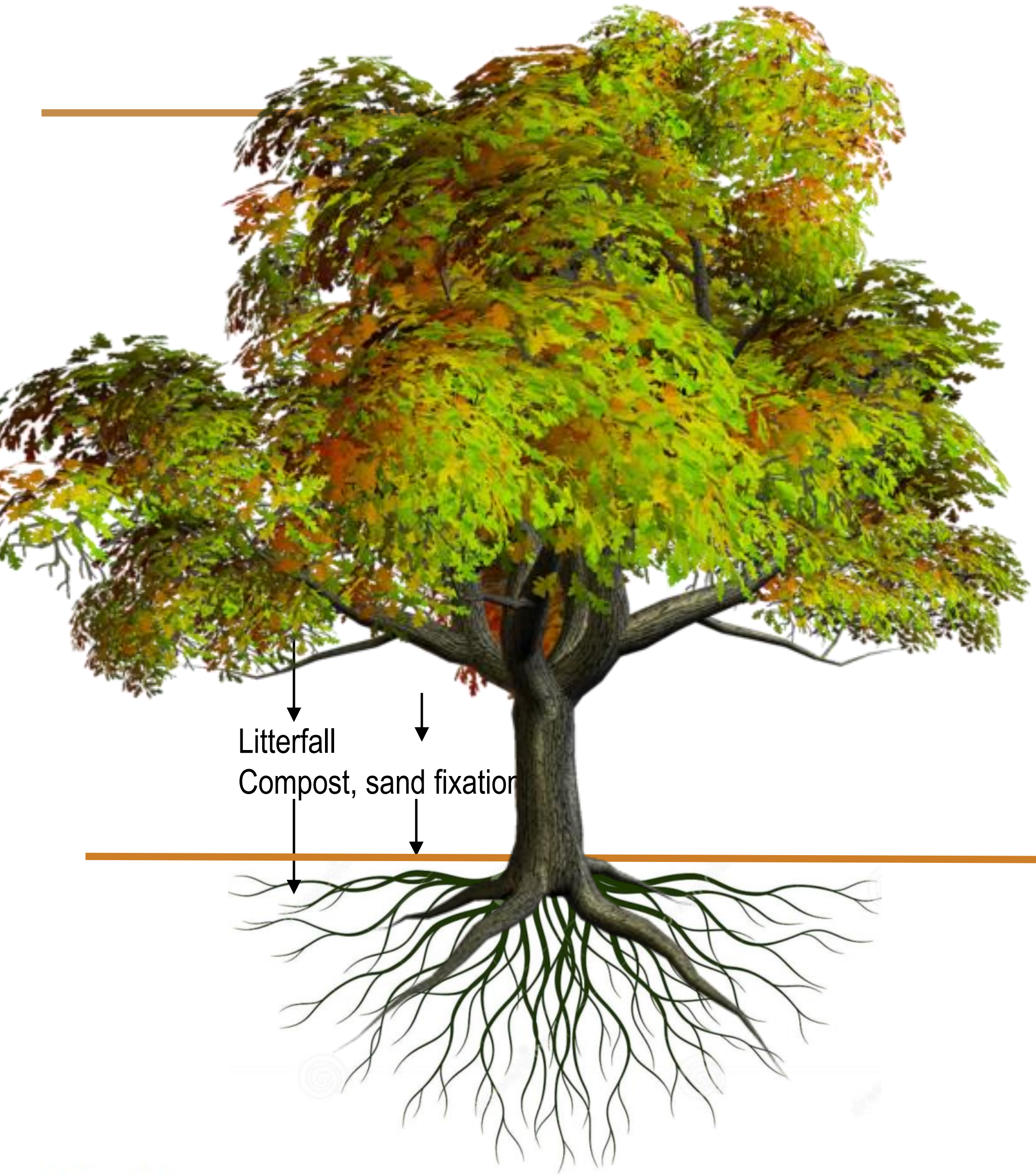
Plant Growth

Input

- Desalinated Seawater
  (Use of renewable energies)
  Drip Irrigation/Fertigation
- Nutrients (N, P, K)

Output

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

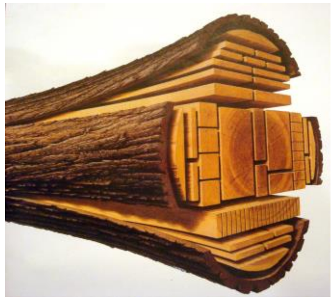


DM

75 %

25 %

60 % timber



40 % slabs, crown, branches, bark

charcoal

Soil fertility

Longterm C-sink

SOC

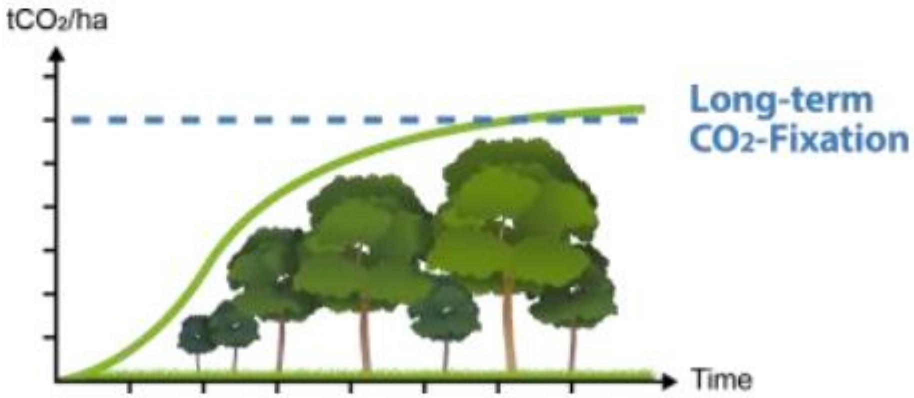
Biocoenosis
Organic life
around charcoal

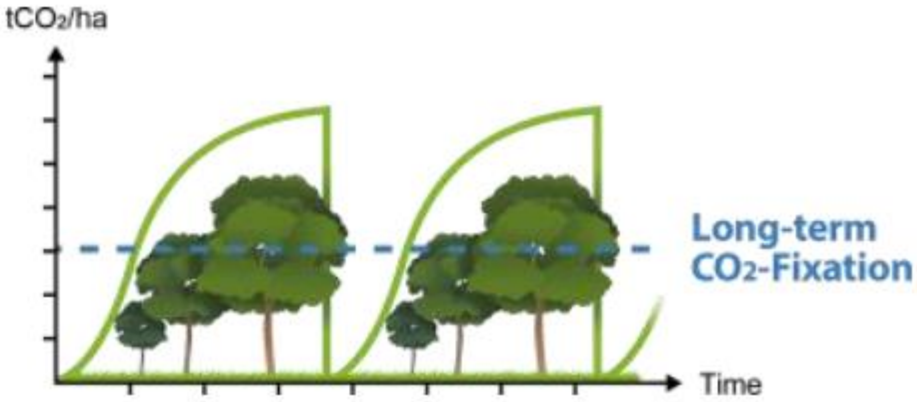
IfaS Institut für angewandtes Stoffstrommanagement

CO2-Fixation

Conservation Forest or Selective Logging

Rotation Forestry





Logging wood for pellet production falls under rotation forestry

$$\text{CFMU, long\_term} = \frac{\sum_{t=1}^{T} \text{CFMU,t}}{T}$$

CFMU, long-term = [tCO2/ha] Long-term CO2-fixation of a MU

CFMU, t = [tCO2/ha] CO2-fixation of a MU in year t

T= [ ] Number of years between the planting start and the end of the crediting period

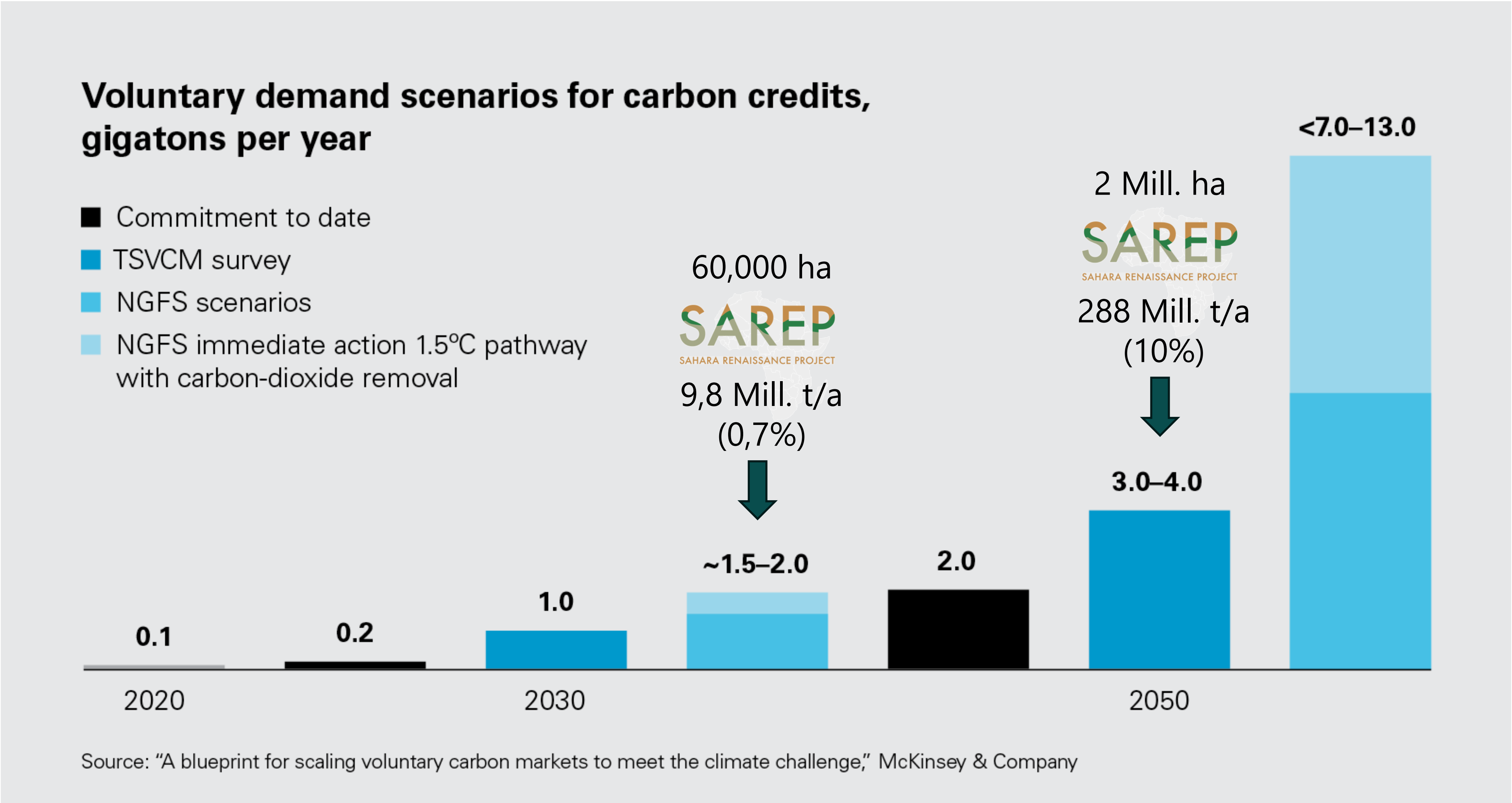
T = 1, 2, 3, … Years

Source: https://globalgoals.goldstandard.org/standards/403_V1.0_LUF_AR-Methodology-GHGs-emission-reduction-and-Sequestration-Methodology.pdf

Plant oil, protein and stored carbon from Jatropha Curcas

Item	Value	Unit
Absorption Capacity	**25**	**t CO_2/ha*a**
Above Soil Biomass	20	t CO_2/ha*a
Below Soil Biomass	5	t CO_2/ha*a
Biomass Dry Matter	4.4	t DM/ha*a
Charring Efficiency	33	%
Biochar	1.4	t_{BC} /ha*a
Carbon Fix Content	80	%
Biochar Sequestration Potential	4.2	t CO_2/ha*a

Carbon Removal Certificates Demand in billion tons



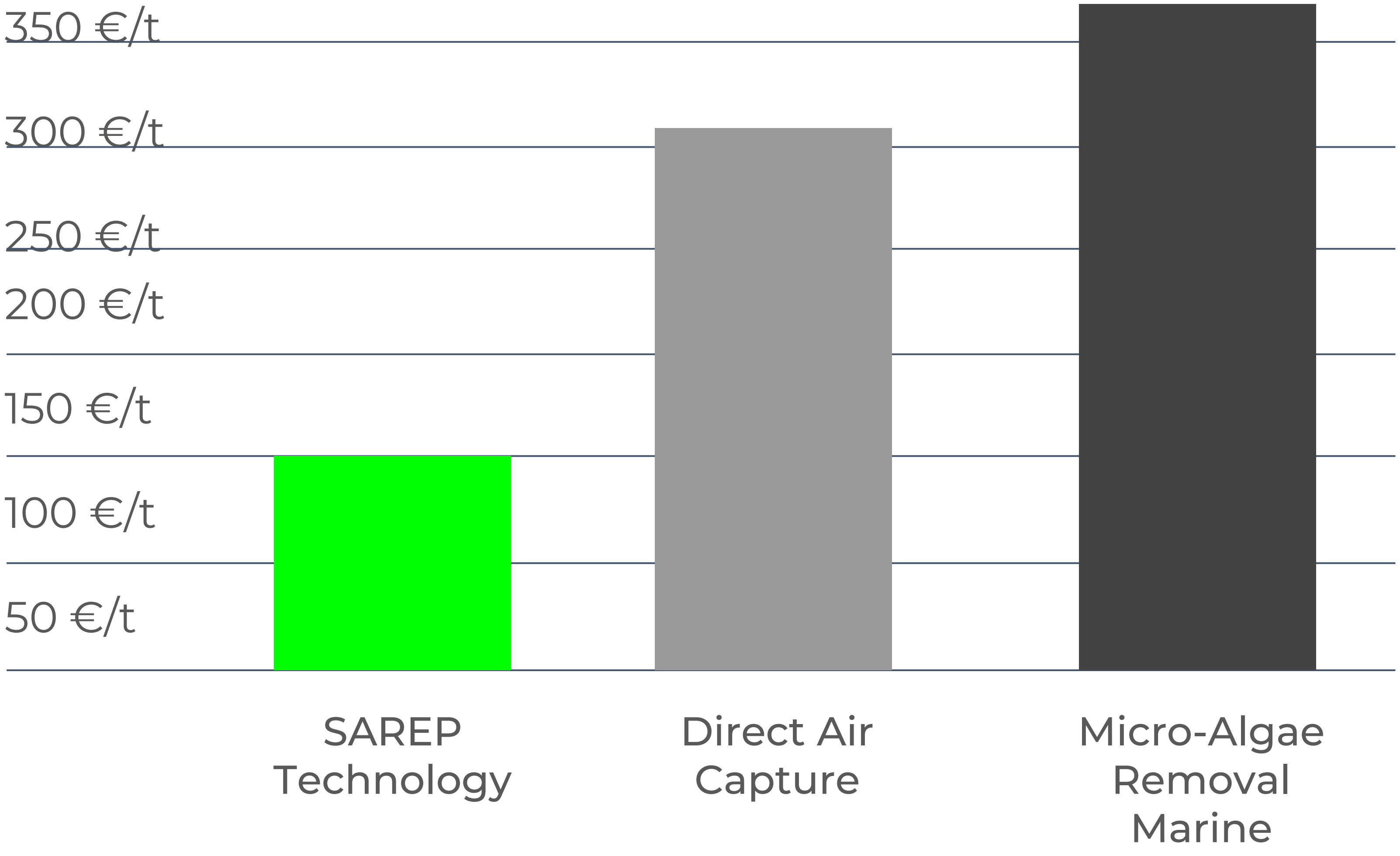
EIB predicts*:
183 USD/tCO in 2025
277 USD/tCO in 2030

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

SAREP Technology less expensive then existing solutions

Carbon Offset Price €/t CO_2 in 2023



SAREP Technology is:

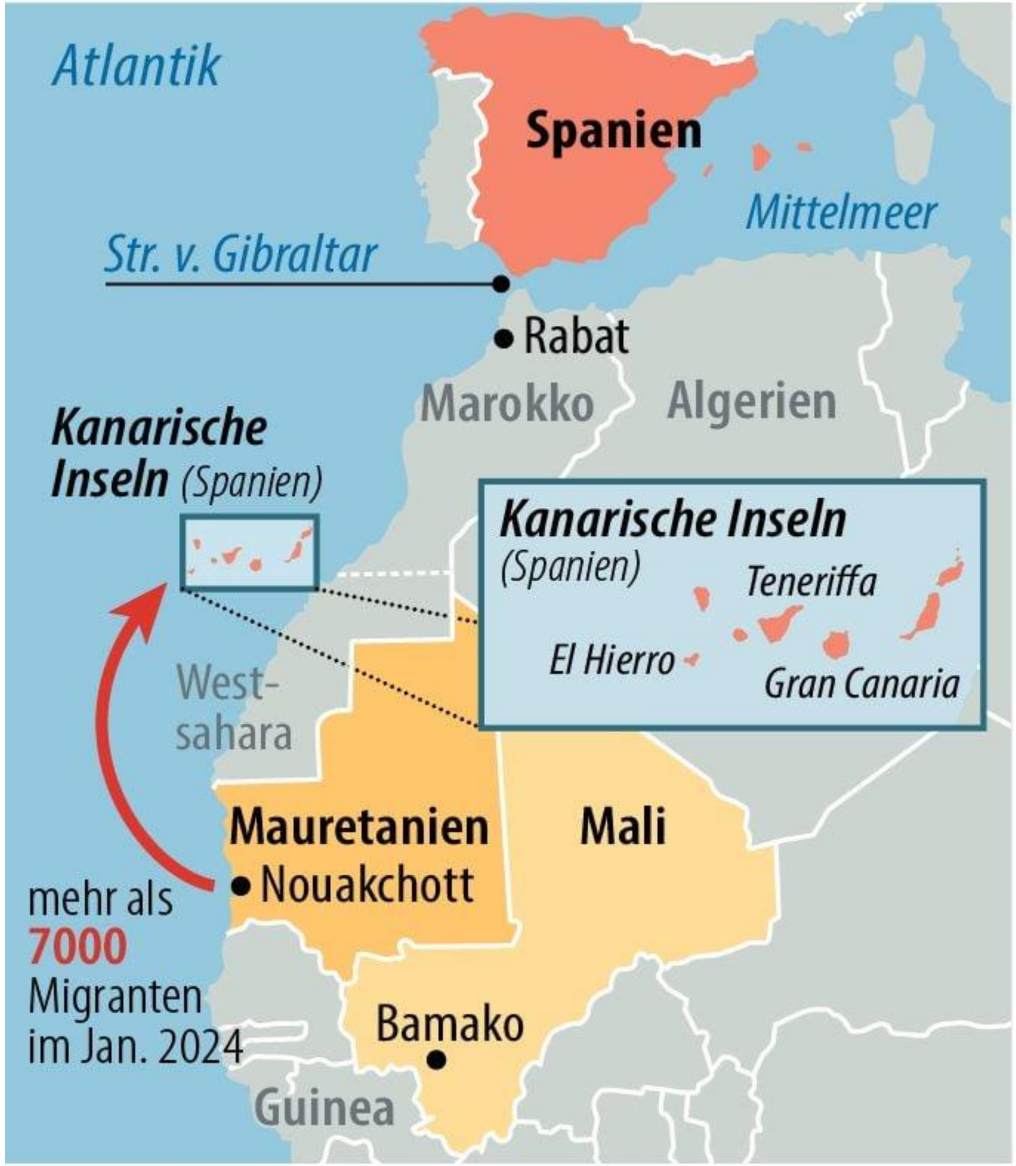
- 3x less expensive than existing solutions
- is highly scalable, due to little to non proprietary technology
- thus presents the most efficient way to capture CO_2 on scale

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**

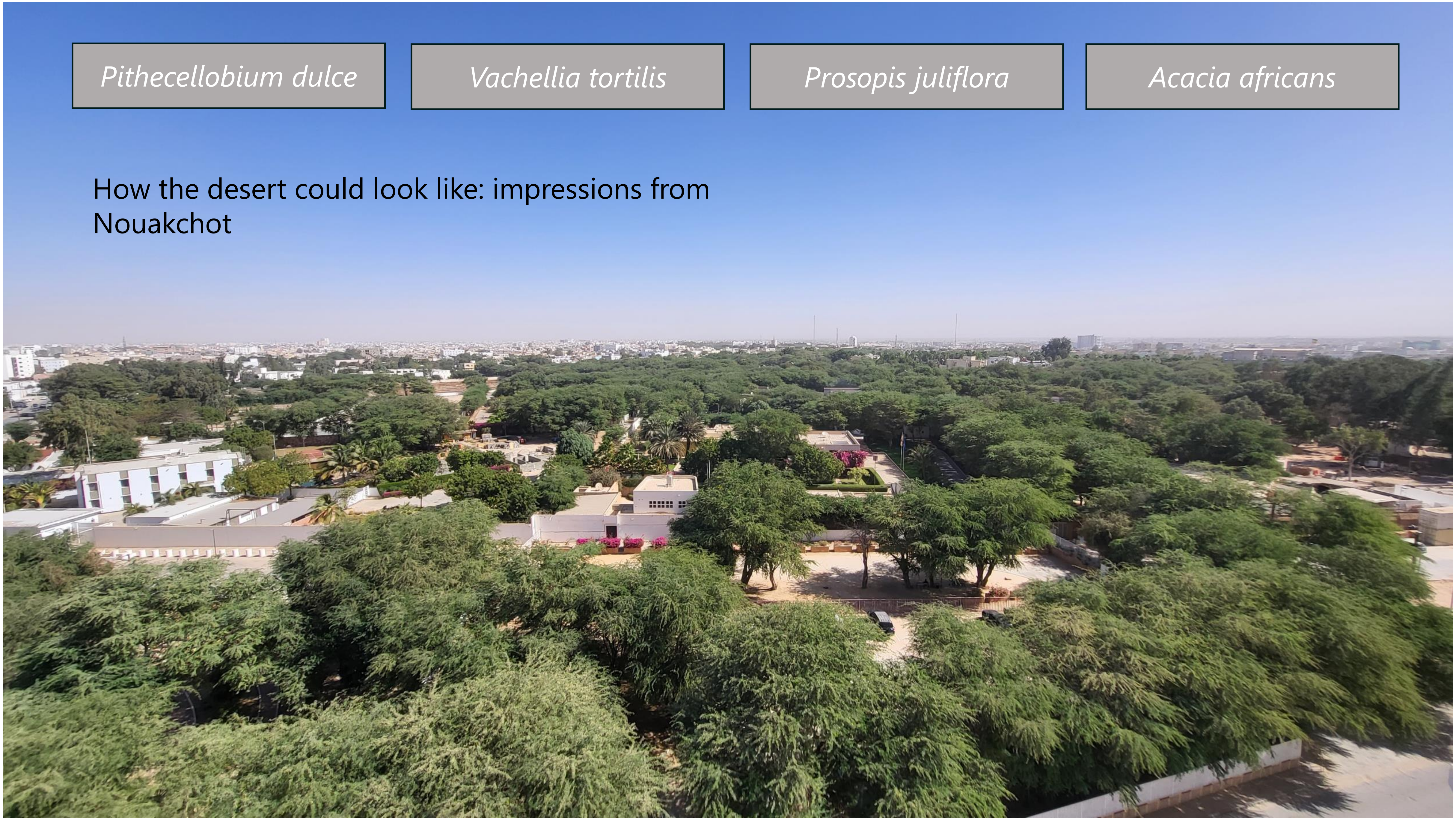
Why Mauretania?

- 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



Pithecellobium dulce | *Vachellia tortilis* | *Prosopis juliflora* | *Acacia africans*

How the desert could look like: impressions from Nouakchot

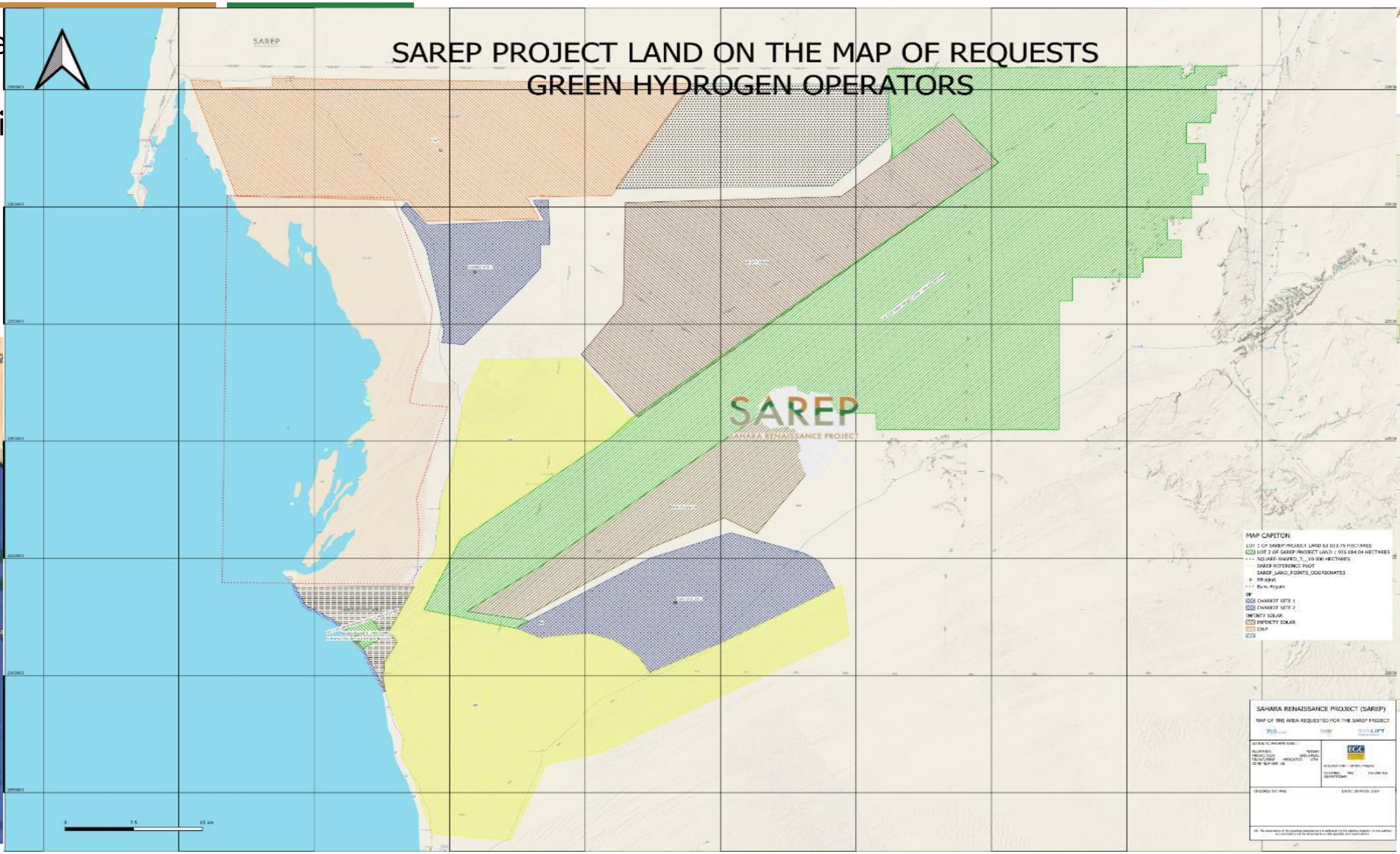



HILUX
TA

Project area: 2 Mill. ha

3 phase de

Full scale i
CO_2/year



Where it begins….

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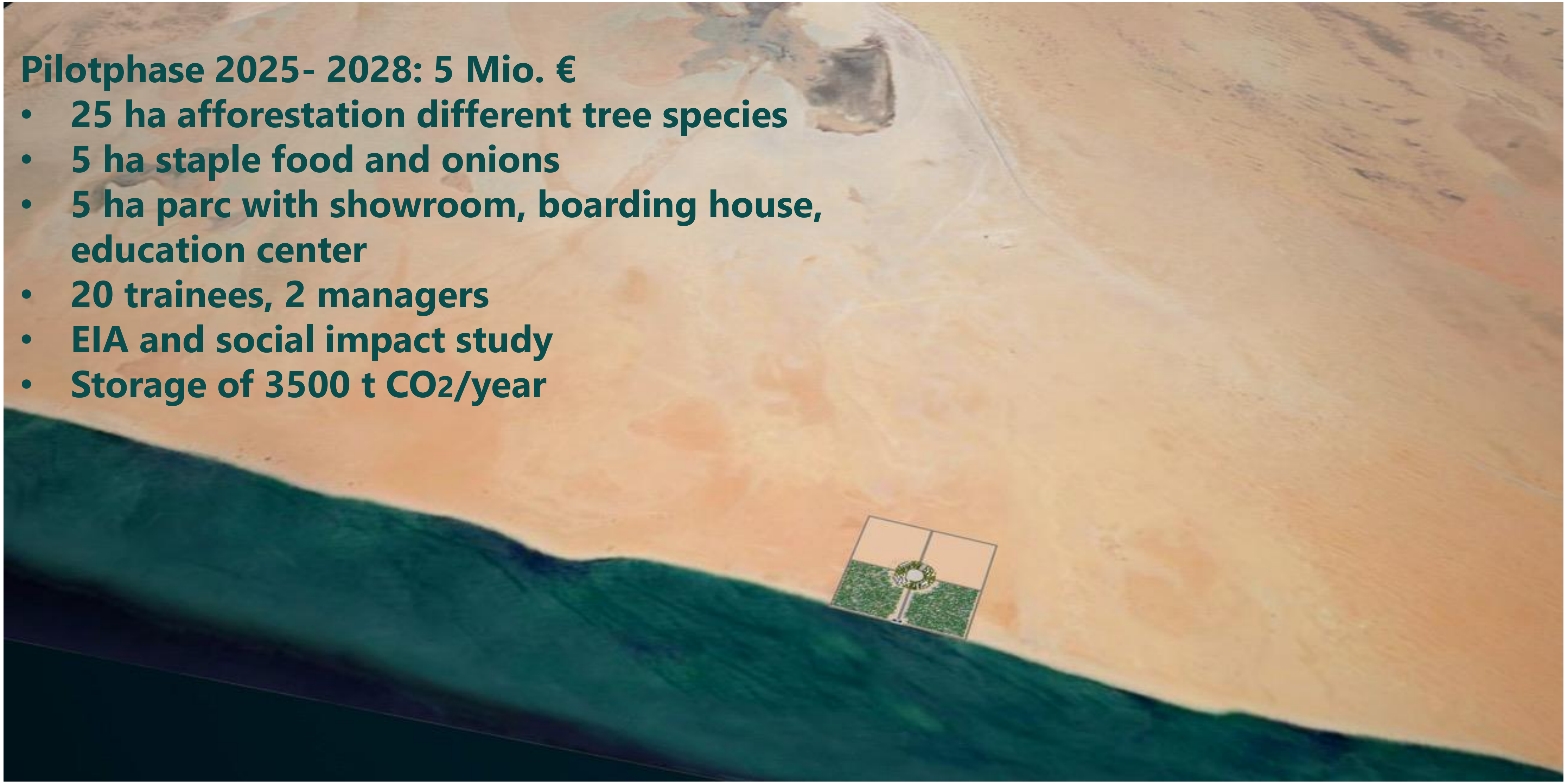
Phase 1: 1000 cbm/day; 30 ha; LCOW 1,60 €/cbm



Pilotphase 2025- 2028: 5 Mio. €

- **25 ha afforestation different tree species**
- **5 ha staple food and onions**
- **5 ha parc with showroom, boarding house, education center**
- **20 trainees, 2 managers**
- **EIA and social impact study**
- **Storage of 3500 t CO_2/year**

Phase 2: 650 ha; LCOW 0,80 €/cbm

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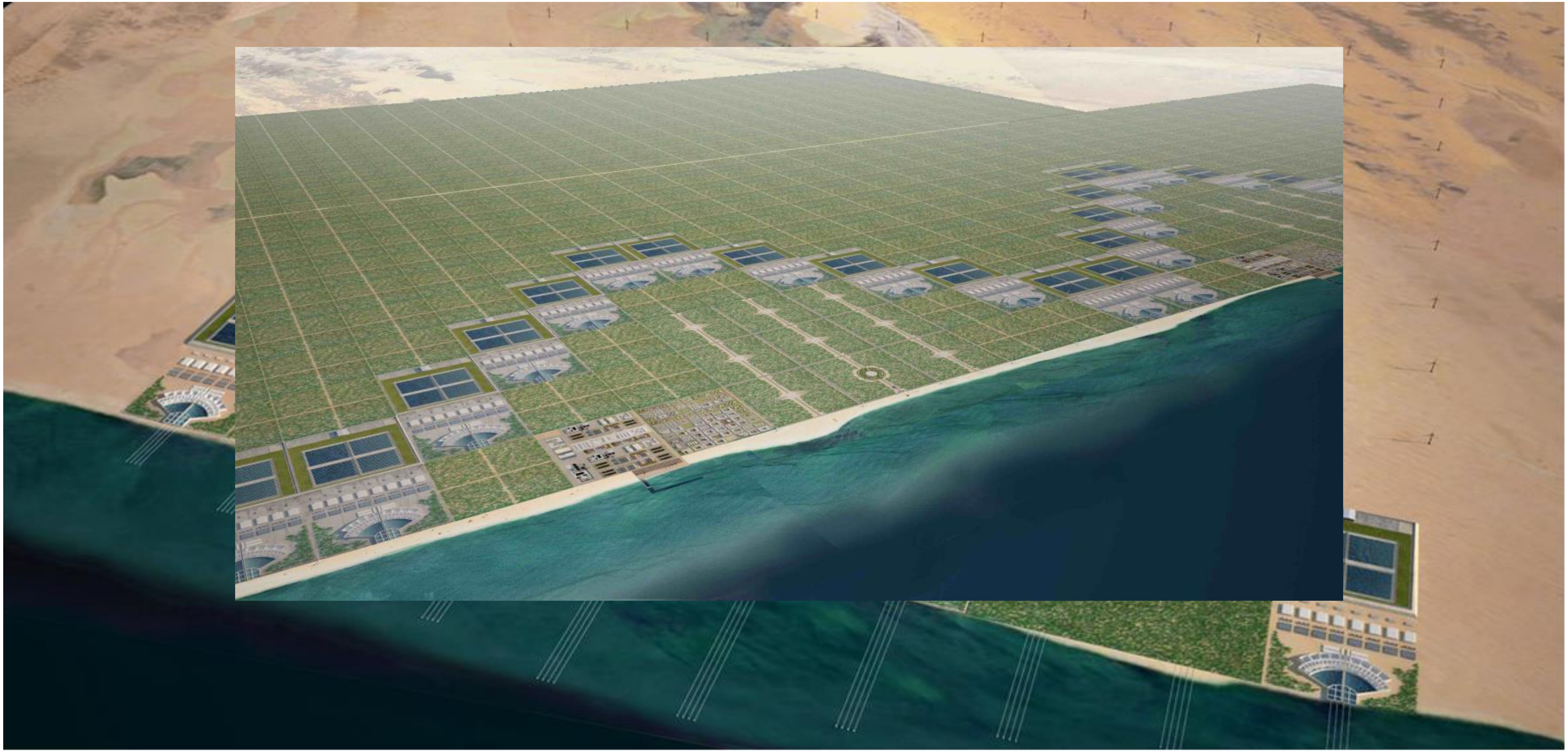
90 Mio. € Investment

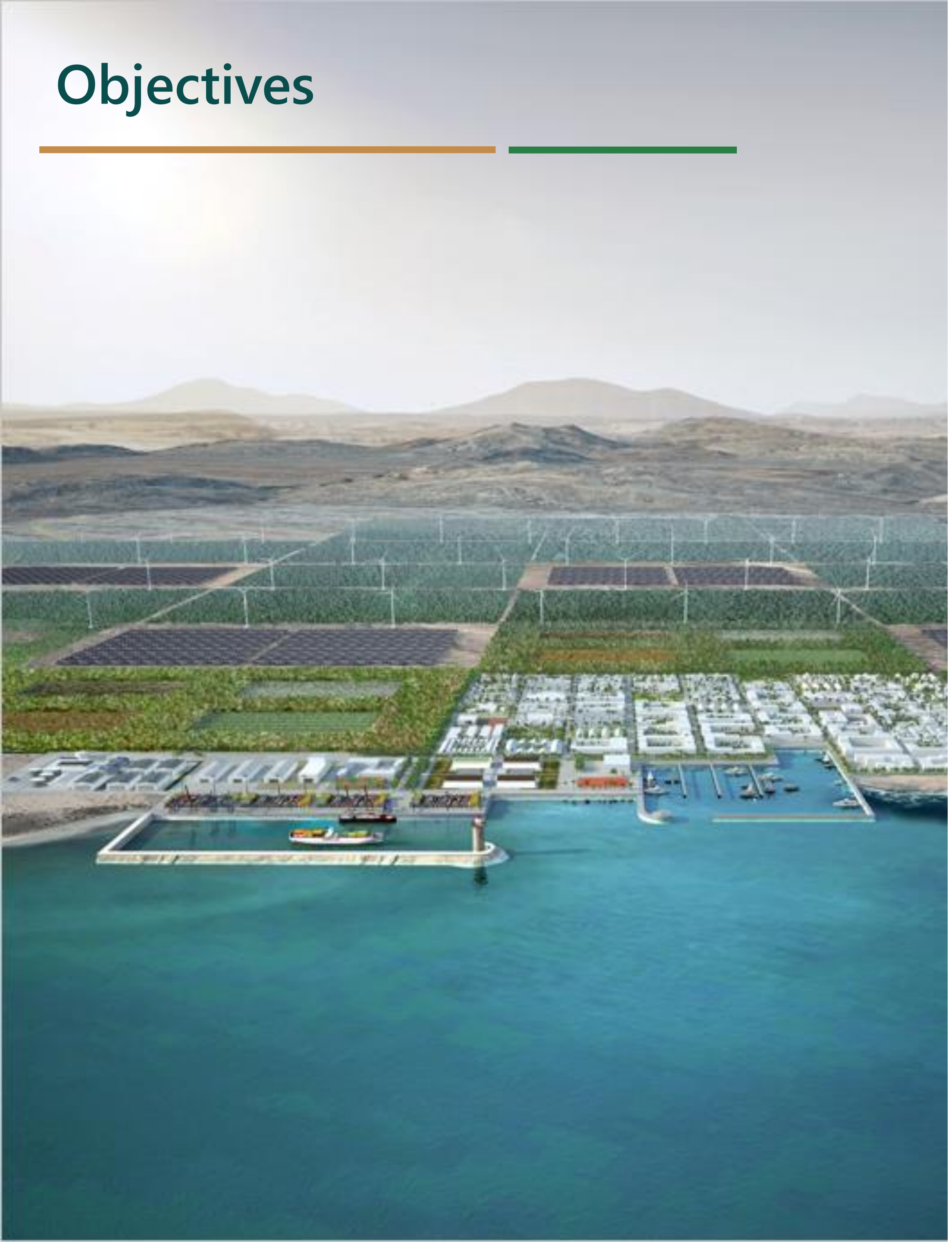
Key facts:

- 20 000 m^3/d desalinated water
- 10.000 m3 sold to Nouakchot
- 250 ha Prosopis juliflora etc.
- 50 ha onions and staple food for local demand
- 10 ha Jatropha curcas / Moringa oleifera

Phase 3: industrial rollout 60.000 to 105.000 ha

Phase 3 – 65.000 ha; LCOW 0,40€/cbm;





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

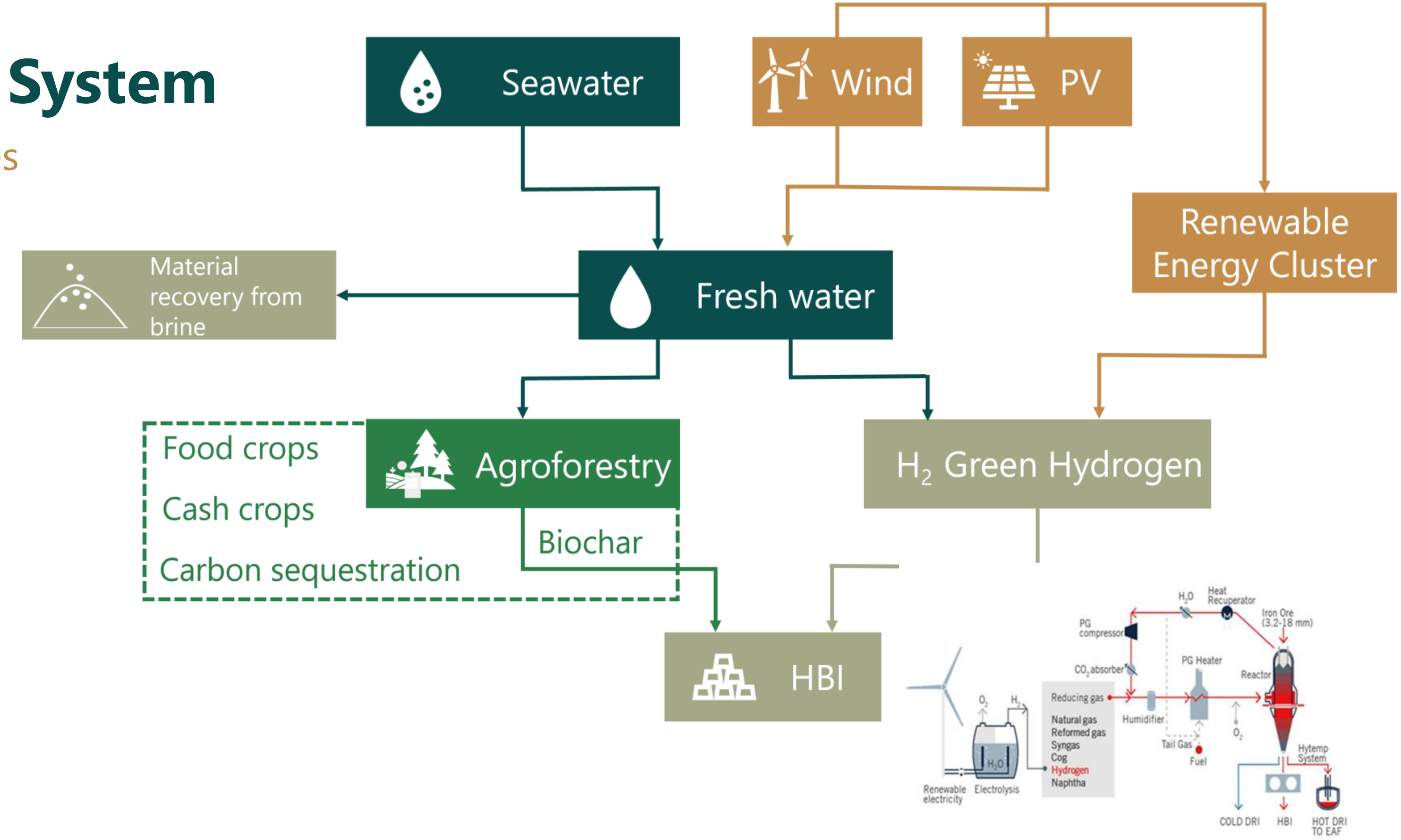
KPI – Basis Scenario

Parameter	Unit	Reference	Scale-up	Maturity
LCoW	€/m³	0,99	0,89	0,46
ES-% reduction			10%	54%
Forestry CAPEX	€/ha	80.202	65.259	45.889
ES-% reduction			19%	43%
WACC		5,4%	5,4%	5,4%
IRR		n.a.	4,1%	5,8%
PBP	a	n.a.	n.a.	28
NPV	k€	n.a.	-1.246	205.719

Workshop with 5 ministers in Nouakchot

Production System

Unfolding Synergies



Next steps!!!

Extracting water, Manganese, Lithium, Potassium, NaCl from brine

Using brine in „new“ 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

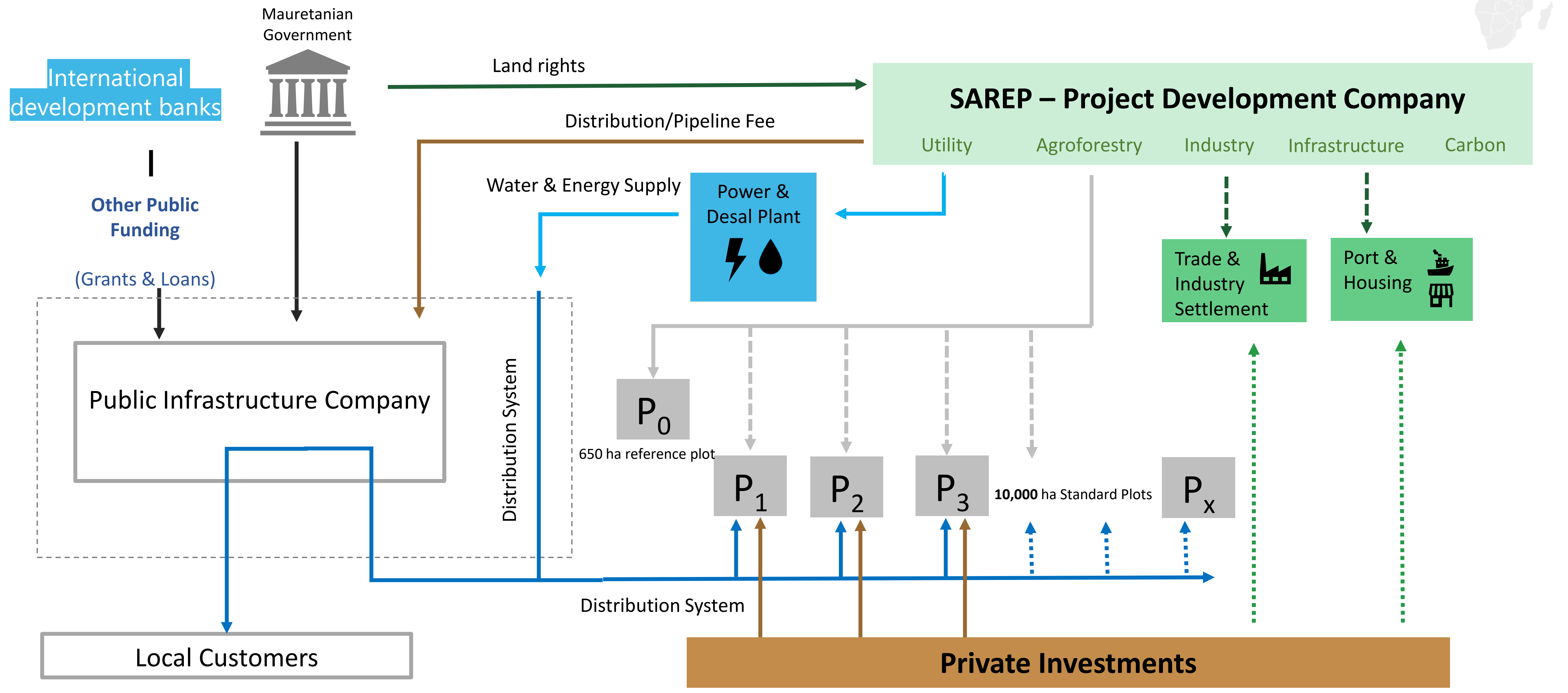
Source: http://www.queller.org/wuestenspargel/

SDG compliance

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

Proposed Stakeholder Structure



Local and international stakeholders

Summary and next steps

- SAREP uses **state of the art technologies** to solve pressing worldwide problems
- SAREP offers **affordable potable water** and **food for local population**
- SAREP offers potential for extraction of **manganese, potassium, NaCl and Lithium** from **brine**
- 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**
- SAREP **starts in 2025** with first **50 ha proof of concept plantation**

Green business model for climate mitigation and regional development

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

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

Dr Felix Flesch, Dr. Gerhard Ohlde
Phone: +49 6782 17 - 2623
e-mail:
f.flesch@umwelt-campus.de
g.ohlde@umwelt-campus.de