Technical and Economic Dimensions of Seawater Desalination & Renewable Energy Production in Mauritania

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Overview

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2) **REdesal** – chances & challenges
3) **REdesal** – the optimal system
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SYNLIFT Industrial Products – the company

SYNLIFT Industrial Products (SIP) was established in 2015 to develop and implement SYNWATER® and SYNUTILITIES® projects für medium and large capacities.

SYNWATER® stands for smart water technologies (water only) - powered by renewables (RE).

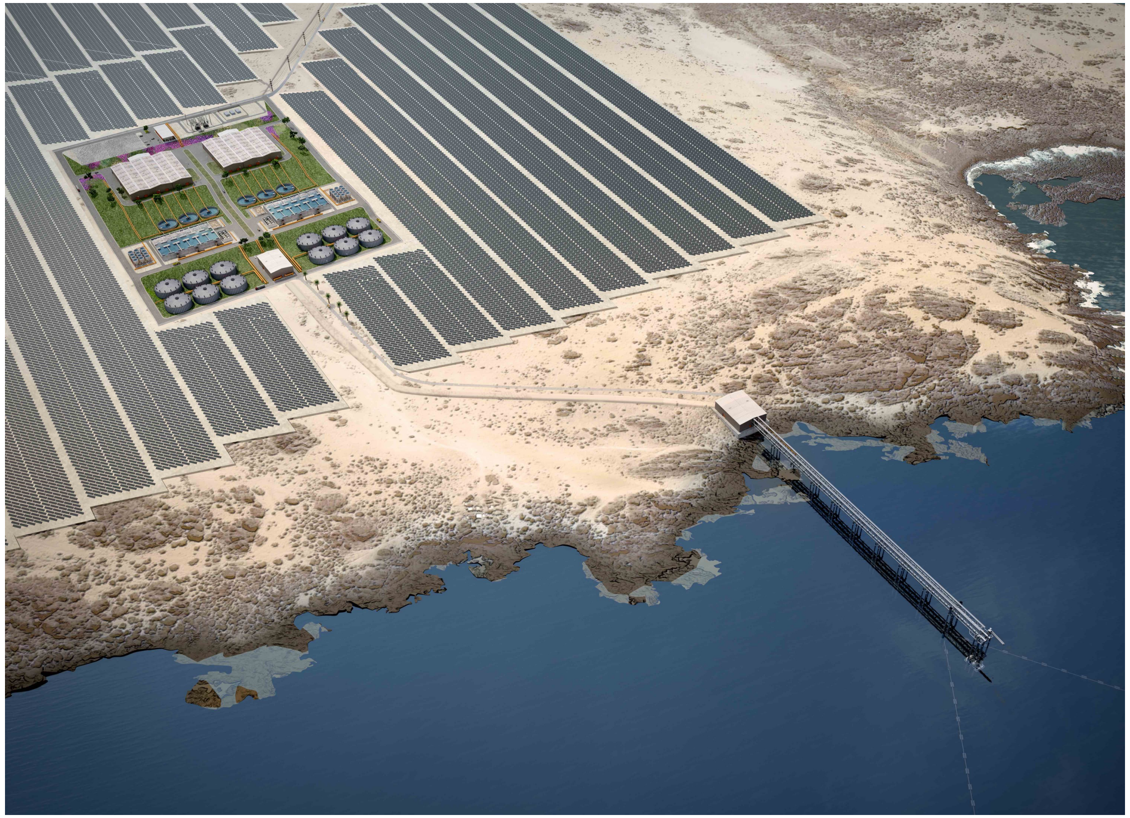
SYNUTILITIES® stands for both energy & water supply - powered by renewables.

REdesal stands for seawater desalination - powered by renewables and is one focus of SIP business activities.

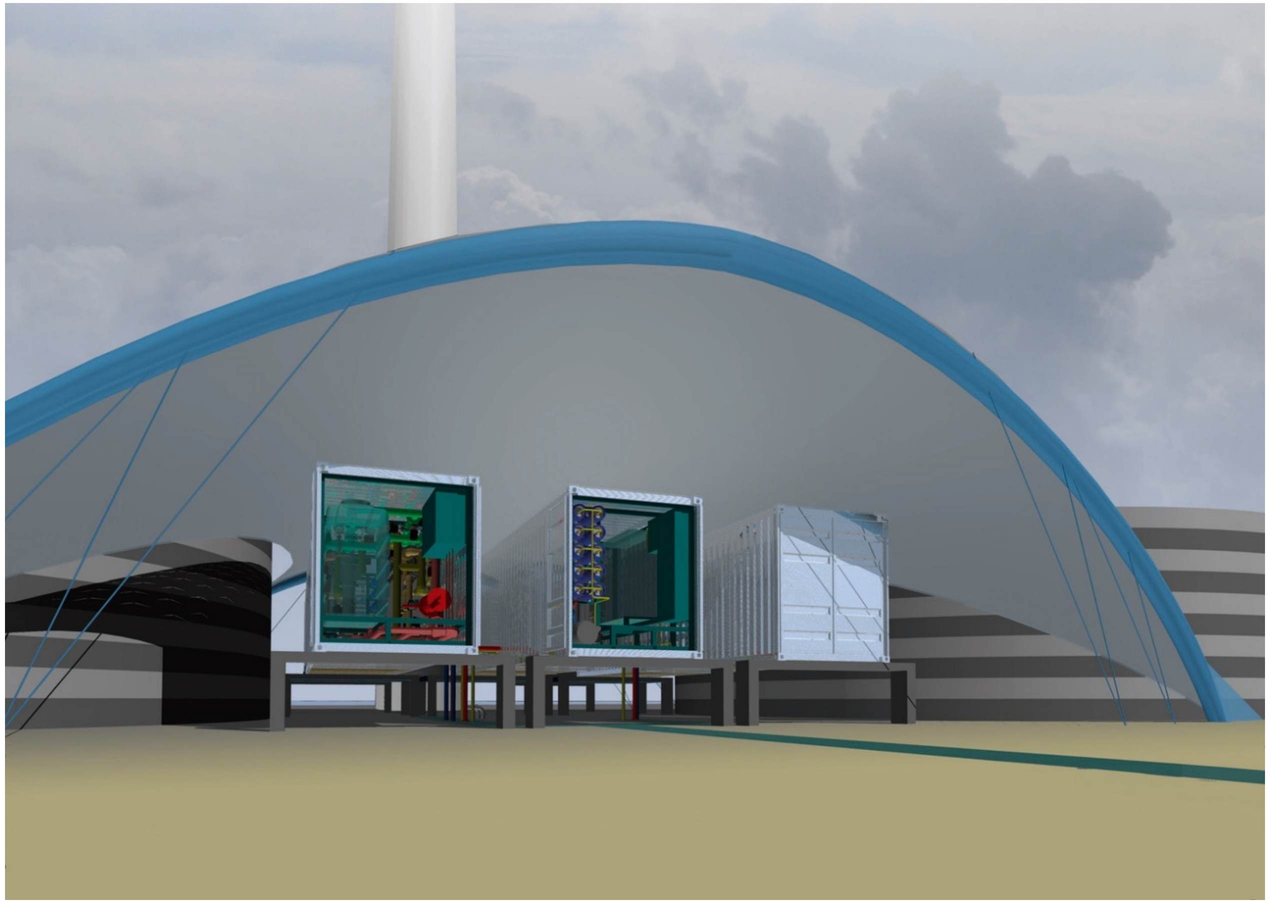
SYNWATER®
desalination by renewables

SYNUTILITIES®
energy & water by renewables

SYNLIFT Industrial Products – REdesal technologies (I)



SYNLIFT Industrial Products – REdesal technologies (II)



Floating WINDdesal – Technology

Extra-Long-Blade Technology (ELBT)

Customized ELBT turbines are used for FWD, which are ideally suited for wind power self-consumption due to their very low specific power (W/m^2).

Energy Management & Flexible Processing

The integrated energy generation, storage and consumption management in combination with a flexible desal processing enables a continuous adjustment of the production level to the current wind energy output and thus a maximum wind penetration.

Intake & Outfall

Intake and outfall are integrated into the floater structure. The outfall is offset horizontally and vertically to the intake during operation.

Mooring System

The variation in length, cross-section and steel grade of the mooring chains enables the anchoring to be optimally adapted to the individual site conditions.

Submarine Piping & Cabling

The permeate is delivered to the mainland by submarine piping. For ongrid configurations, the piping together with the power cable forms a submarine media line.

Modules	Production Level [1] (m^3/d)		Supply Equivalent [2] (Number of inhabitants)	
	recommended	maximal	recommended	maximal
FWD 10,000/15,000	10,000	15,000	100,000	150,000
FWD 20,000/30,000	20,000	30,000	200,000	300,000
FWD 30,000/50,000	30,000	50,000	300,000	500,000

1) The value *recommended* indicates the operating capacity enabling a high wind penetration level of 90% +/- x%. The value *maximal* indicates the installed or maximum production capacity.

2) Based upon an assumed private water consumption of 100 liter per capita and per day the number of inhabitants is presented, which could be supplied per FWD unit operating on a recommended or maximal production level.

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Water Supply – general requirements

Global Challenge Water Supply

* Limitations of surface and groundwater resources,
* Increasing effects of climate change,
* Increasing water demand

are already leading to challenges in water supply - and the trend is rising.

In the near future, water supply bottlenecks or emergencies will occur worldwide and also in highly developed industrialized countries, unless future-proof paths in water supply are followed.

Requirements for Future-proof Desalination Systems

To meet existing and future water needs, seawater desalination (SWD) is the key technology for coastal regions worldwide.

Essential requirements for effective and sustainable SWD systems

* Minimal interference in the maritime and terrestrial environment;
* Minimal CO_2 footprint operating the energy-intensive process;
* Short-term availability;
* Scalable supply capacities for medium and large structural units;
* Cost-effective water supply in competition with established (conventional) desalination solutions.

Constructing desalination today means:

Delivering water for the next generation

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REdesal – chances

Using the unlimited resources of seawater as well as solar and wind energy, REdesal can enable a reliable, sustainable and cost-effective water supply.

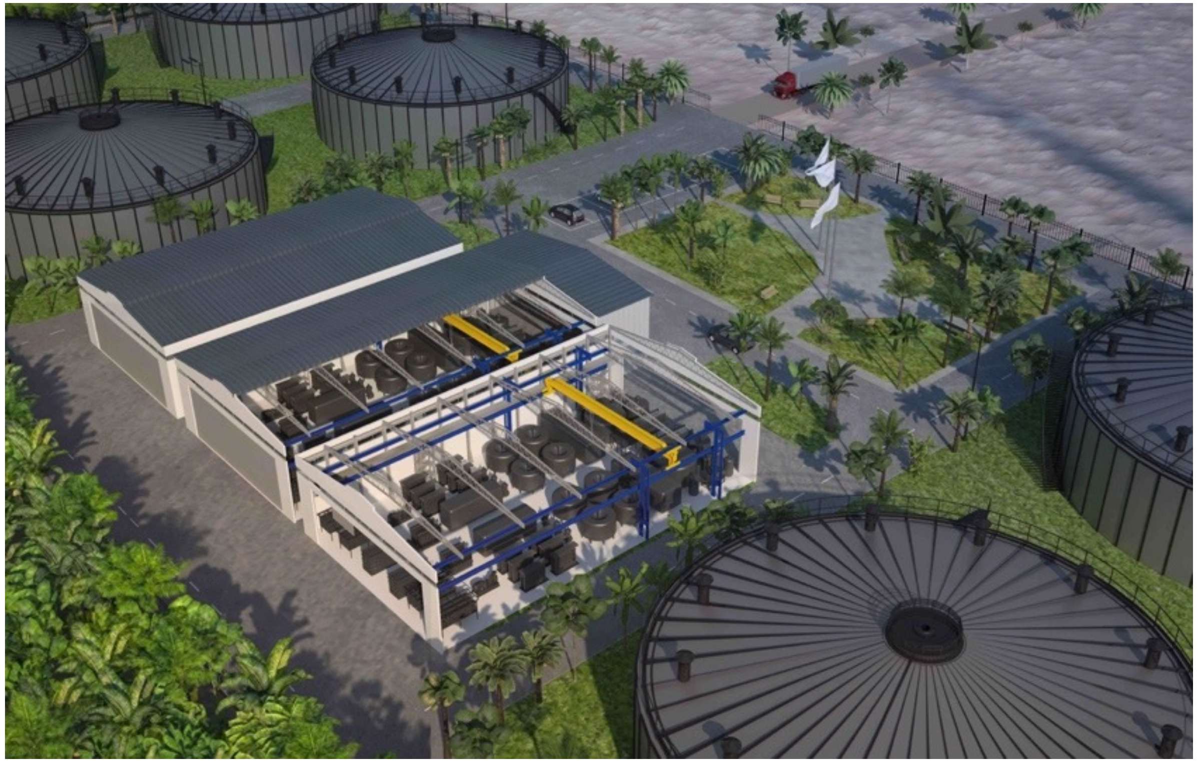
REdesal – challenges

Challenge 1:

Wind and/or solar powered seawater desalination shall be operated at ***maximum RE penetration*** (100% if possible).

Challenge 2:

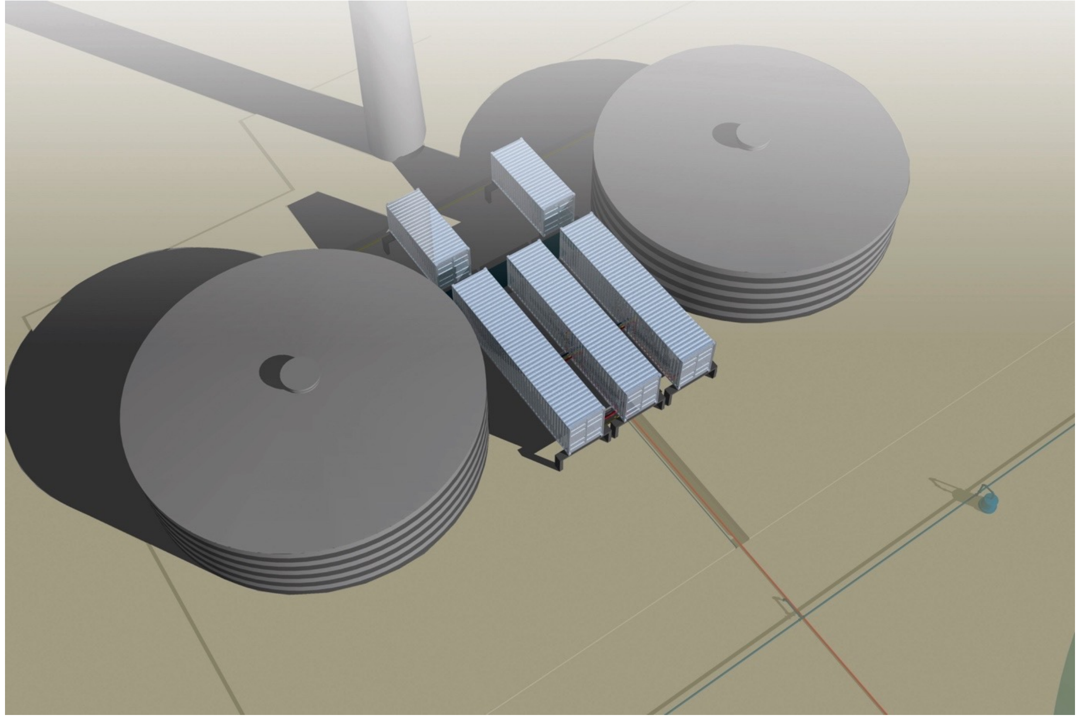
The final product drinking water shall be provided ***at minimum cost***.



REdesal – the optimal system (I)

An optimal REdesal system is site-specific and based upon an integrative system approach in which all four technology parts are optimally coordinated with one another:

energy production, energy storage, energy consumption & product storage.

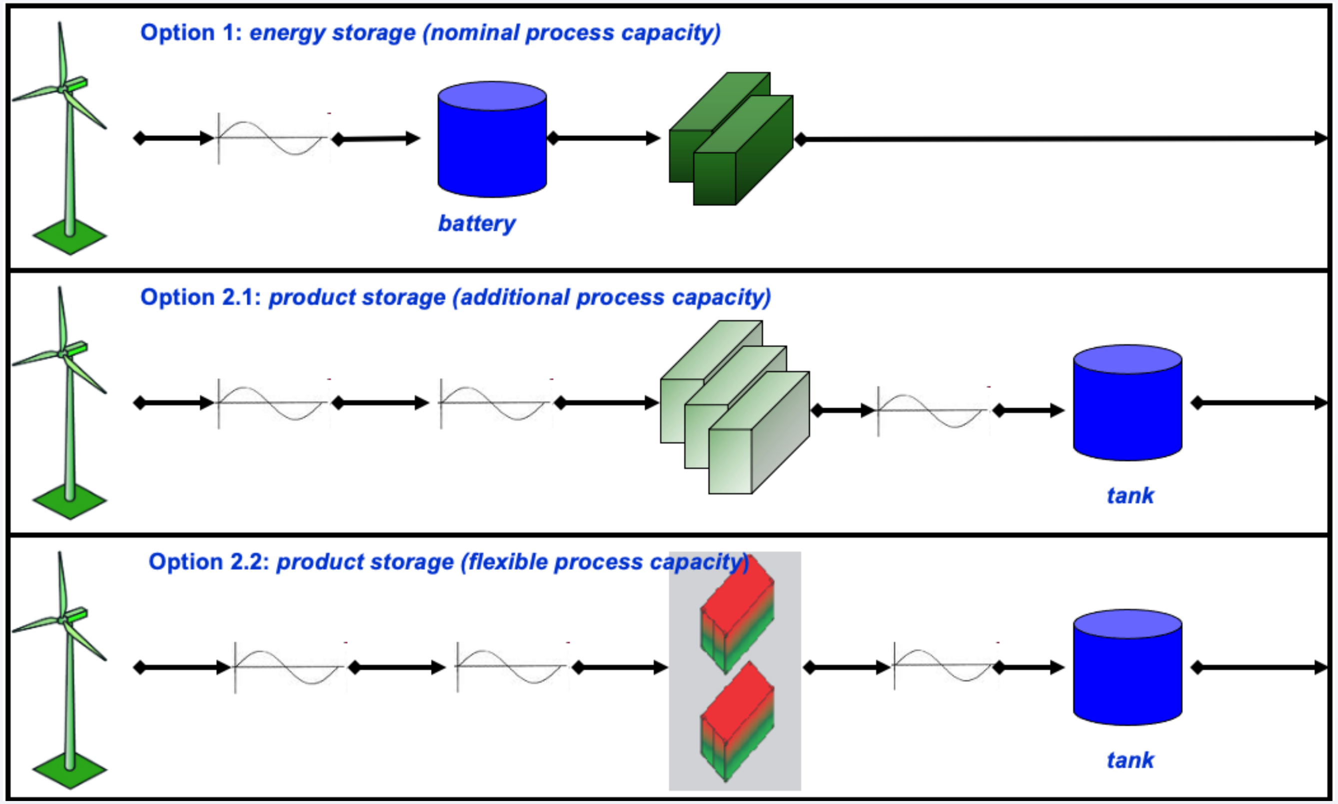


REdesal – the optimal system (IIa)

Two options for RE system integration – technically

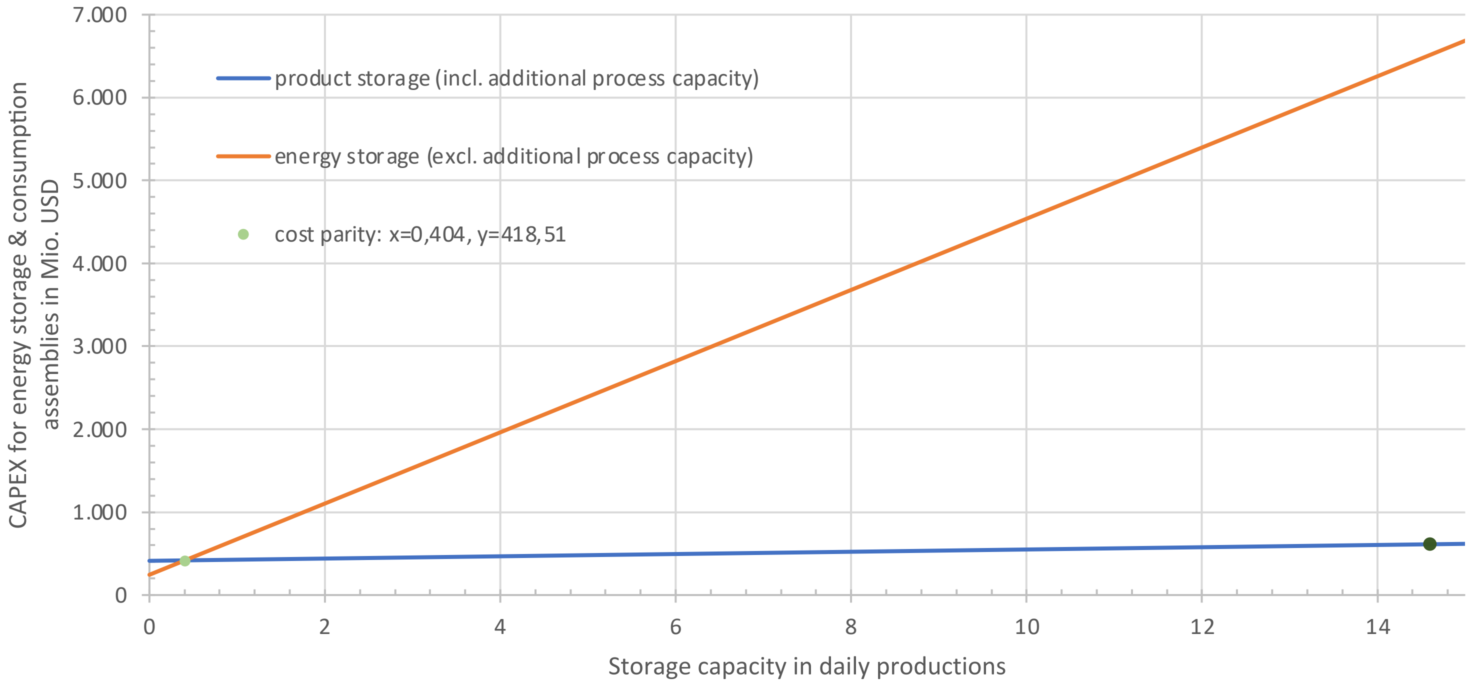
Option 1: The *intermediate* product *energy* is stored and thus, the processing is decoupled in time from the RE power supply.

Option 2: The *final* product *water* is stored and thus, the process control is directly coupled to the RE power supply and requires flexible and extended process capacities (preferred solution).



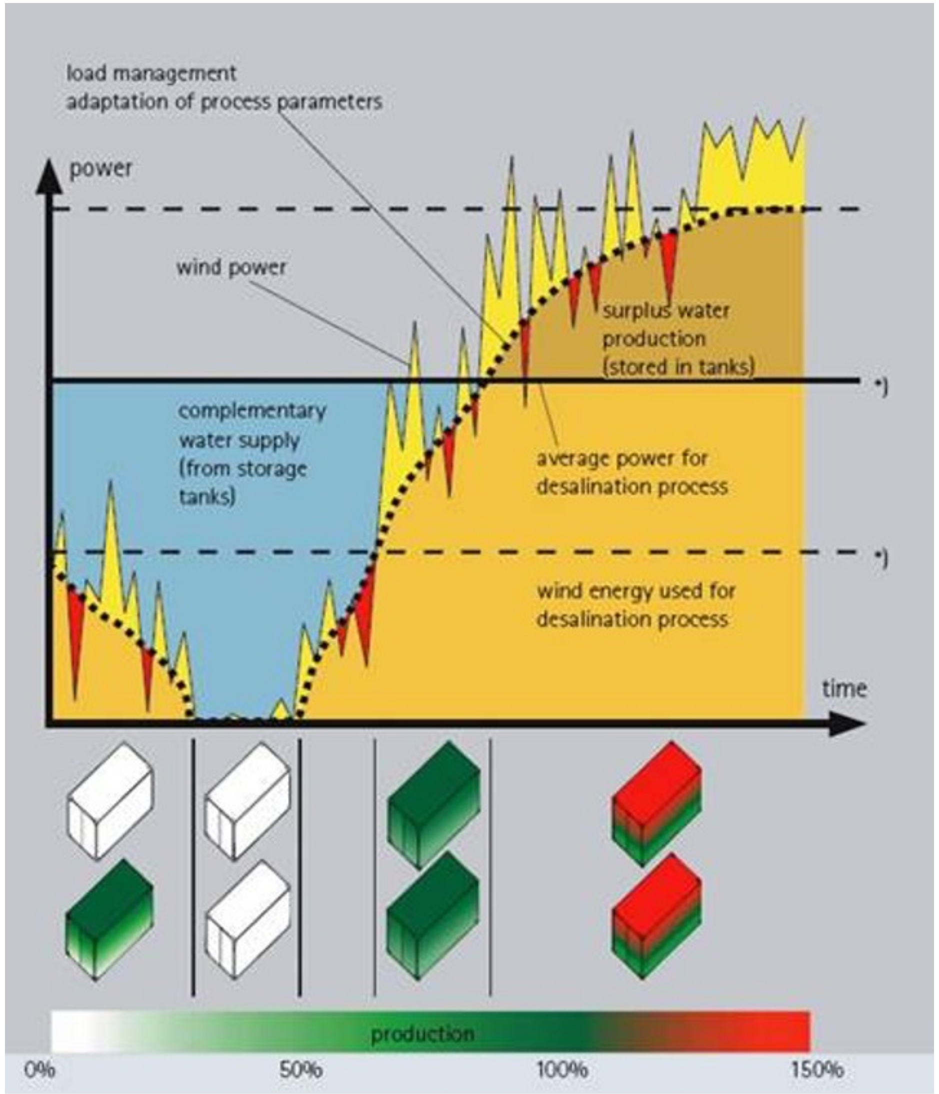
REdesal – the optimal system (IIb)

Two options for RE system integration - economically



REdesal – the optimal system (IIc)

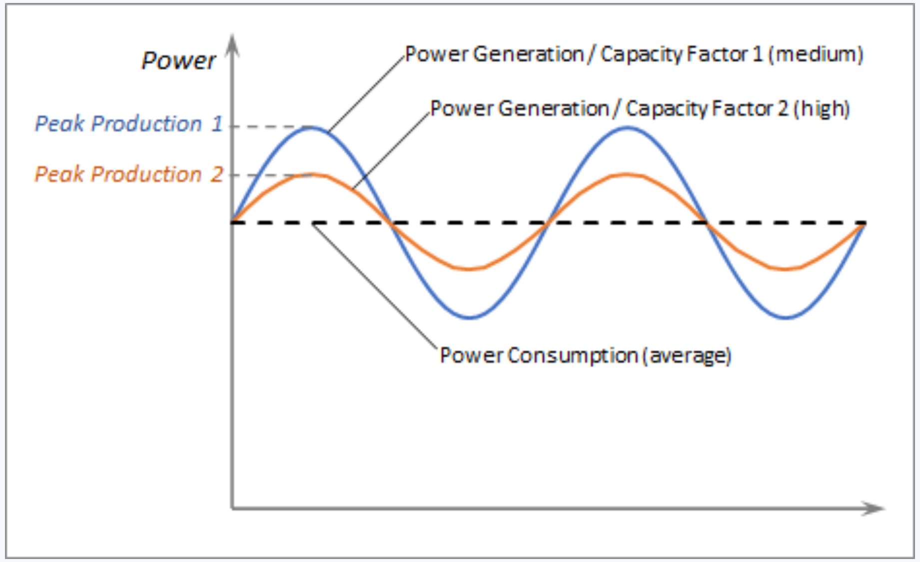
The preferred option for RE system integration



REdesal – the optimal system (III)

Technology Sector 1: ***Energy Generation*** *(wind and/or solar technologies)*

RE technologies should be used with a maximal capacity factor – if necessary by developing further standard technologies.



REdesal – the optimal system (IV)

Technology Sector 2: ***Energy Storage*** *(seconds & minutes reserve)*

Energy storage capacities must be minimized for cost reasons. Required multi-hour and multi-day reserves can be realized as product storage in combination with flexible and expanded process capacity.

The primary task for energy storage is to absorb short-term fluctuations from renewables' energy output.

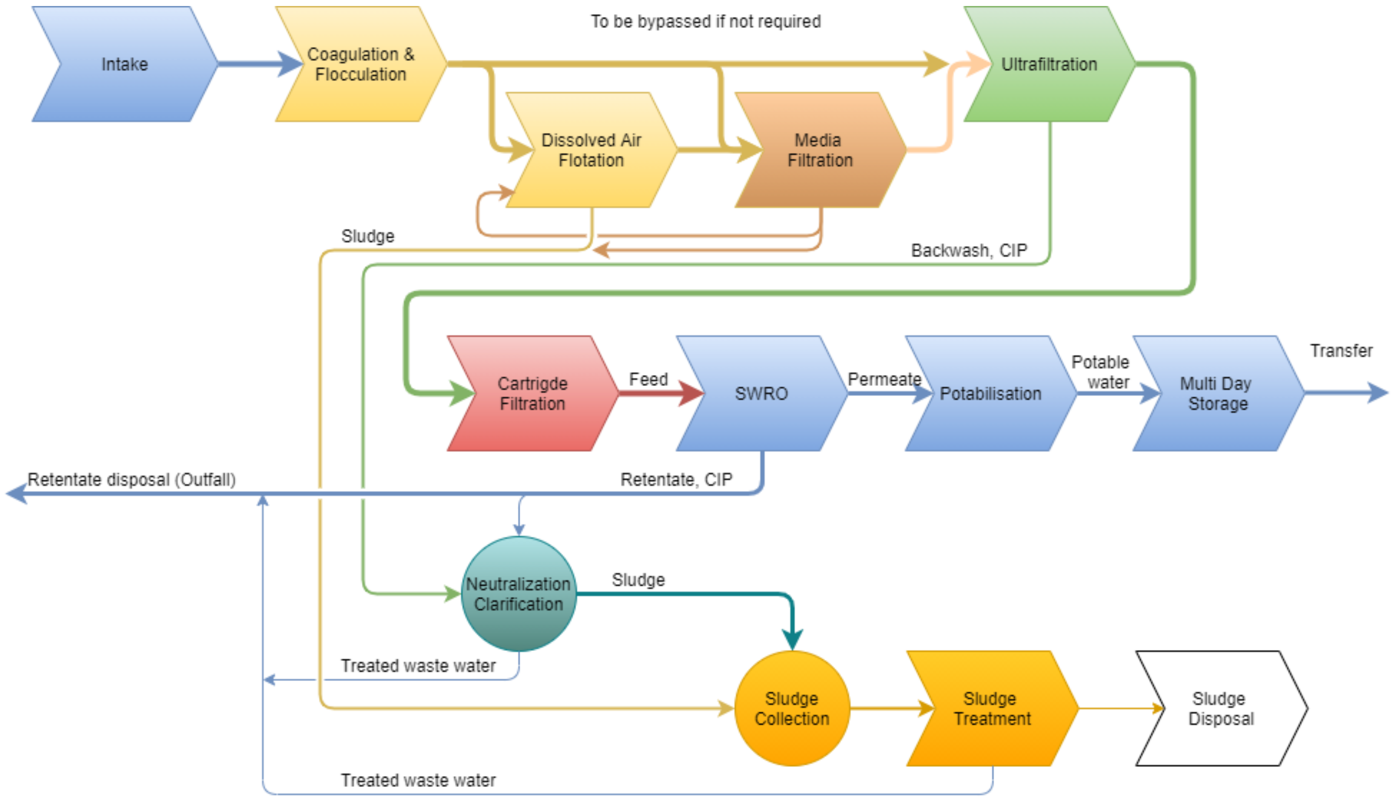
Technology options are e.g.:

- Flywheel as seconds reserve;
- Li-ion batteries as minutes reserve;
- VRF batteries as multi-minutes reserve.

REdesal – the optimal system (V)

Technology Sector 3: ***Energy Consumption*** *(flexible RO processing)*

In addition to *continuous* load adjustment (primarily via frequency-controlled pumps), optimal flexibility of the RO process also includes *discrete* load adjustment (switching RO modules on and off).



REdesal – the optimal system (VI)

Technology Sector 4: *Product Storage* *(reservoirs vs. tanks)*

Longer periods with below-average renewable energy availability usually require multi-day storage. These are much cheaper to implement as reservoirs with floating covering than with tanks, especially for large capacities.

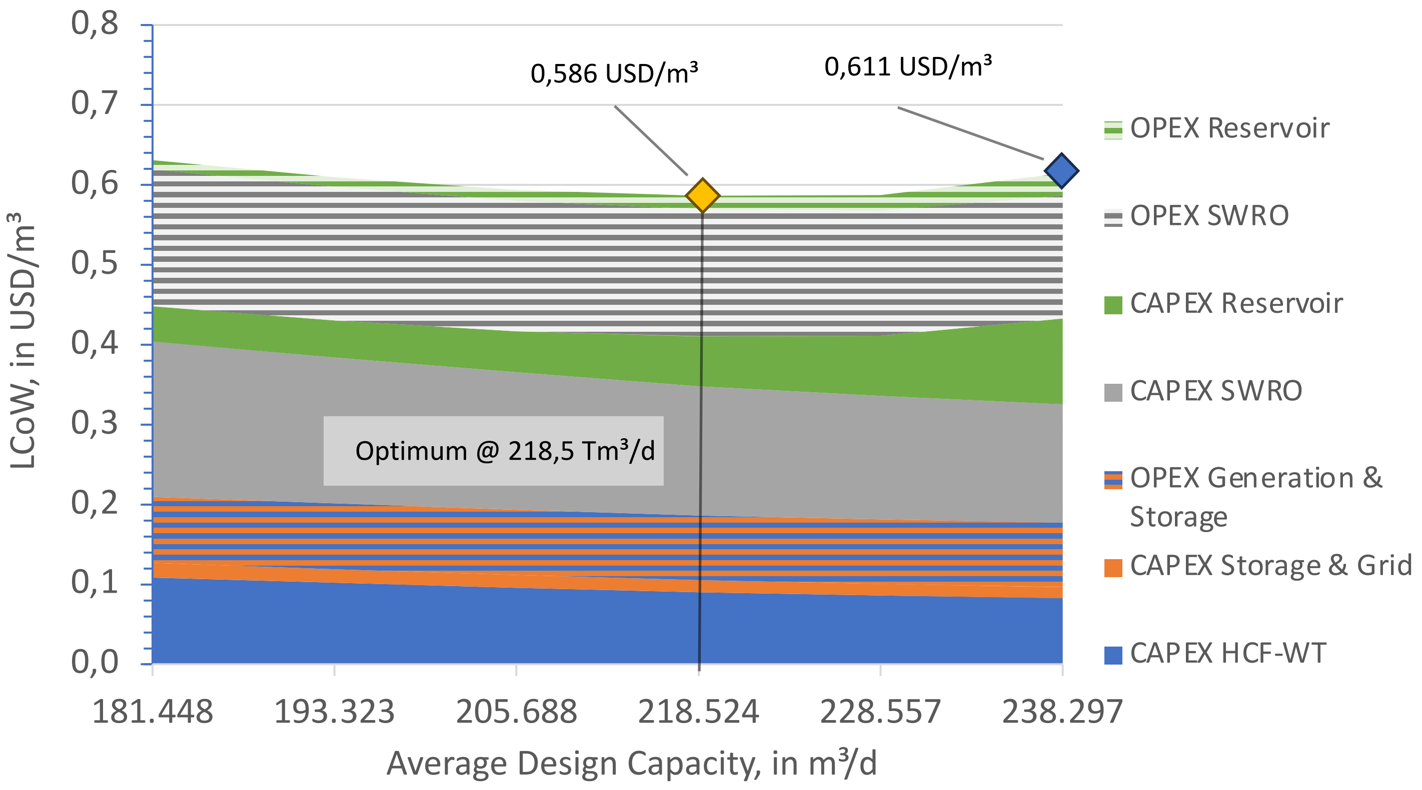
(Water reservoir with Dynactive covering system (source: Benecke-Kaliko/Continental AG).

REdesal – economics

The final product cost (LCoW) depends on numerous aspects such as:

- ❖ Site conditions (wind & solar resources, raw water quality, local infrastructure, etc.);
- ❖ Rights & permissions;
- ❖ Purchasing costs/world market prices;
- ❖ Financing costs;
- ❖ Capacities.

The final product costs (LCoW) therefore vary within a range between approx. 0.30 – 1.20 EUR/m³.



REdesal & RE – potential for SAREP & Mauritania (I)

REdesal & RE – potential for SAREP & Mauritania (II)

The Mauritanian coast has very good to excellent wind (class 1) and very good solar radiation resources and therefore offers ideal pre-conditions for cost-effective seawater desalination – even on a global scale.
For SAREP with a future REdesal capacity of **2.0 - 2.5 million m^3/d** per system, LCoW of approx. **0.30 - 0.40 EUR/m^3** is forecast.

For the water supply of Nouakchott with a capacity of approx. **0.2 million m^3/d**, LCoW of approx. **0.60 - 0.80 EUR/m^3** is forecast. It is planned to later integrate this REdesal plant into SAREP's water supply system, from which further synergy effects and cost reduction potential are expected.

For both solar & wind energy we would expect LCoE between approx. **2,0 – 3,0 EURCent/kWh**.

REdesal – next steps for SAREP & Mauritania (I)

REdesal – next steps for SAREP & Mauritania (II)

SAREP – reference plot

The agreements with the Mauritanian government are intended to be made in 2023 so that the realization of the reference plot (agroforestry activities on up to 1,000 hectares) can begin at short notice.

Water supply for Nouakchott

The German side has offered to develop and to sign a Joint Development Agreement (JDA) with the Water Ministry/SNDE in 2023 in order to realize a REdesal plant with approx. 200,000 m^3/d in 2024 – 2025/2026.

Acknowledgments

Thank you for your attention!

Our sincere appreciation to Prof. Peter Heck and his team for preparing this important conference and hosting us at this wonderful place.

The entire SYNLIFT team will be happy to provide you with further information.