

From Coal Age to StorAge

High temperature thermal storage of electricity for global energy transition from fossil to renewables – converting coal plants into storage plants

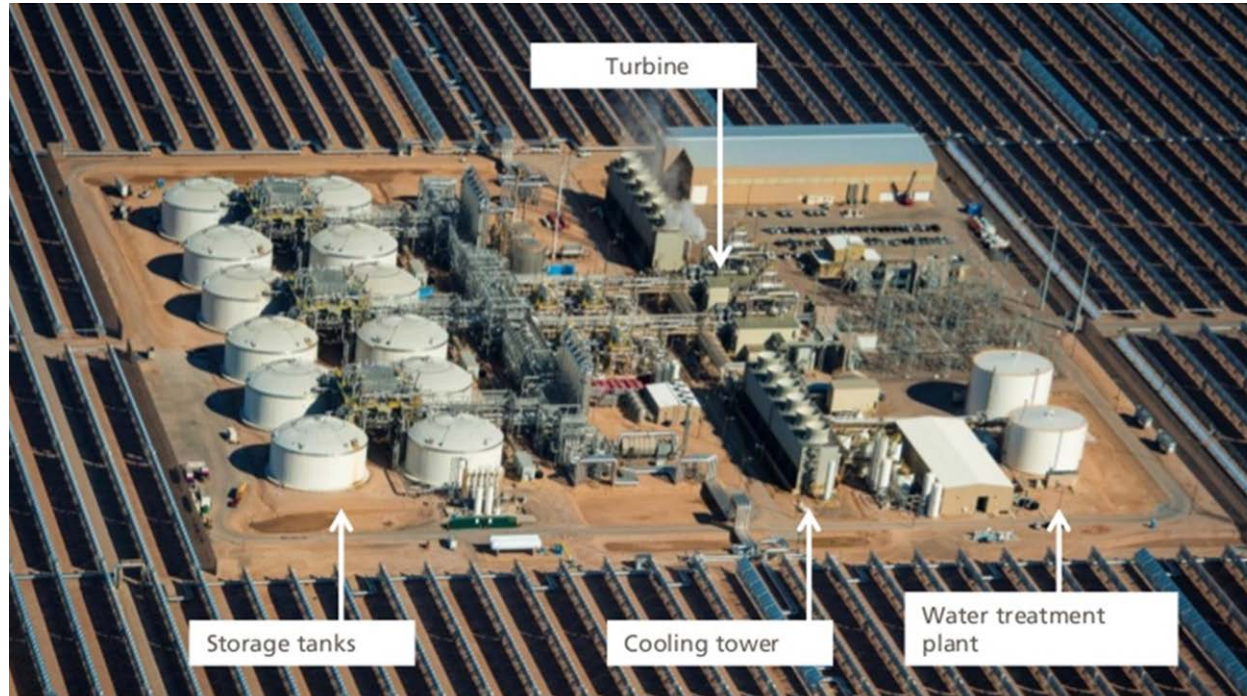


Adapted by Malta Inc from EcoEnlightened Charitable Org. Inc.

Michael Geyer, Senior Advisor



Today world's largest utility scale electricity storage is thermal – operating since 2012 6 hours of 280MWe discharge capacity at Solana CSP Plant in Arizona, USA



Source: Abengoa

... and it is part of a classical thermal steam cycle power plant
... it is proven and bankable at utility scale



Why not use this thermal electricity storage for decarbonization of coal plants?

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Photographer: Krisztian Bocsi

Climate Changed

Germany's Coal Plants May Be Converted to Giant Batteries

By [Brian Parkin](#) and [William Wilkes](#)

10 de abril de 2019 9:01 GMT-4

The storage units “could be converted from the mid-2020s to innovative, long-term power plants storing surplus wind and solar power,” the Economy and Energy Ministry said in its 32-page report on coal phaseout planning. No particular storage technology has been selected for the switch yet, according to the April 4 report.



German Coal Commission published Jan 28, 2019
its report to step out from coal by 2038

Today 46GW coal plants

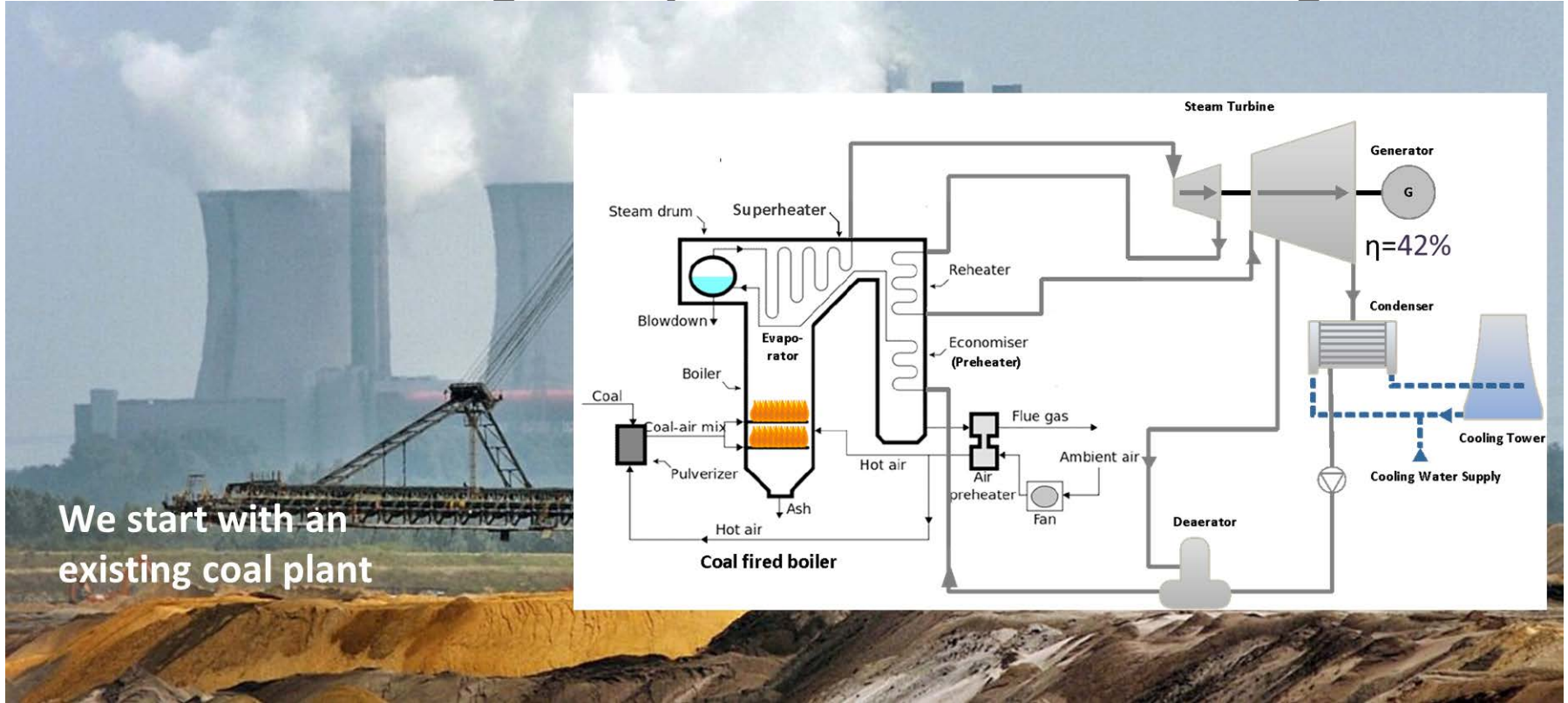
- 2022 to be shut down 7GW
- 2030 to be shut down additional 16GW
- 2038 to be shut down remaining 23GW
- Renewables to be increased from 40% in 2018 to 65% in 2030
- This requires some 7GW additional storage capacity

How to retrofit an existing coal plant with thermal storage



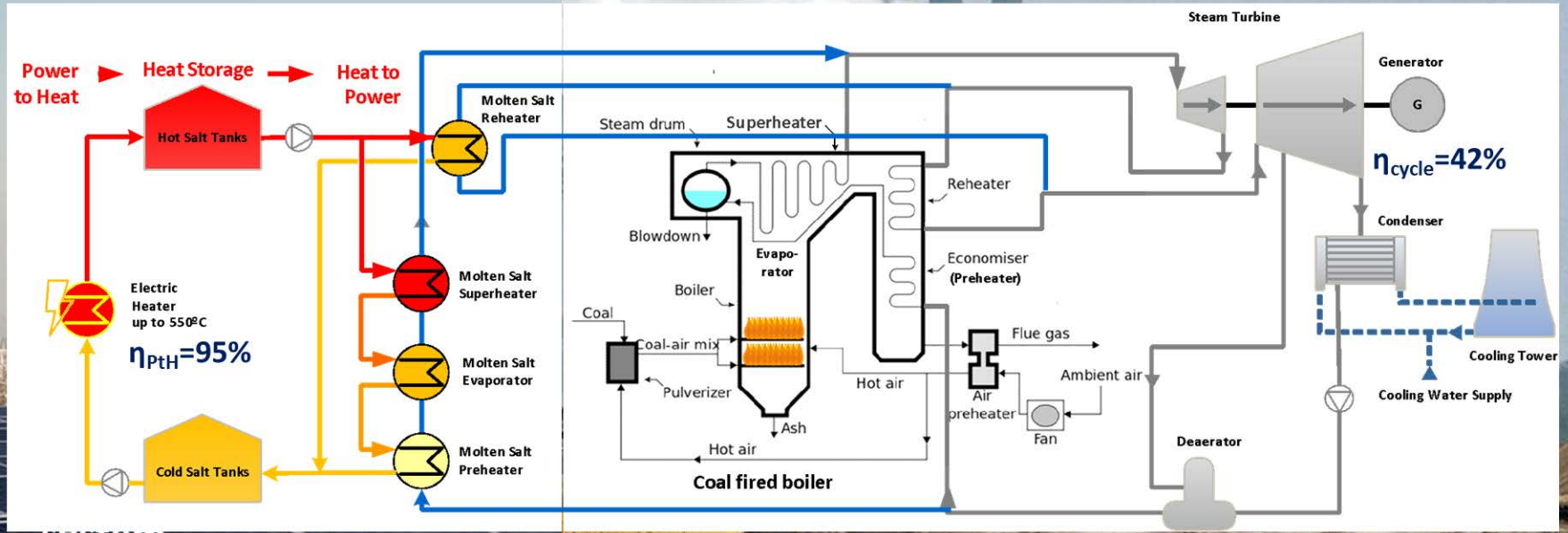
We start with an existing coal plant

Retrofit of existing coal plant with thermal storage



adding a molten salt storage island to the existing

Integration of molten salt storage system in existing coal plant – $\eta_{\text{roundtrip}} = 40\%$



system

All you need is this:

Source: Volcanic S.A.

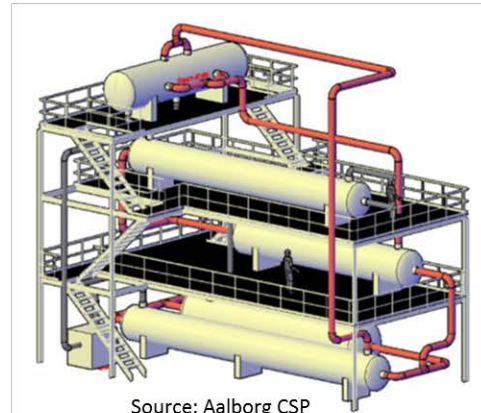


Electric heaters for charging molten salts - fired by PV/wind power

Molten salt tanks – hot and cold



Molten salt steam generators for discharging



Source: Aalborg CSP



Store2Power Pilot Project Germany

Köln/Essen, 15 March 2019

RWE Power AG

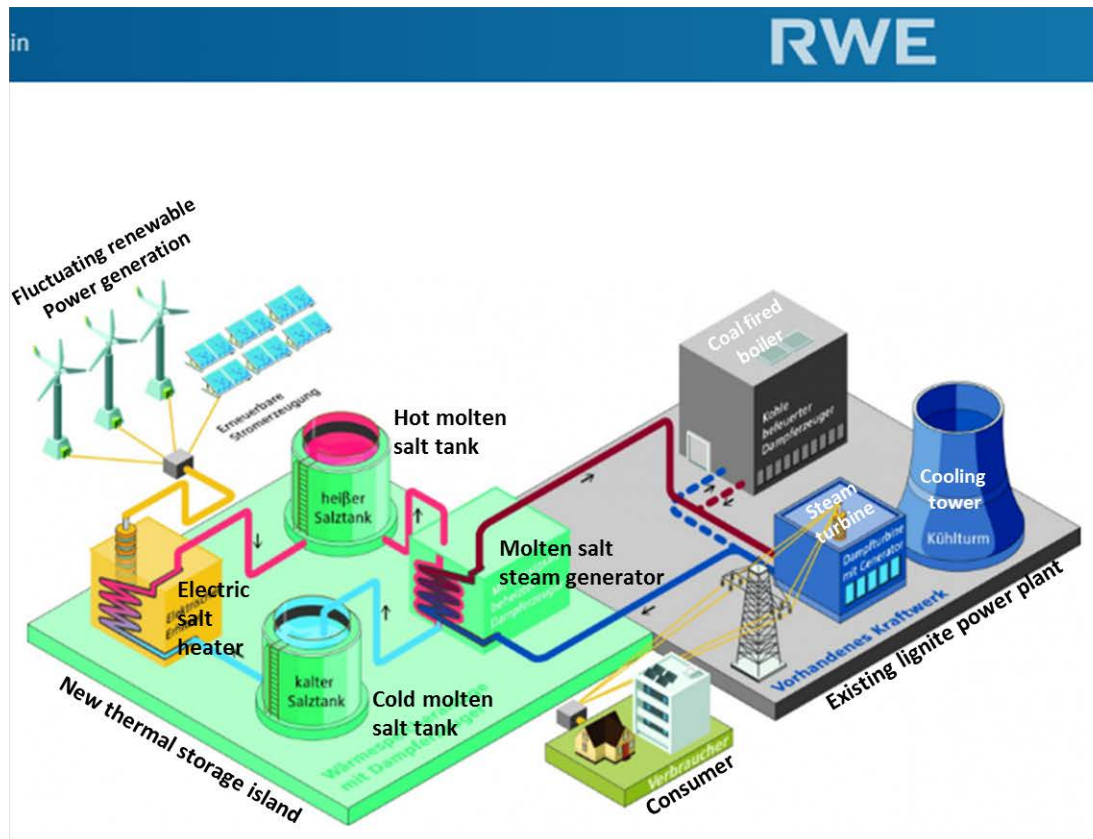
Ground-breaking pilot project: thermal storage power plant to be built in Rhenish lignite area

Newsfacts:

- RWE Power, DLR and Aachen University of Applied Sciences team up in development process
- Molten salt plant integrates renewables and conventional energy and creates future potential for power plant sites
- State of North Rhine Westphalia funds development with €2.9 million

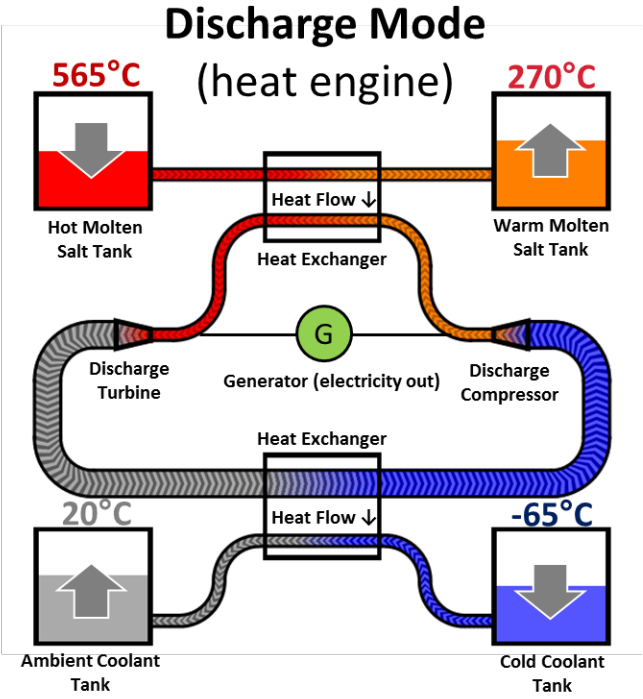
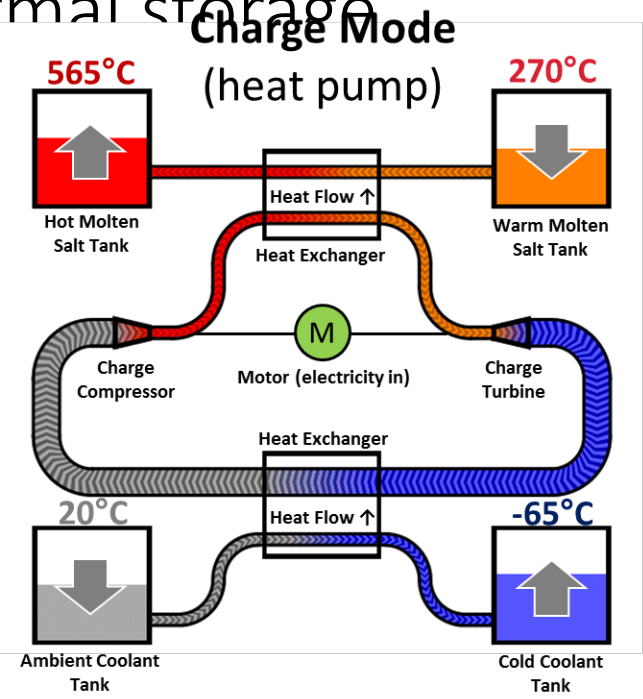
RWE Power AG, DLR and FH Aachen currently analyzing techno-economic feasibility of converting a German lignite plant in the lignite region Rheinisches Revier into a storage plant by retrofit with a high temperature molten salt storage system to be charged with renewable electricity from the German grid. Supported with 2.9Mio Euro grant from state Government North Rhine Westphalia

Construction of pilot planned for 2021/22



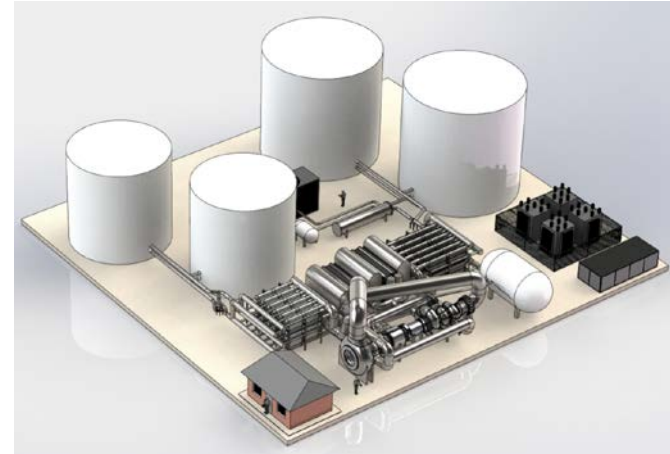
<https://news.rwe.com/ground-breaking-pilot-project-thermal-storage-power-plant-to-be-built-in-rhenish-lignite-area/>

With heat pumps – charge/discharge efficiency tomorrow can be raised to over 60% with molten salt thermal storage



Malta pumped heat electricity storage boosts efficiency to over 60%

- Malta cycle is a **closed loop air Brayton cycle** with recuperation.
- Charge cycle is a **heat pump** that uses turbomachinery to convert electrical energy into thermal energy. The thermal energy is transferred via heat exchangers to salt (hot) and coolant (cold) and stored in hot and cold reservoirs.
- Generation cycle is a **heat engine** that uses heat exchangers and turbomachinery to convert the thermal energy back to electrical energy.
- Storage mediums are **Molten Salt** and an **Antifreeze Liquid** mixture.
- Turbomachinery will be customized for cycle operation for improved efficiency and time to market project implementation focus.
- Heat Exchangers will be customized for cycle conditions but utilize well-known metals and manufacturing processes for improved time to market.
- **Target Capex for 100MWe discharge 10 hours capacity** with 60% charge/discharge roundtrip efficiency is **100USD/kWhe**.



Yes we can convert coal plants into dispatchable renewable storage plants



- ✓ Yes - we can convert a lignite baseload plant to a renewable baseload plant by replacing its coal fired boiler with a molten salt fired steam generator and adding storage tanks for the cold/hot molten salts and molten salt resistance heaters
- ✓ The capital cost of doing that will be about 100-120 Euro/kWhe storage capacity will take about 18 months.
- ✓ Assuming 20Euro/MWhe PV electricity cost for storage charging and 40% steam cycle efficiency, the dispatchable discharging electricity will then cost about 60-70 euros/MWhe.
- ✓ All the components are mature technologies; only the combination of technologies is new, but it a pilot plant has been started now by RWE and DLR at a lignite plant in the Rheinisches Revier in Germany
- ✓ This will convert coal plants to non-carbon plants, utilizing most of the existing equipment in the plants and saving jobs.
- ✓ This will decarbonize the power park while granting 100% dispatchability
- ✓ With heat pumps round trip efficiency can be increased in future to over 60% at target CAPEX of 100USD/kWhe for 100MWe 10hour systems and further reduce cost of dispatchable discharging electricity to 50 euros/MWhe and below

