

Harvesting energy **FROM THE SUN**



Contribution of Power-to-X-to-Power in Retrofitting of Coal-Fired Power Plants

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Transition from Boilers to Renewable Systems



"Experience from thermal systems and large-scale CSP power plants has **transitioned** into technology

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integration expertise"



The Renewable-Palette – Possible Technology Integration





Generator

ORC

HT Electrolysis

Steam condenser

& Cooling tower



"From the transition experience,

comes the **integration** experience"

The Renewable-Palette – Possible Technology Integration



"Power-to-X-to-Power

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is a concept that is based on both

transition & integration"



Power-to-X-to-Power contribution to Energy-Transition & System Integration





Rationale	Concept C	ase Study
 Global Energy Policy CO₂ emmessions & enviroenmental aspects Decommissioning of CPP (i.e NG) Competing resources (natural gas) are also a reason Commercial Feasibility of TES Capacity of TES project in (e.g. China) 	 Demolishing of Coal components Such as, boiler, chimney Replacement with RE-Package MS-Electric Boiler, SGS & TES Re-using of existing components Steam Turbine Generator, Transformers, H.V switch-gear & water treatment plant/DH system, if any. 	 Example of 4.0 GWh_{th} CPP Initial Investement Investement in H-TES, EB, SGS, TES-tanks. Potential Savings THE REUSABLE ASSETS HAS LONG LIFETIME WITH CONTINUED MAINTENANCE Lower temp = longer lifetime



Potential CO2 saving from 3 Coal Fired Plants in Denmark

3 Coal fired plants Combined CO2 in 2017:

• 4.609.111 Ton.CO2/Year 2017.

Potential equivalent CO2 if from cars:			
•	Reduction number of cars: Total Cars in DK.2019	1.936.601 3.002.889	
•	Or 6.000 Jumbojets CPH – New York t/r		

CO2 Savings Denmark Equivalent to 64% of total Privat Cars



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A. Retrofitting of (CPP) with P-X-P

Commercial Feasibility of TES



Projects commenced and planned to

be completed before end 2020

http://en.cnste.org/html/news/2017/1013/330.html



Commercial Feasibility of TES

Projects commenced and planned to be completed before end 2020







Typical Coal fired power plant unit

generating electricity and heat



Typical reusable assets from converted Coal fired power plant

THE REUSABLE ASSETS HAS LONG LIFETIME WITH CONTINUED MAINTENANCE Lower temp = longer lifetime

A unique chance to make Green power at reduced Investment.







Replacement Equipment-Package





Coal fired power plant Retrofitted and

downscaled to operate 100%

Renewable





In Denmark we have 5.000 MW wind

power increasing to 7.500 MW











Export – 1.962 MW At 59 kr/MWh (Money in the box)





The Danish Electricity situation

"Blowing in the Wind"



The Danish Electricity situation

2 days later!

"Blowing in the Wind"

Cost of storage – Who pays ?? Can it be used to pay back the investment ??

A solution can combine <u>CSP</u> and surplus <u>Wind</u> Electricity with <u>high</u>

temperature and low temperature

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<u>storage</u>

Surplus Wind and Solar Electricity charging to High Temperature Energy Storage - Discharge on demand

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B. Expansion of Wind Farms in Synergy with P-X-P

Integration with *low temperature energy Storage* - (PTES)

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Principal future Wind/Electrified power plant with Molten Salt HIGH TEMPERATURE Energy Storage

Investment Cost of <u>EB-TES-SGS</u> Package

It may not be profitable only driven by the spotmarked, Storing energy capacity must have a value Installation of one plant **4.000 MW**_{th} High temperature Energy Storage Investment cost 100 mio or **650 mio DKK**

Investment in **40.000** MW_{th} (10 x 4.000 MWht) = 10 x 650 = **6,5 bill. DKK**

-Capex financing through grants from Danish "Klimakompenseringsfonde"

-Opex Business case through :

- Buying and selling Electricity
- Selling heat
- Provision of Grid Balancing and stability services.

Potential & Possible Sector Integration

Hydrogen and fuel production. Support Green Transport Sector

Potential & Possible Sector Integration

Possible integration with CSP Solar plants for Export opportunities

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Achievable supported Political Goals

- 70% National CO2 reduction goal
- United Nations Sustainable Development Goals

THANK YOU FOR YOUR ATTENTION

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