References and assumptions for calculations in: http://buschbacher.at/BesserAlsEFuelsEN.html					
Indicator		**Value**	**Unit**	**Reference**	**Remark**
Conversion efficiencies within the production of synthetic hydrocarbons	Electricity to hydrogen	70%		https://www.oeko.de/fileadmin/oekodoc/PtX-Hintergrundpapier.pdf	Figure 2-2 of the reference; always relying on the more favorable value (future potential gaseous hydrogen). Calculation is based on the lower calorific value.
	Electricity to methane	61%			
	Electricity to liquid e-fuels	53%			
	Hydrogen to methane	87%		reversely calculated from the total efficieny values for methan and e-fuels	
	Hydrogen to liquid e-fuels	76%			
Efficiencies for gas powered combined cycle cogeneration plantes	maximum achieved electric power output of the exemplary power plat during a test (without district heating)	603,8	MW	https://web.archive.org/web/20160128155608/https://www.zfk.de/energieeffizienz/kwk-fernwaerme/artikel/duesseldorf-kraftwerk-bricht-zahlreiche-weltrekorde.html	
	maximum achieved electric efficiency of the exemplary power plant during a test (without district heating)	61,50%			
	achievable district heating output of the exemplary power plant	300	MW		
	achievable total efficiency of the exemplary cogeneration power plant (electricity + district heating)	85%			
	Fuel input	982	MW	reversely calculated from power and efficiency values above	
	remaining electric power output at maximum district heating output	535	MW		
	Electric efficiency at maximum district heating output	54%			
	Share of district heating output in the fuel input at maximum district heating output	31%			
Indicators of the Carnot battery project "High-T-Stor" (similar principle, but much smaller and for shorter storage duration)	Height of the core storage unit	2,47	m	Felix Holy et. al.: Sensibler Hochtemperaturspeicher bis 1200 °C mit extern beheiztem Gasturbinenprozess – Entwicklung und Simulation einer neuartigen Carnot-Batterie zur dezentralen Sektorenkopplung, in: vgbe energy journal 6/2023	
	Width of the core storage unit	2,44	m		
	Length of the core storage unit	2,41	m		
	Height of the storage unit including insulation	3,84	m		
	Width of the storage unit including insulation	3,64	m		
	Length of the storage unit including insulation	3,99	m		
	Average insulation layer	0,69	m		
	Total thermal capacity	8,76	MWh		
	Upper temperature limit of the storage	1200	°C		
	Capacity useable for reconversion into electricity	4,78	MWh		The amount of heat, necessary to heat up the storage from ambient temperature to the lowest temperature level usable as input to the gas turbine cycle can't be used for reconversion into electricity. Anyway, this energy isn't lost, it can be used either directly for district heating or remaining in the storage for the next season.
	Usable temperature difference for reconversion into electricity	600	K		
	Heat losses per total capacity	5%	per day		
Conceivable high-temperature heat storage next to the gas power plant Vienna-Simmering	Base area	50 000	m²	https://www.wien.gv.at/stadtplan/	Inkscape vector graphics used for measurement
	Perimeter	900	m		
	Height	60	m	Assumption	
	Insulation layer	2	m	Assumption	Insulation effect isn't competely proportional to the insulation layer thickness (heat transfer resistance at the boundary surface of air and insulation), therefore it was assumed that the 2m thick insulation reduces the heat losses to the half compared to a 0,69m thick insulation
	Heat loss reduction factor per surface area compared to the exemplary project "High-T-Stor" thanks to thicker insulation	2		Assumption	
	Average storage duration	210	Tage	Assumption	
	Total thermal capacity	1 809 346	MWh	Extrapolated by volume from the exemplary "High-T-Stor" storage	
	Capacity useable for reconversion into electricity	987 291	MWh		
	Heat losses in absolute figures per day	385	MWh/d	Extrapolated by the volume-surface-ratio and the assumption of doubled insulation effectiveness (at about triple insulation layer thickness) compared to the exemplary "High-T-Stor" heat storage	
	Relative heat losses (per reconvertable capacity) per season	8,2%		Calculated by the ratio of heat losses to (reconvertable) heat stored in the storage	
	Electric power output of unit 1 of the Vienna-Simmering gas power plant	700	MW	https://de.wikipedia.org/wiki/Kraftwerk_Simmering#Block_1_und_2	
	Electricity that can be generated from the heat stored in the storage	342 211	MWh	Calculted by efficiency and thermal capacity useable for reconversion into electricity	
	Full load hours	489	h	Calculated by the ratio of energy and power output	
Temperature and efficiency conditions of natural gas powered vs heat storage powered combined cycle power plants	Turbine inlet temperature of the gas turbine (natural gas powered)	1500	°C	https://elib.dlr.de/78973/1/Gasturbinen_der_n%C3%A4chsten_Generation.pdf	Slide 22 of the reference; The turbine inlet temperature for the heat storage powered cycle was assumed intentionally higher than a realistic average temperature of the whole storage as the storage doesn't cool off evenly, but remains warmer closer to the exit than to the intake, where air enters with the lowest temperature of the cycle.
	Turbine exit temperature of the gas turbine (both natural gas powered and heat storage powered)	620	°C		
	Turbine inlet temperature if the gas turbine (heat storage powered)	1000	°C	Assumption	
	Theoretically possiblce Carnot efficiency of the gas turbine stage (natural gas powered)	50%		Carnot's rule: theoretically maximum possible efficiency = temperature range of a cycle process divided by the the upper temperature of the cycle, both in Kelvin	
	Theoretically possiblce Carnot efficiency of the gas turbine stage (heat storage powered)	30%			
	Efficiency loss of a heat storage powered combined cycle power plant compared to a natural gas powered one	20%		Assumption: the difference in efficiency of the whole power plant in percentage points is equal to the difference of the theoretically possible efficiencies of the gas turbine stage because of the lower turbine inlet temperature in case of a heat storage powered turbine compared to a natural gas powered turbine	
	Electric efficiency of a heat storage powered combined cycle power plant	35%		electric efficiency of the exemplary natural gas powered combined cycle power plant (see above) minus calculated efficiency difference	
	Total efficiency of the heat storage powered combined cycle power plant	85%		Including heat used for district heating, assumption that the total efficiency and those heat losses not usable for district heating are the same as in case of a natural gas powered power plant	
	Share of the heat taken from the heat storage that can be used for district heating	50%		Difference between total efficiency and electric efficiency	
Efficiencies and performance factors of other energy conversion processes	Annual performance factor of heat pumps	3,5		https://de.m.wikipedia.org/wiki/W%C3%A4rmepumpe#Jahresarbeitszahl	Estimated average over air, soil and groundwater heat pumps with different heating systems and flow temperatures
	Efficiency of a condensing gas boiler	98%		https://www.heizung.de/gasheizung/gasbrennwertheizung.html#wirkungsgrad	Referring to the lower calorific value (similar to the efficiency value for the production of synthetic methane above)
	Losses in the district heating network	10%		https://de.m.wikipedia.org/wiki/Fernw%C3%A4rme	Estimation according to the bandwith in the reference
	Efficiency of a internal combustion engine car (tank to wheel)	20%		https://en.wikipedia.org/wiki/Electric_car#Energy_efficiency	Values for realistic operation, much higher "up to xy% efficiency" claims for internal combustion engines refer to optimum operation points that are far away from realistic use of the engine.
	Efficiency of a battery electric car (plug to wheel)	77%			
Capacities and energy densities of batteries	Average battery capactiy of battery electric cars, offered in 2024	72,3	kWh	https://ev-database.org/de/cheatsheet/useable-battery-capacity-electric-car	Average of the offered models, not weighted by sold cars
	Gravimetric energy density of lithium ion batteries on cell level	287	Wh/kg	https://www.researchgate.net/profile/Adrian-Koenig-3/publication/349034233_An_Overview_of_Parameter_and_Cost_for_Battery_Electric_Vehicles/links/601cf3a14585158939807eca/An-Overview-of-Parameter-and-Cost-for-Battery-Electric-Vehicles.pdf	Table 1 of the reference, values for cylindric cells in 2020
	Volumetric energy density of lithium ion batteries on cell level	775	Wh/l		
	Gravimetric energy density of lithium ion batteries on battery level	150	Wh/kg		Fig. 4 &5 of the reference; value for Tesla Model 3 from the diagram
	Volumetric energy density of lithium ion batteries on battery level	350	Wh/l		
	Gravimetric energy density of sodium ion batteries on cell level	130	Wh/kg	https://www.batterydesign.net/sodium-ion-battery	Estimation according to the bandwith in the reference
	Volumetric energy density of sodium ion batteries on cell level	290	Wh/l		
	Gravimetric energy density of sodium ion batteries on battery level	62	Wh/kg	Extrapolated from the difference between cell and battery densities of lithium ion batteries (Assumption: the proportion of battery volume to cell volume is the same for sodium ion batteries as for lithium-ion batteries and the material outside the cells has the same gravimetric density as in case of lithium ion batteries)	
	Volumetric energy density of sodium ion batteries on battery level	131	Wh/l		
Various indicators of exemplary cars (electric: VW ID.3, with combustion engine: VW Golf VII)	Battery capacity	82	kWh	https://de.wikipedia.org/wiki/VW_ID.3	Gross capacity, large battery, WLTP testing cycle
	Range	546	km		
	Required gross battery capacity per range	150	Wh/km	Calculated from battery capacity and range	
	Nominal tank volume	50	l	https://de.wikipedia.org/wiki/VW_Golf_VII	
	Reserve volume	15%		https://de.wikipedia.org/wiki/Kraftstofftank	Estimation according to the bandwith in the reference
	Gravimetric density of diesel fuel	0,83	kg/l	https://de.wikipedia.org/wiki/Dieselkraftstoff	
	Weight of the tank itself	5	kg	Estimation	
	Admissible tank weight (to be used alternatively for the battery)	53	kg	Calculated from volume, gravimetric density and weight of the tank itself	
Daily course of a photovoltaic system on a summer day in central Europa (basis for diagrams)				https://www.energiesparhaus.at/forum-ertrag-einer-8-kwp-anlage-im-tagesverlauf-in-den-sommermonaten/71347	