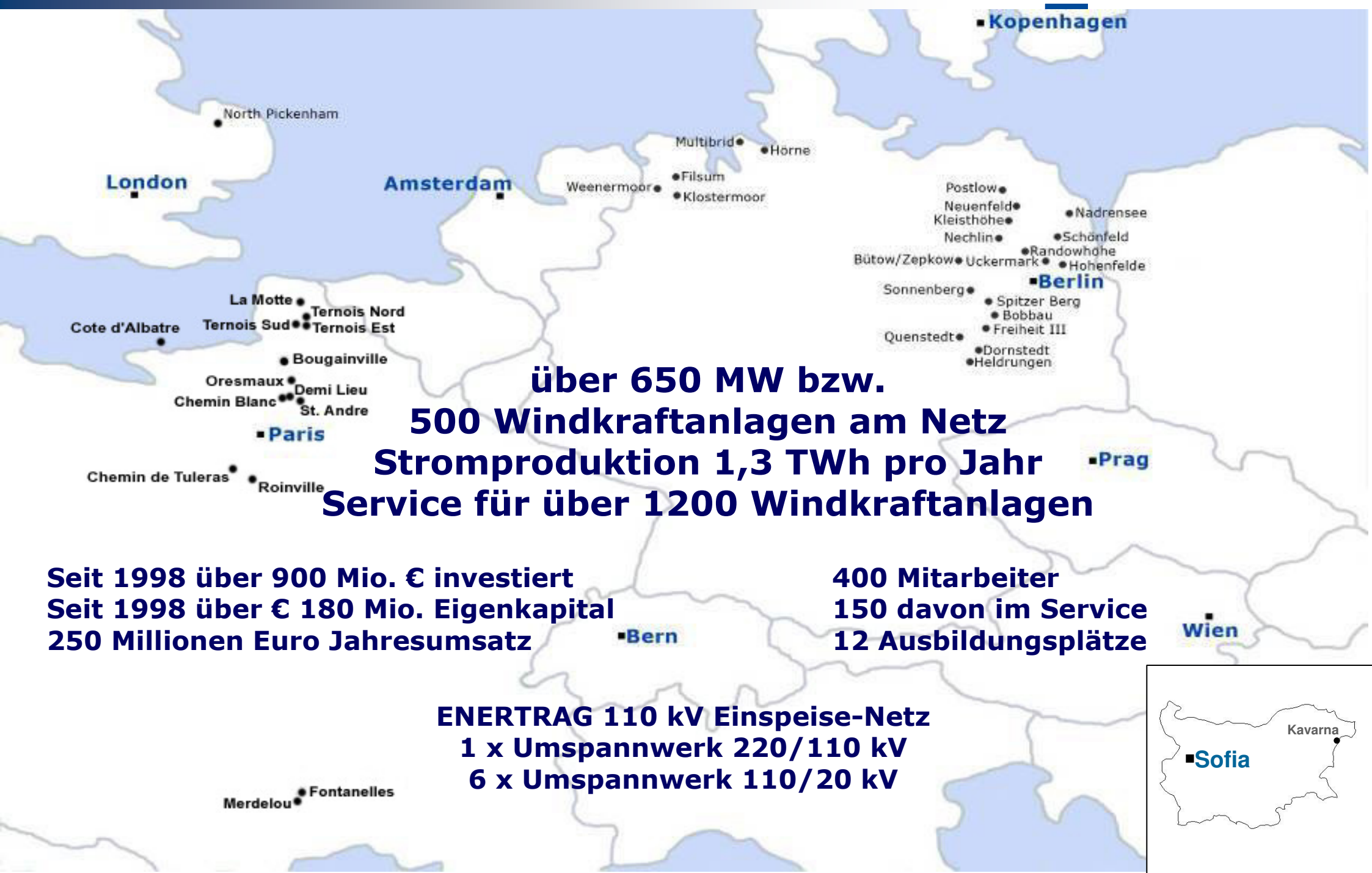




ENERTRAG ist ein auf Nachhaltigkeit spezialisiertes europäisches Energieunternehmen



- Projektierung von Windfarmen in DE, F, BG, PL, IT, UK
 - Errichtung und Instandhaltung von Energieanlagen
 - Finanzierung von Energieprojekten
 - Projektierung, Bau und Betrieb von Stromnetzen
- Entwicklung und Steuerung vernetzter Kraftwerke / Hybridkraftwerke
 - Technologieentwicklung



**über 650 MW bzw.
500 Windkraftanlagen am Netz
Stromproduktion 1,3 TWh pro Jahr
Service für über 1200 Windkraftanlagen**

**Seit 1998 über 900 Mio. € investiert
Seit 1998 über € 180 Mio. Eigenkapital
250 Millionen Euro Jahresumsatz**

**400 Mitarbeiter
150 davon im Service
12 Ausbildungsplätze**

**ENERTRAG 110 kV Einspeise-Netz
1 x Umspannwerk 220/110 kV
6 x Umspannwerk 110/20 kV**



Ressource

Reichweite

Potential

- fossile Energie ca. 50 bis 150 Jahre bis zu 2 Mio. kWh/ha
- Wind unendlich 1 Mio. kWh/ha
- Biomasse unendlich 0,06 Mio. kWh/ha
- Sonne unendlich 1 Mio. kWh/ha



Wirkungsgrad

Wieviel Prozent der Sonnenenergie kommen beim Verbraucher an?

40% (1 Mio. kWh/ha)

20% (1 Mio. kWh/ha)

2% (ca. 0,05 Mio. kWh/ha)

0,5%



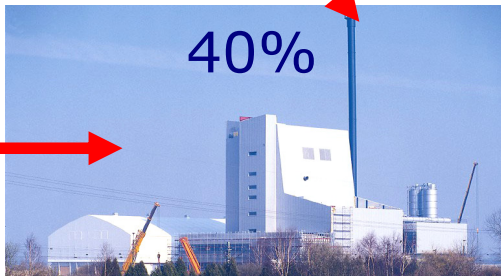
Pflanzen



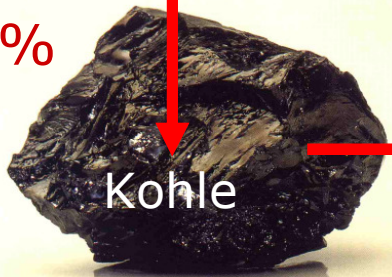
50%



40%

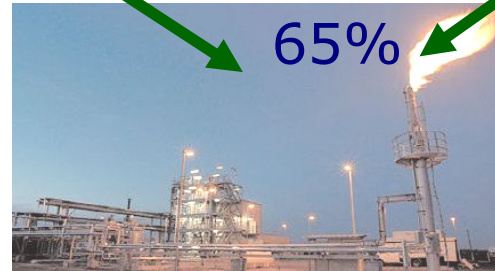


1%



Kohle

65%



80%



50%

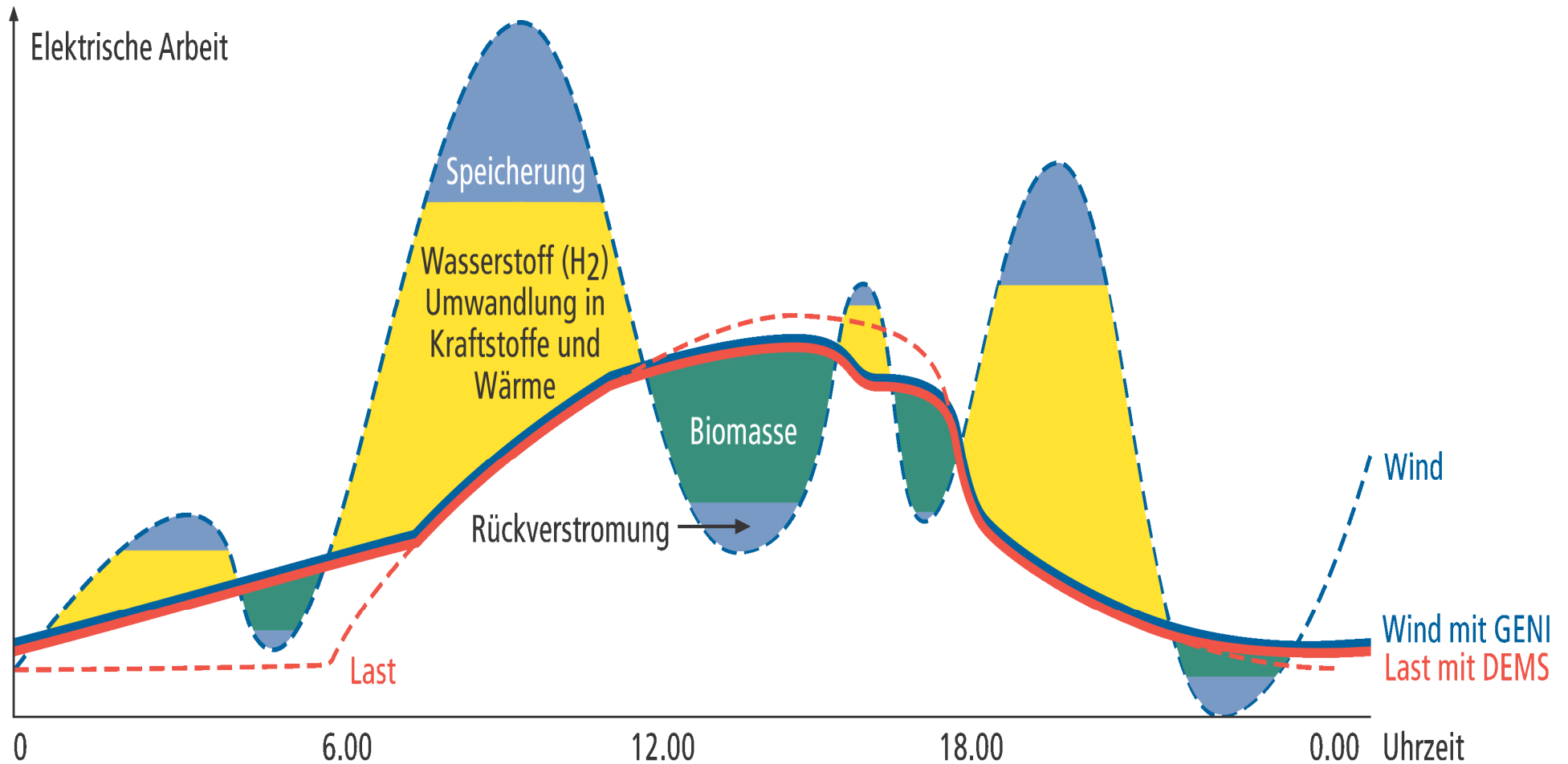


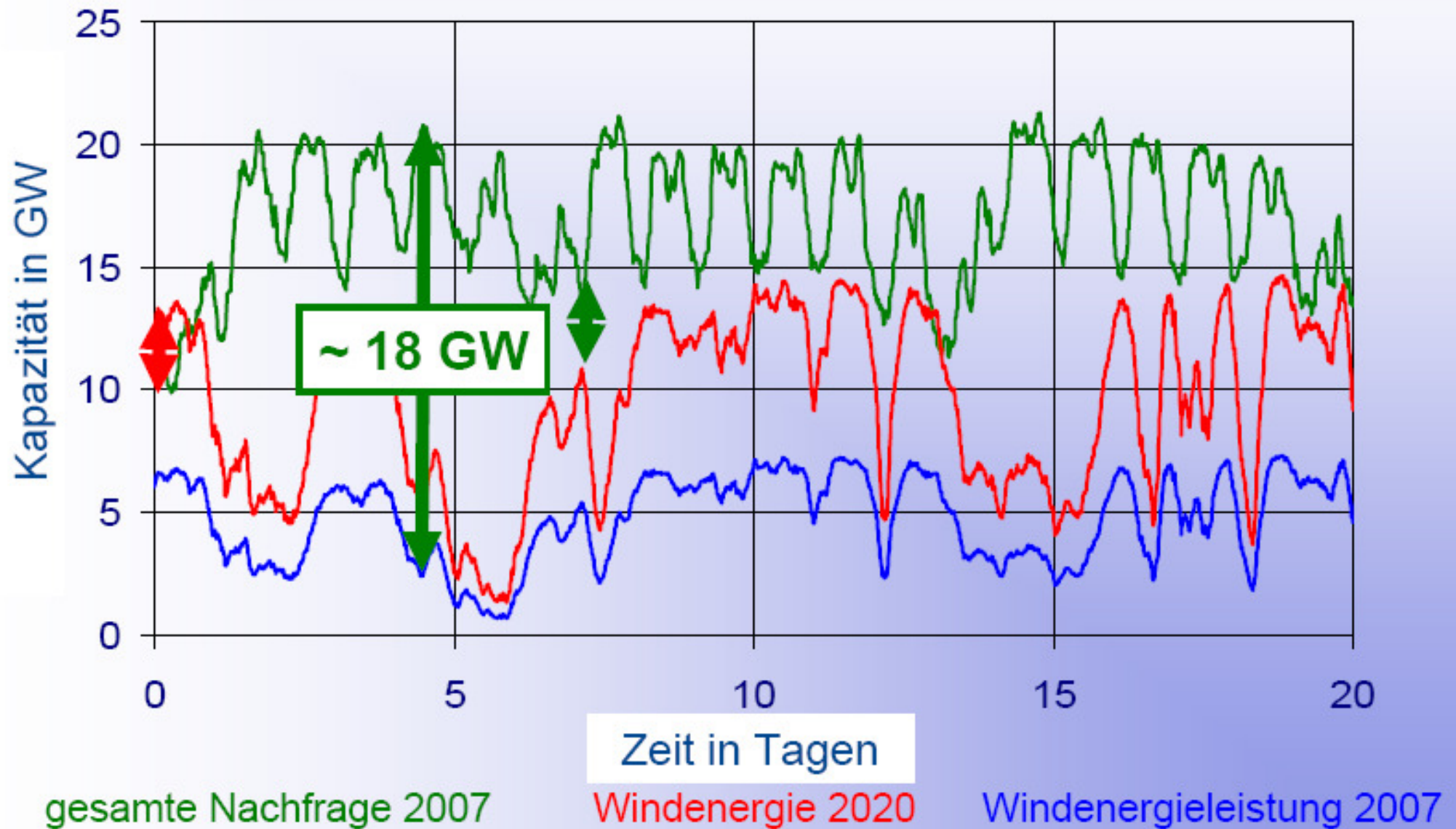
Windkraft

Photovoltaik

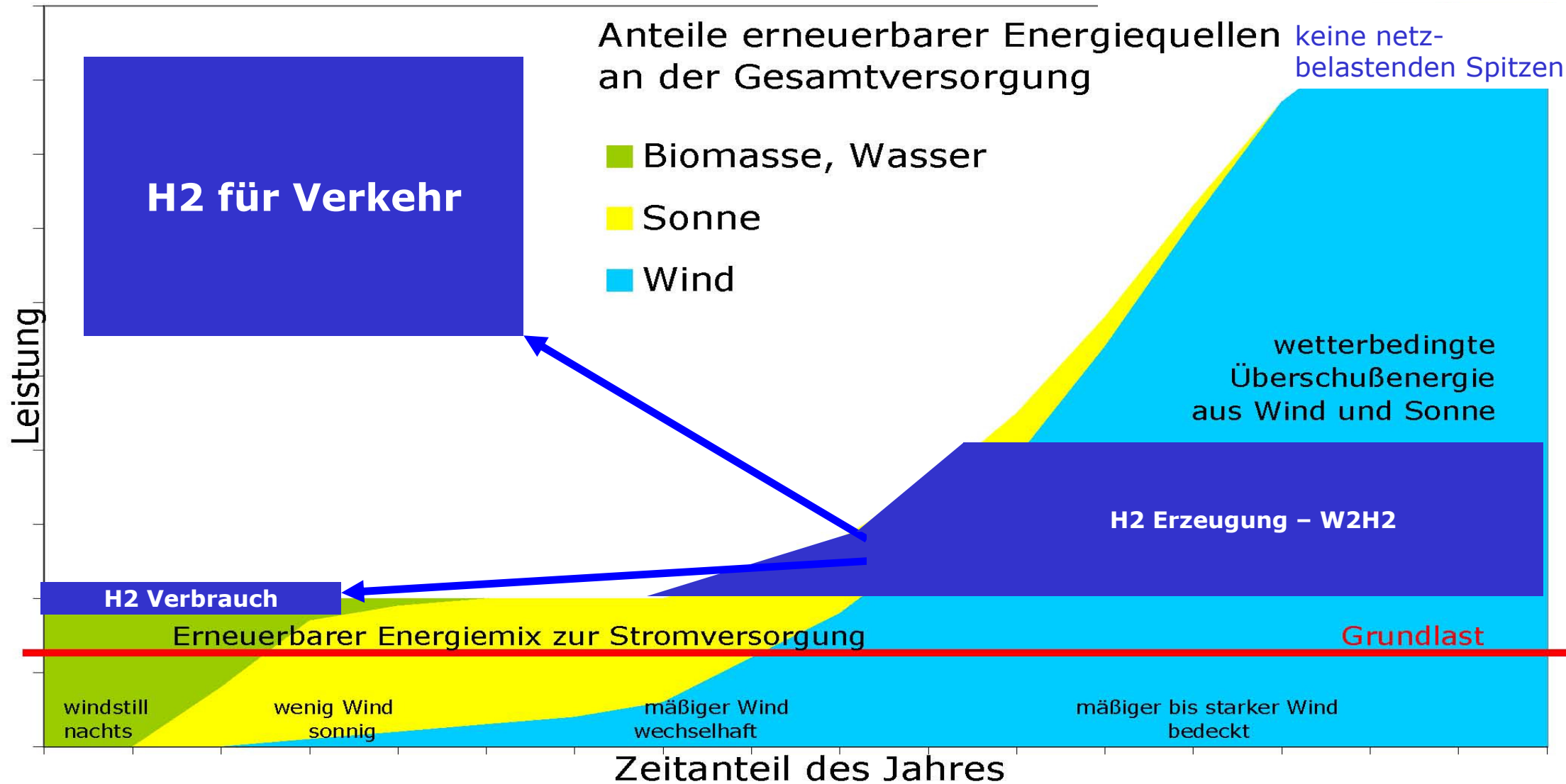


Gesamt 0,005% bzw. 0,4% ← → **Gesamt 20%**

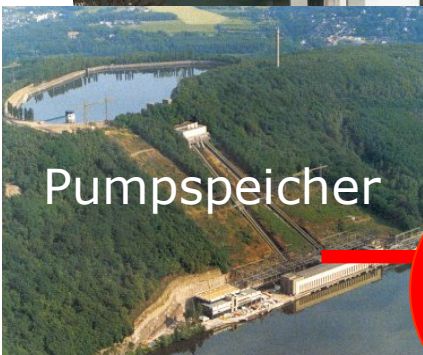




Ein Mix aus Windkraft, Solarenergie und Biomasseenergie ersetzt konventionelle Kraftwerke vollständig.

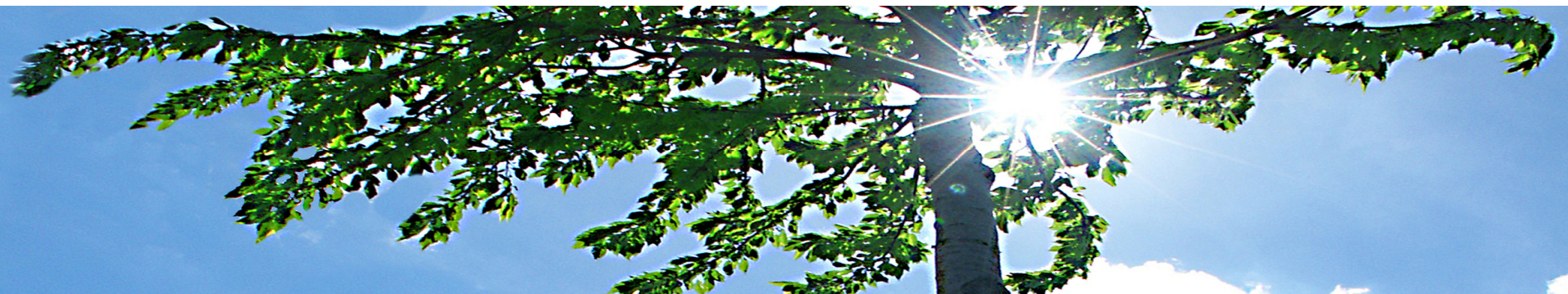


Energie nach Bedarf – Energiemix ab 2020



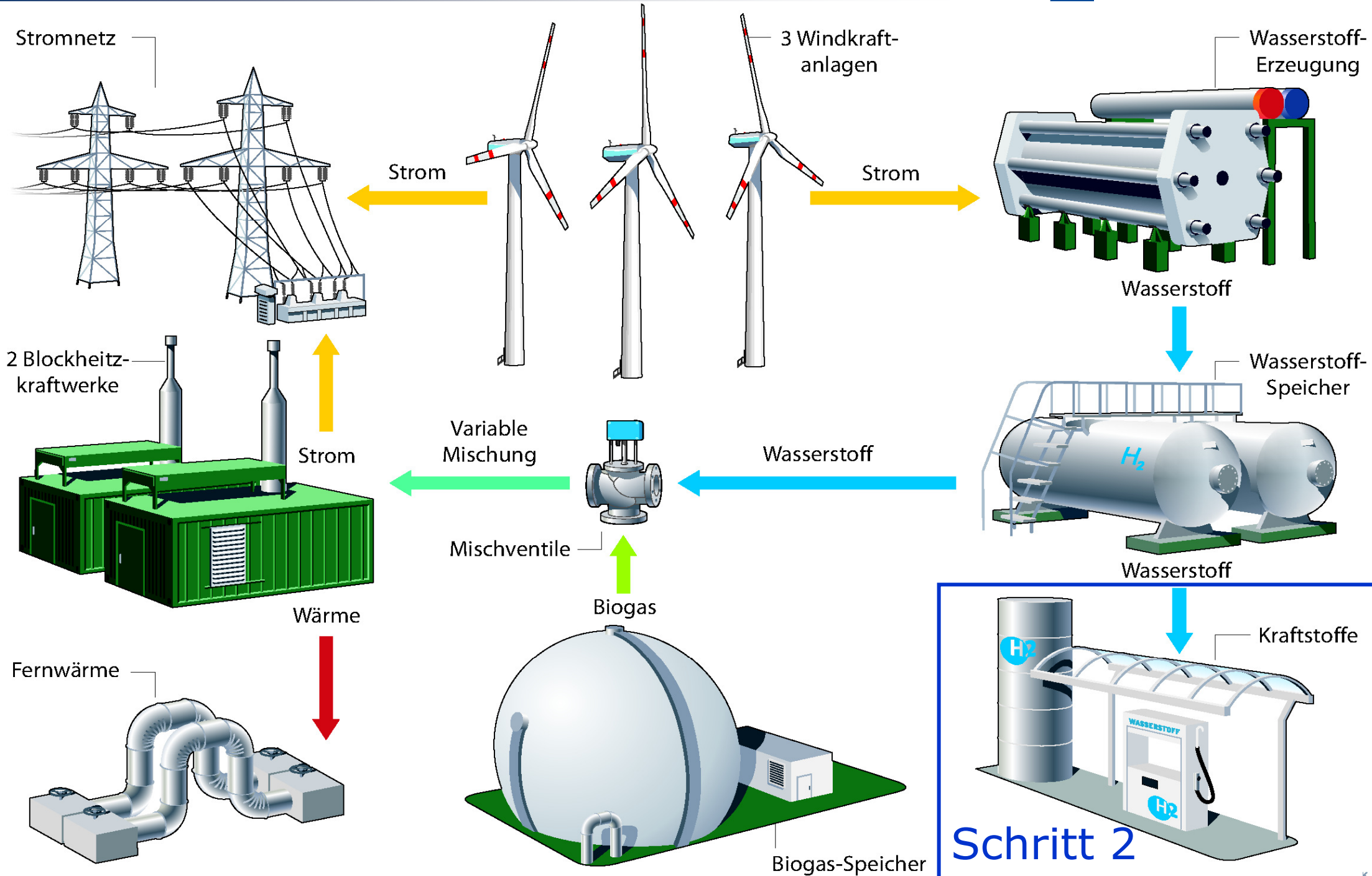
A wide, horizontal photograph of a bright blue sky filled with scattered white cumulus clouds.

Nachhaltige Energieversorgung ENERTRAG-Hybridkraftwerk



- **Windkraftanlagen (ENERCON E82)**
 - je 2 MW Nennleistung
 - Jahresenergieertrag ca. 18.000 MWh/a
- **Elektrolyseur**
 - Gasproduktion: 120 Nm³/h Wasserstoff,
60 Nm³/h Sauerstoff
 - Gasreinheit Wasserstoff: 99,997%
 - Ausgangsdruck: atmosphärisch (ca. 15-20 mbar)
 - Ausgangsdruck Kompression: 31 bar (a)
- **Stationärer Gasspeicher:**
 - 5 Stück Druckbehälter
 - Gesamtfassungsvermögen von 1.350 kg Wasserstoff bei 31 bar(a)
- **Block-Heiz-Kraft-Werk (BHKW)**
 - Mischgas aus min. 30% Biogas + max. 70% Wasserstoff
 - voll Inselnetzfähig
 - Leistung (el): max. jeweils 350kW (je nach Gasmisch) / 700 kW gesamt
 - Leistung (th): max. jeweils 340kW /680 kW gesamt

Funktionsprinzip Hybridkraftwerk



Regionale Einspeisenetze statt teurerem Umbau der Versorgungsnetze

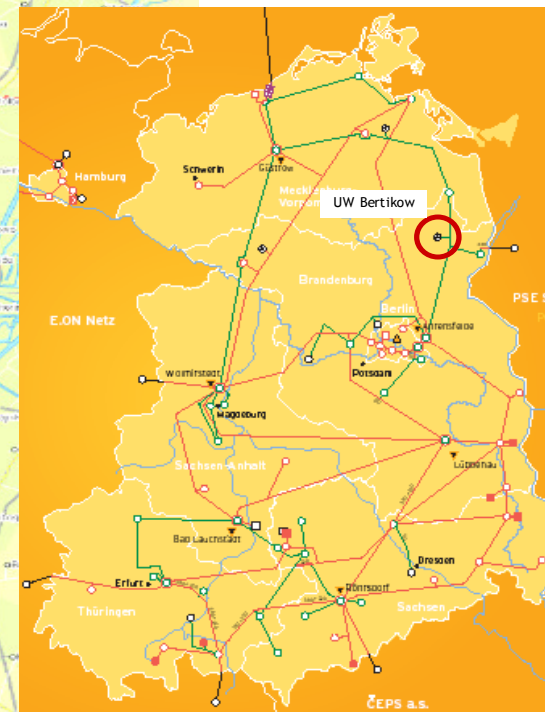
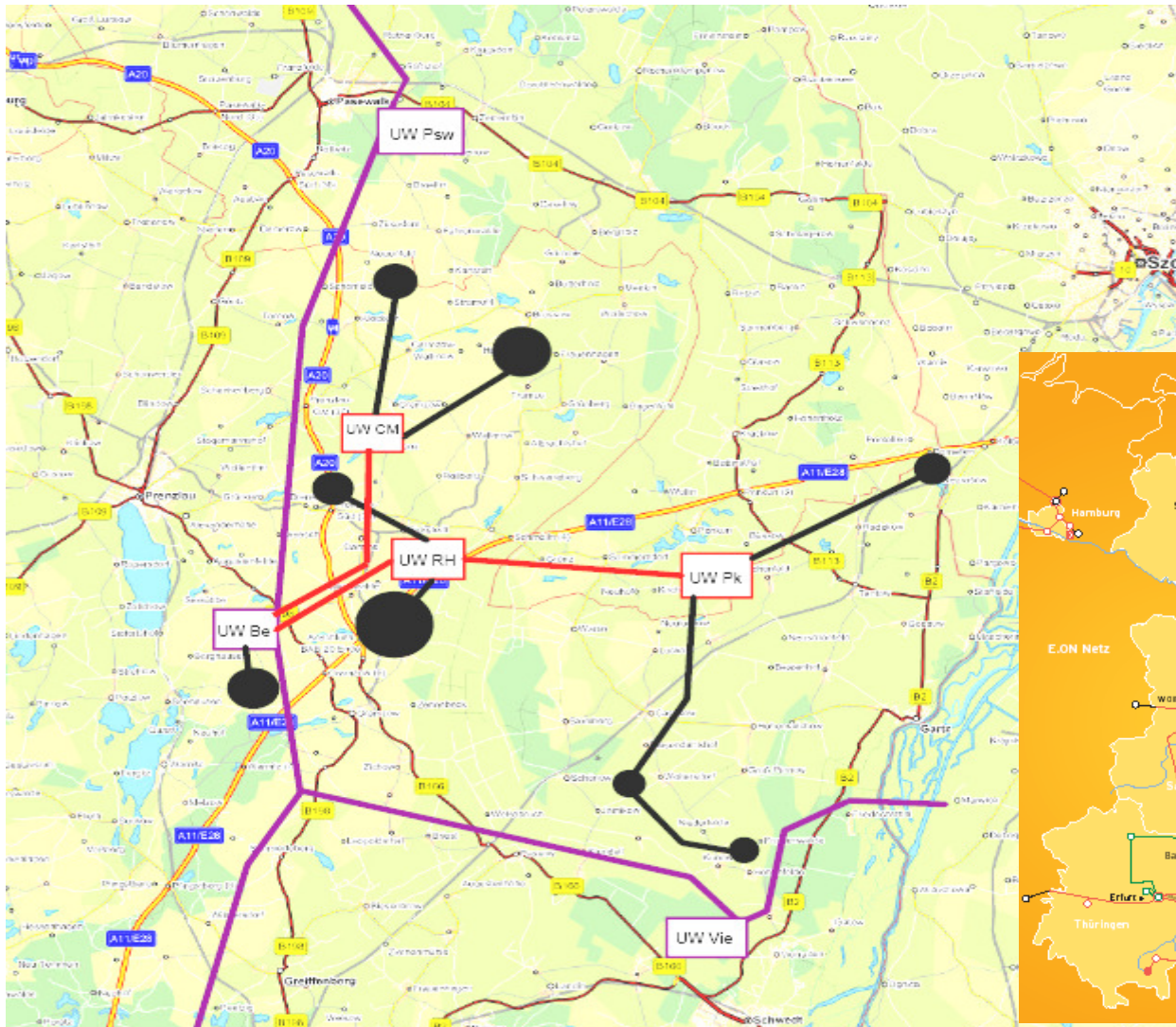
Ist-Stand Kraftwerk Uckermark

Energiemix

20 MW Biomasse

300 MW Windkraft

ausbaubar auf über 1000 MW



Einspeisenetz

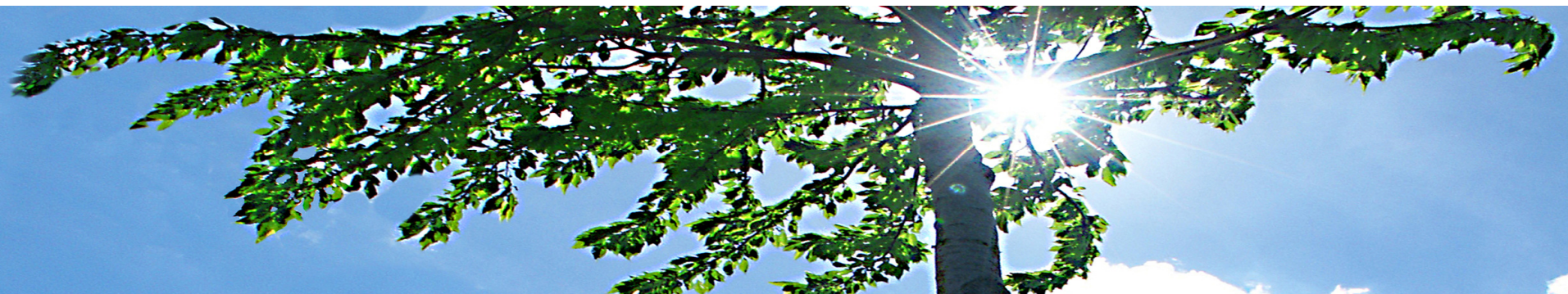
37 km 110 kV

72 km 20 kV

direkt mit dem
Übertragungsnetz
verbunden

A wide horizontal band of a bright blue sky filled with scattered white clouds.

Speichersysteme



*Netzqualitäts-
verbesserung*

*Energie
Management*

Hohe Leistung

Hohe Energie

Ein- /Ausspeicherdauer:

Sekunden

Minuten

Stunden

Flickerkompensation
Spannungsstabilisierung
Frequenzstabilisierung

Rotierende Reserve
Schwarzstartfähigkeit
Unterbrechungsfreie
Stromversorgung

Lastspitzenglättung
Lastausgleich
Stromhandel
Integration fluktuierender
Einspeisung
Inselnetze

Schwungrad

NaNiCl/NaS

DSK

NiCd/NiMH

Redox Flow

SMES

Li

Druckluftspeicher

Pb

Pumpspeicher

Wasserstoff

© FraunhoferUMSICHT

Quelle: Fraunhofer-Institut UMSICHT

physikalischer Speicher

Pumpspeicherwerke

- Neubau in Europa nur begrenzt möglich!
- Kurzzeitspeicher
- Wirkungsgrad ca. 70%
- Energiedichte 0,7 kWh/m³

Druckluftspeicher

- Kurzzeitspeicher
- Wirkungsgrad ca. 42%
- Energiedichte 2,4 kWh/m³

Chemischer Speicher

Wasserstoffspeicher (+ physikalischer Speicher)

- Langzeitspeicher bis zu Monaten
- Wirkungsgrad (Strom – Strom) bis 50%
- Energiedichte 170 kWh/m³ / 216 MJ/kg

Batterie

- Minuten- bis Stundenspeicher
- Wirkungsgrad ca. 70%
- Energiedichte 1 MJ/kg



Physikalische Speicher:

- Druckluftspeicher
- Schwungmassenspeicher
- Pumpspeicher

Chemische Speicher:

- Batterie
- Wasserstoff

Pumpspeicher-Kraftwerk Goldisthal

$P = 1\,060\text{ MW} / W = 8\text{ h} * 1\,060\text{ MW} / \eta > 80\%$

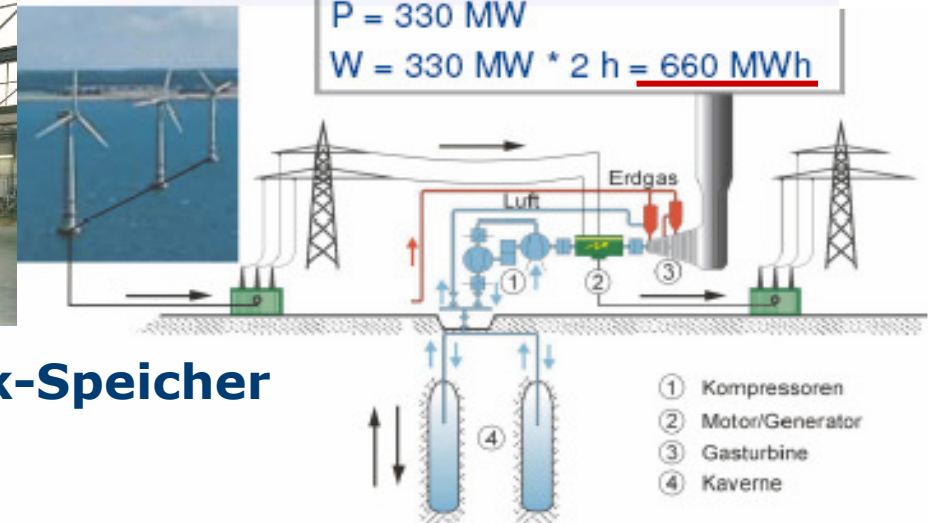


Druckluft-Speicher-GT-Kraftwerk

E.ON Huntorf:

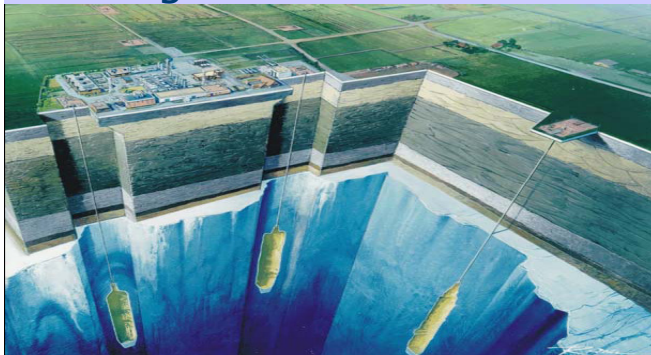
$P = 330\text{ MW}$

$W = 330\text{ MW} * 2\text{ h} = 660\text{ MWh}$



H2-Kavernen-Speicher

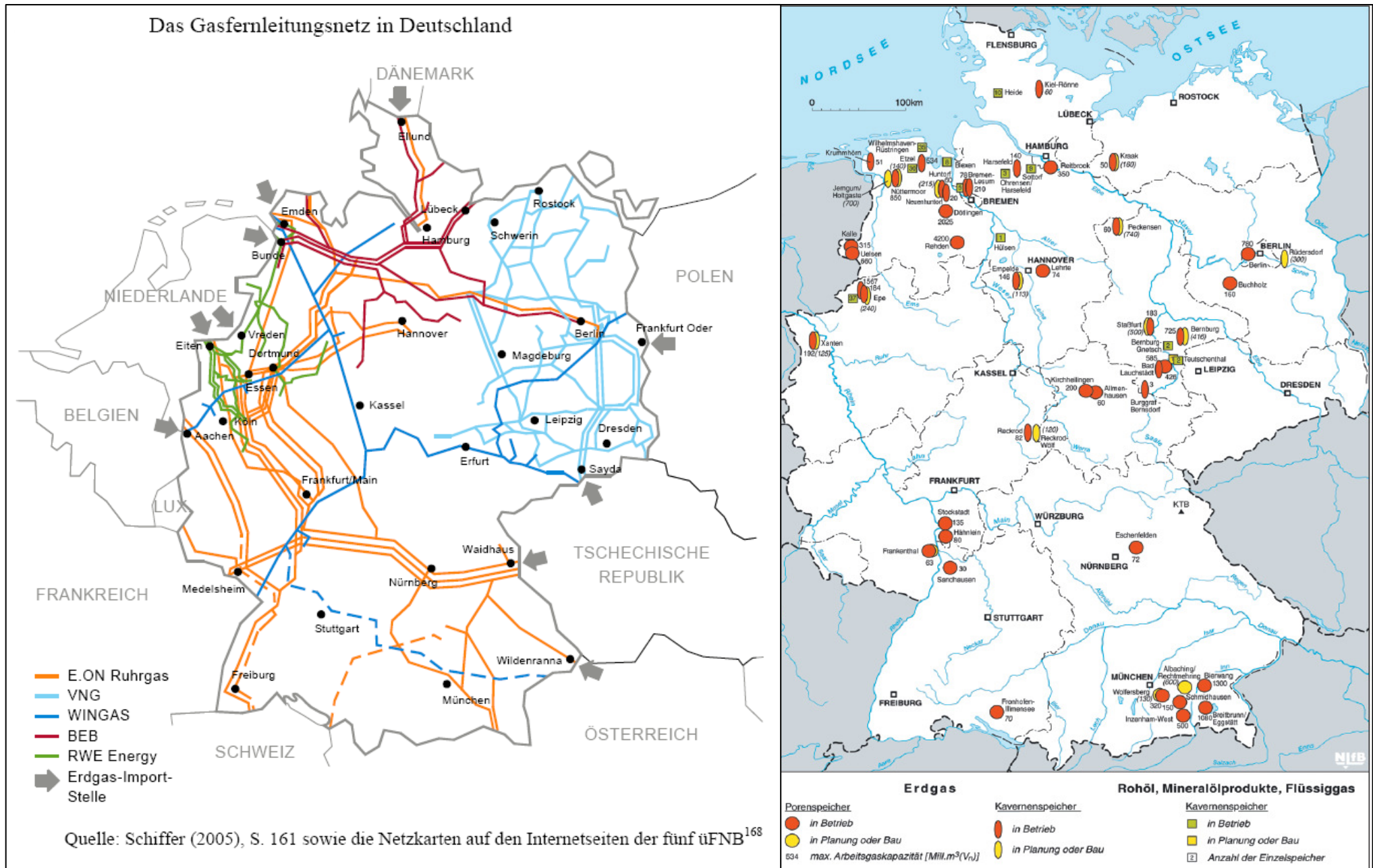
- Volumen: 70 Mio. m³
- Energie: 13 Mio. MWh



Wasserstoff-Druck-Speicher „Huntorf“

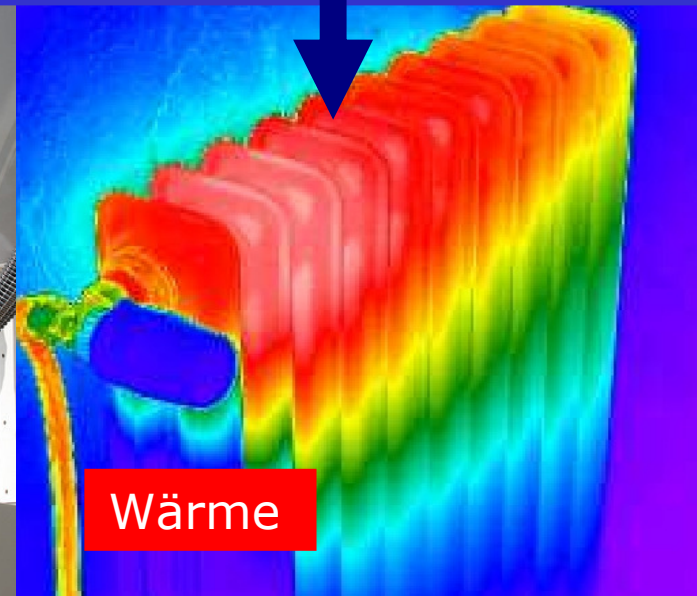
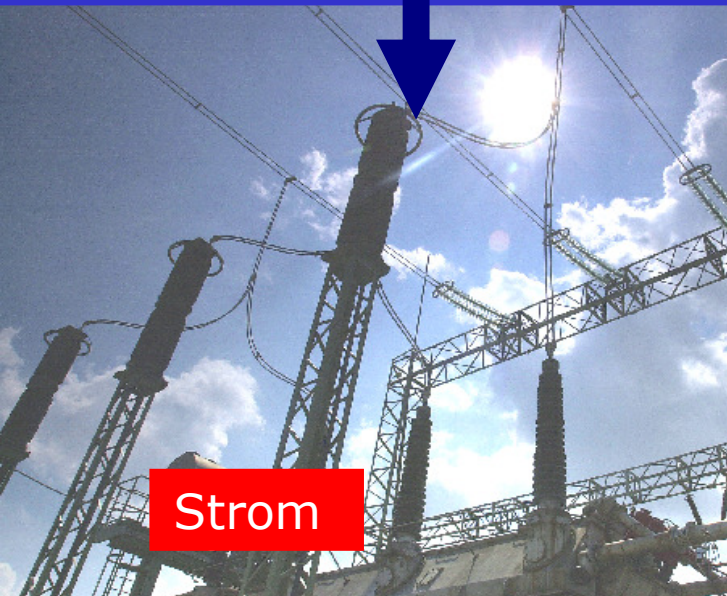
$P = 330\text{ MW}$

$W = 330\text{ MW} * 364\text{ h} = 120.000\text{ MWh}$

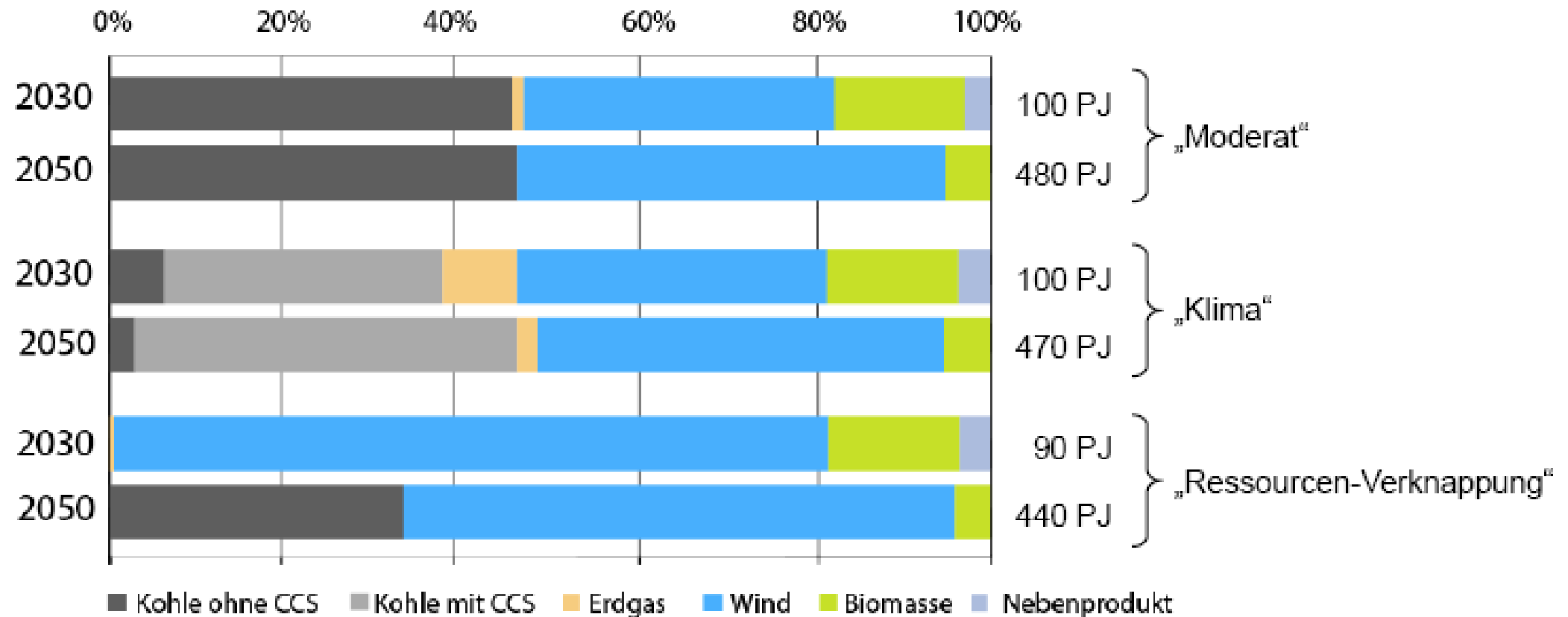




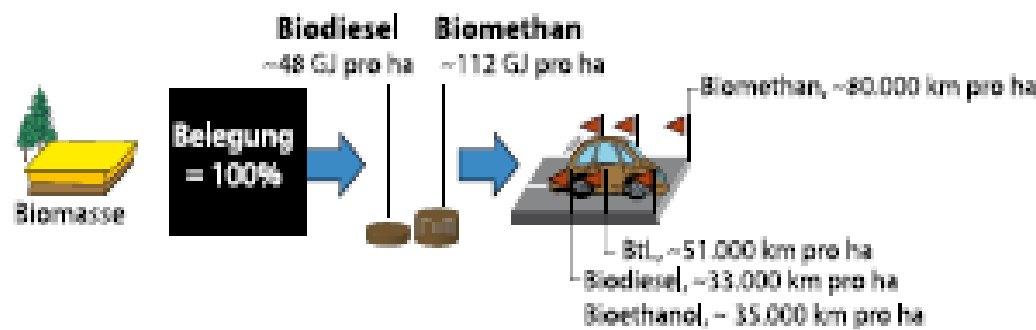
Einspeisenetz + Hybrid-Kraftwerk



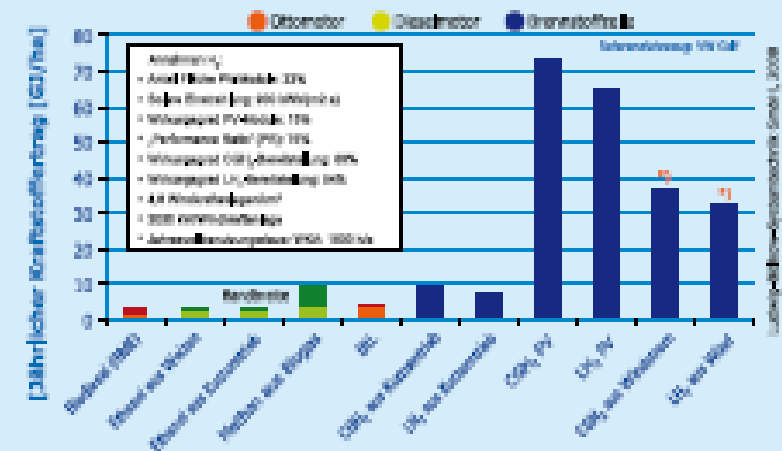
Anteile der Primärenergieträger an der Wasserstoffproduktion



- Der Wasserstoff wird aus verschiedenen Primärenergiequellen hergestellt werden. Je nach Szenario liefern die einzelnen Quellen unterschiedliche Anteile
- Entscheidend für den zukünftigen Energiemix zur Produktion von Wasserstoff sind politische Ziele und Rahmenbedingungen sowie das Erreichen technischer Entwicklungsziele



Die „Produktivität“ eines Hektars Land kann auch im „Fahrzeugen pro Hektar“ ausgedrückt werden, die pro Jahr mit alternativen Kraftstoffen versorgt werden können.



*1) mehr als 90% der Kraftstoffe werden in anderen Ländern zur Verfügung gestellt (Landwirtschaft) (Quelle: Windenergie: [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61] [62] [63] [64] [65] [66] [67] [68] [69] [70] [71] [72] [73] [74] [75] [76] [77] [78] [79] [80] [81] [82] [83] [84] [85] [86] [87] [88] [89] [90] [91] [92] [93] [94] [95] [96] [97] [98] [99] [100] [101] [102] [103] [104] [105] [106] [107] [108] [109] [110] [111] [112] [113] [114] [115] [116] [117] [118] [119] [120] [121] [122] [123] [124] [125] [126] [127] [128] [129] [130] [131] [132] [133] [134] [135] [136] [137] [138] [139] [140] [141] [142] [143] [144] [145] [146] [147] [148] [149] [150] [151] [152] [153] [154] [155] [156] [157] [158] [159] [160] [161] [162] [163] [164] [165] [166] [167] [168] [169] [170] [171] [172] [173] [174] [175] [176] [177] [178] [179] [180] [181] [182] [183] [184] [185] [186] [187] [188] [189] [190] [191] [192] [193] [194] [195] [196] [197] [198] [199] [200] [201] [202] [203] [204] [205] [206] [207] [208] [209] [210] [211] [212] [213] [214] [215] [216] [217] [218] [219] [220] [221] [222] [223] [224] [225] [226] [227] [228] [229] [230] [231] [232] [233] [234] [235] [236] [237] [238] [239] [240] [241] [242] [243] [244] [245] [246] [247] [248] [249] [250] [251] [252] [253] [254] [255] [256] [257] [258] [259] [260] [261] [262] [263] [264] [265] [266] [267] [268] [269] [270] [271] [272] [273] [274] [275] [276] [277] [278] [279] [280] [281] [282] [283] [284] [285] [286] [287] [288] [289] [290] [291] [292] [293] [294] [295] [296] [297] [298] [299] [300] [301] [302] [303] [304] [305] [306] [307] [308] [309] [310] [311] [312] [313] [314] [315] [316] [317] [318] [319] [320] [321] [322] [323] [324] [325] [326] [327] [328] [329] [330] [331] [332] [333] [334] [335] [336] [337] [338] [339] [340] [341] [342] [343] [344] [345] [346] [347] [348] [349] [350] [351] [352] [353] [354] [355] [356] [357] [358] [359] [360] [361] [362] [363] [364] [365] [366] [367] [368] [369] [370] [371] [372] [373] [374] [375] [376] [377] [378] [379] [380] [381] [382] [383] [384] [385] [386] [387] [388] [389] [390] [391] [392] [393] [394] [395] [396] [397] [398] [399] [400] [401] [402] [403] [404] [405] [406] [407] [408] [409] [410] [411] [412] [413] [414] [415] [416] [417] [418] [419] [420] [421] [422] [423] [424] [425] [426] [427] [428] [429] [430] [431] [432] [433] [434] [435] [436] [437] [438] [439] [440] [441] [442] [443] [444] [445] [446] [447] [448] [449] [450] [451] [452] [453] [454] [455] [456] [457] [458] [459] [460] [461] [462] [463] [464] [465] [466] [467] [468] [469] [470] [471] [472] [473] [474] [475] [476] [477] [478] [479] [480] [481] [482] [483] [484] [485] [486] [487] [488] [489] [490] [491] [492] [493] [494] [495] [496] [497] [498] [499] [500] [501] [502] [503] [504] [505] [506] [507] [508] [509] [510] [511] [512] [513] [514] [515] [516] [517] [518] [519] [520] [521] [522] [523] [524] [525] [526] [527] [528] [529] [530] [531] [532] [533] [534] [535] [536] [537] [538] [539] [540] [541] [542] [543] [544] [545] [546] [547] [548] [549] [550] [551] [552] [553] [554] [555] [556] [557] [558] [559] [560] [561] [562] [563] [564] [565] [566] [567] [568] [569] [570] [571] [572] [573] [574] [575] [576] [577] [578] [579] [580] [581] [582] [583] [584] [585] [586] [587] [588] [589] [590] [591] [592] [593] [594] [595] [596] [597] [598] [599] [600] [601] [602] [603] [604] [605] [606] [607] [608] [609] [610] [611] [612] [613] [614] [615] [616] [617] [618] [619] [620] [621] [622] [623] [624] [625] [626] [627] [628] [629] [630] [631] [632] [633] [634] [635] [636] [637] [638] [639] [640] [641] [642] [643] [644] [645] [646] [647] [648] [649] [650] [651] [652] [653] [654] [655] [656] [657] [658] [659] [660] [661] [662] 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[995] [996] [997] [998] [999] [1000]

Primär-
energie

Belegte
Landfläche

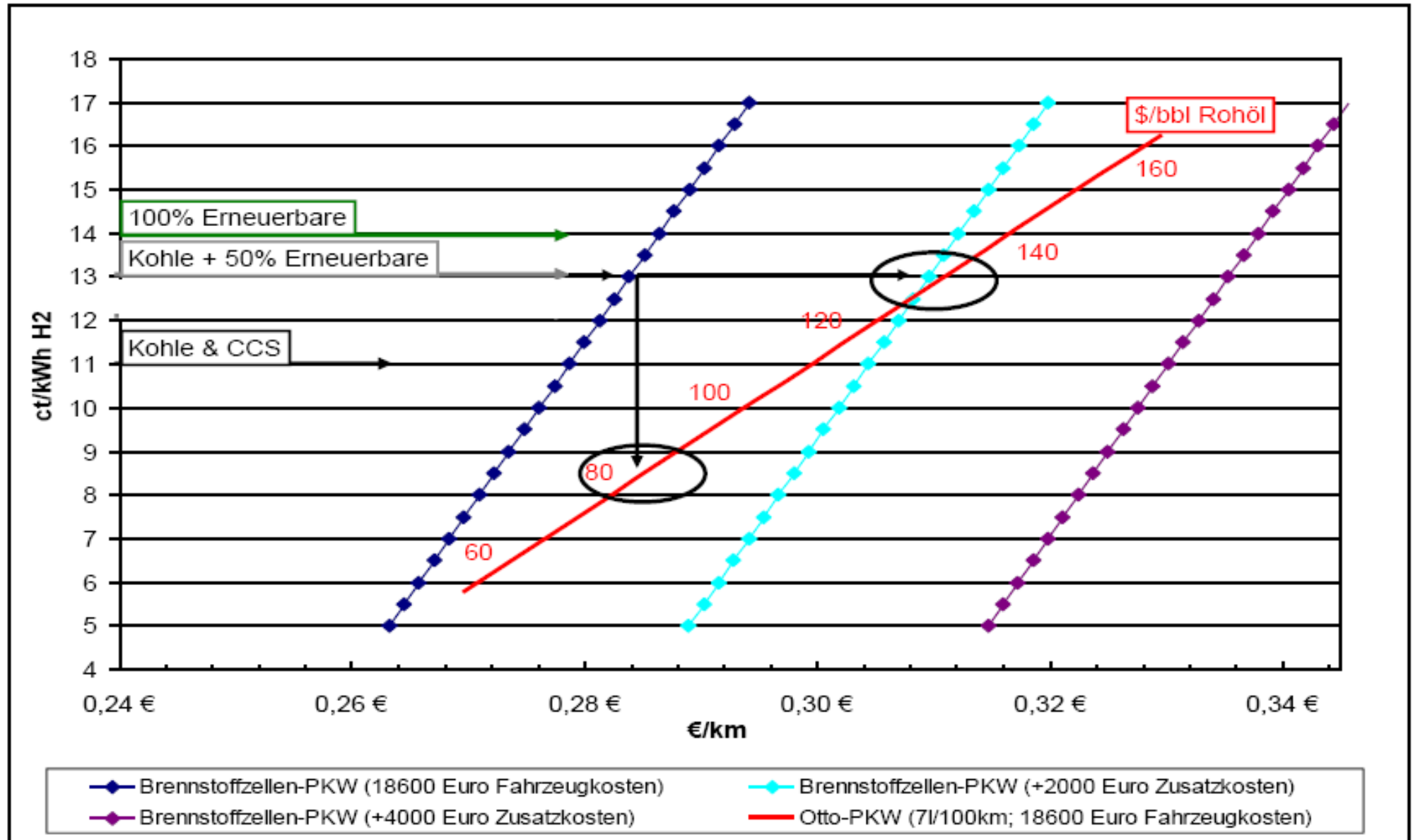
Kraftstoff-
produktion
pro Hektar

Quelle-zu-Rad-Wirkungsgrad
(Fahrzeug-km pro ha)

ha = Hektar
VM = Verbrennungsmotor

Referenzfahrzeug: VW Golf (Concawe/EUCAR/JRC 2006), durchschnittliche Fahrleistung = 12.500 km pro Jahr

Wirtschaftlichkeitsvergleich: Wasserstoff-Brennstoffzellen-PKW vs. konventionelle PKW



PKW's:

- BMW Hydrogen7
- GM Opel HydroGen4
- Ford Focus FCV
- Daimler B-Class F-Cell
- VW Tiguan HyMotion3
- VW Cady

Busse

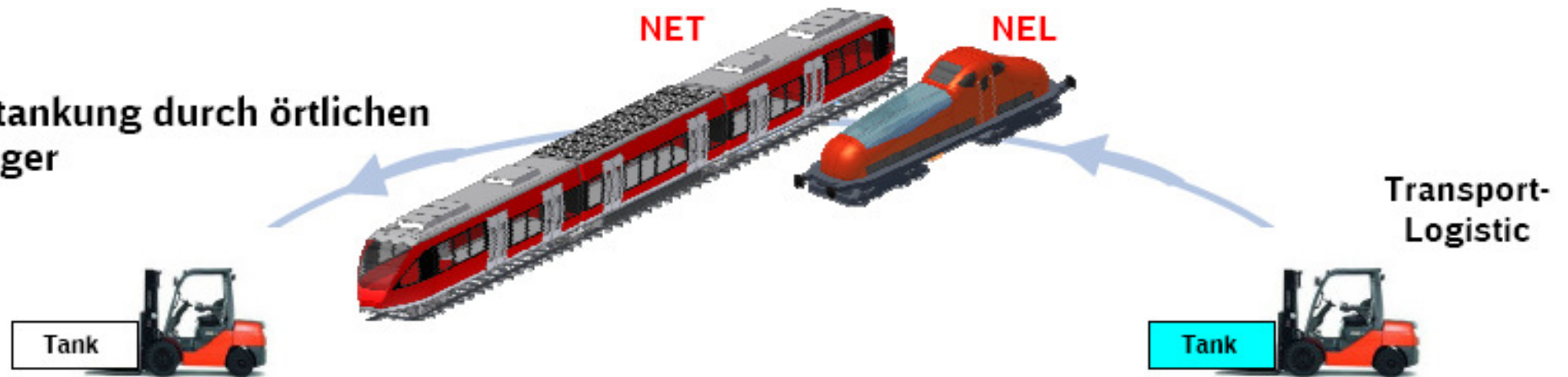
- MAN
- Daimler Benz CITARO

Nutzfahrzeuge

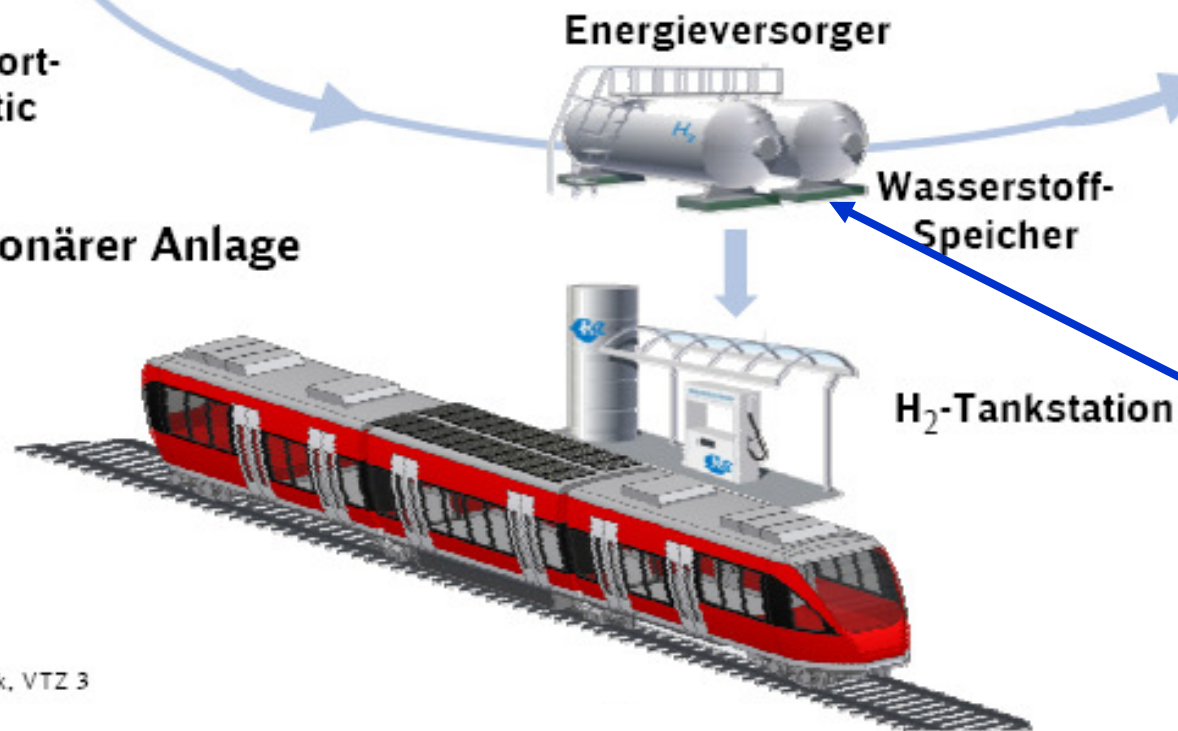
- PROTON Motor
- Gabelstapler



Stufe 1 Mobile Betankung durch örtlichen H₂-Versorger



Stufe 2 Betankung an stationärer Anlage





TOTAL



Clean Energy Partnership

CEP



Verantwortungsvolle Energiewirtschaft

