TOLLE
ENERGY & ENVIRONMENT
CONSULTING

Beyond cogeneration
„300“-power plants
the perfect addition to the renewable generation park

IRES 2012

ICC Berlin

November 12 –14, 2012

Dr.-Ing. Arnold Tolle

www.tolle.de

Business Portfolio

TOLLE
ENERGY & ENVIRONMENT
CONSULTING

- Combined Heat and Power (CHP) Power Plants
  - ⇒ Initial technical concept, transforming of existing plants
  - ⇒ Project development (joint ventures)
  - ⇒ Focused technology: Combined Cycle (gas & steam turbines)
- Optimizing of existing power and energy plants
- Feasibility studies, basic engineering
- Overall environmental protection energy concepts
- Sustainable energy business strategies
- Assessments
- Support relating to Emissions Trading

Geibelstr. 46b
D-22303 Hamburg

Tel. +49(40) 69213790
Fax: +49(40) 69213799

eMail: arnold@tolle.de
internet: http://www.tolle.de

Building up the regenerative energy system

TOLLE ENERGY & ENVIRONMENT CONSULTING

- Situation
  - ⇒ Many locations with high heat demand
    - Mainly in Industry (Paper, Chemistry, Food)
    - Some big communal heat distribution nets
  - ⇒ Rapidly growing regenerative power generation
    - Fluctuating (>>>IRES)
      - From daily to seasonal effects
  - ⇒ Structural change in power generation
    - Phase out of nuclear energy
    - Shut down of older, uneconomical power plants
- We are in a phase of transition

Building up the regenerative energy system

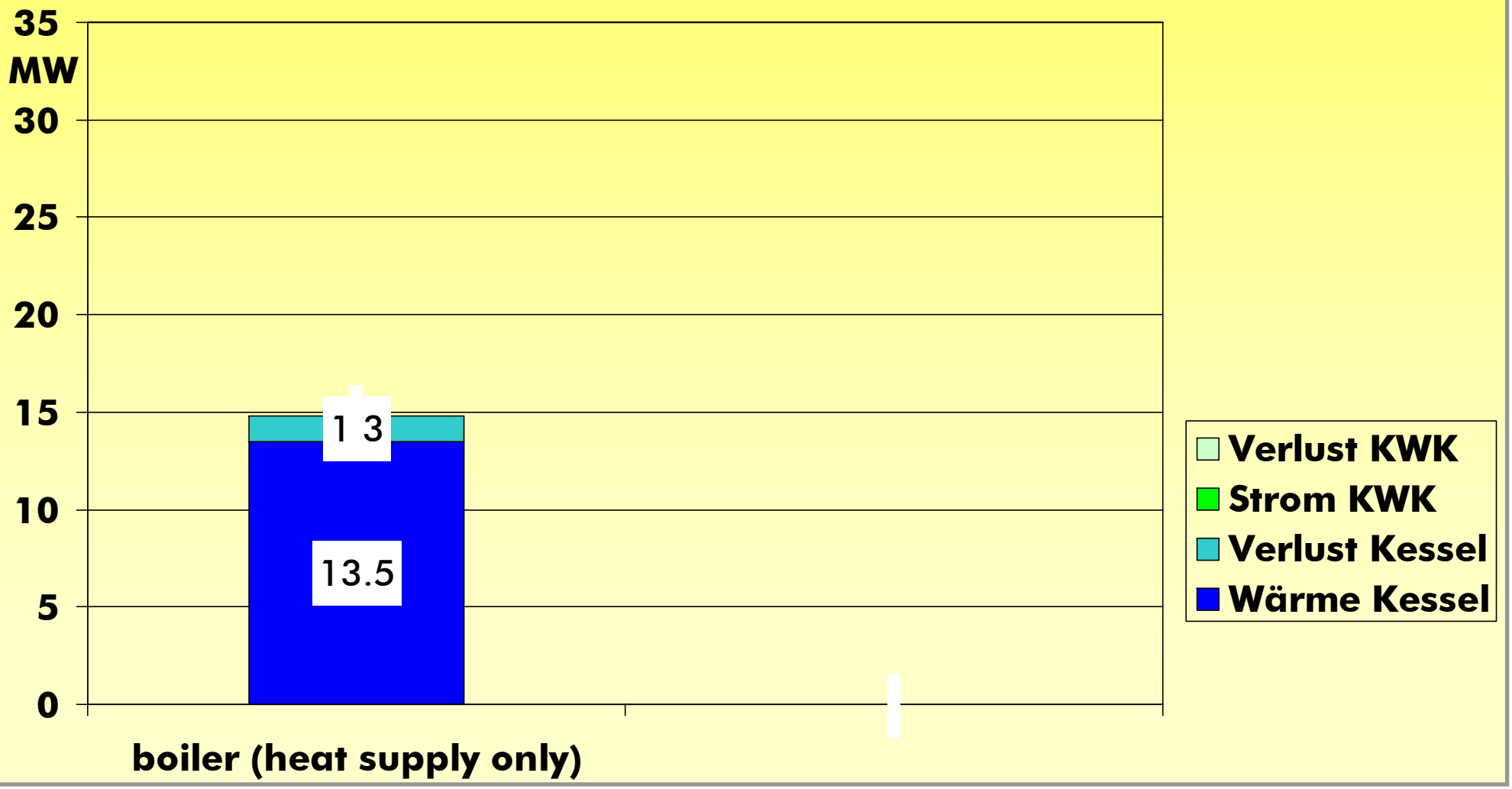
TOLLE ENERGY & ENVIRONMENT CONSULTING

- Goal: Reduce CO2 emissions
  - ⇒ Focus at absolute and specific emissions
  - ⇒ Efficiency alone does not help
    - Coal based CHP has very limited CO2 reductions, if any
- Goal: Use the most economical way
  - ⇒ Avoid unnecessary transition costs
- Benchmark for fossil power generation:
  - ⇒ Specific emissions of power generation
  - ⇒ 300-power

Definition CHP-Efficiency

Efficiency of additional fuel for CHP power generation

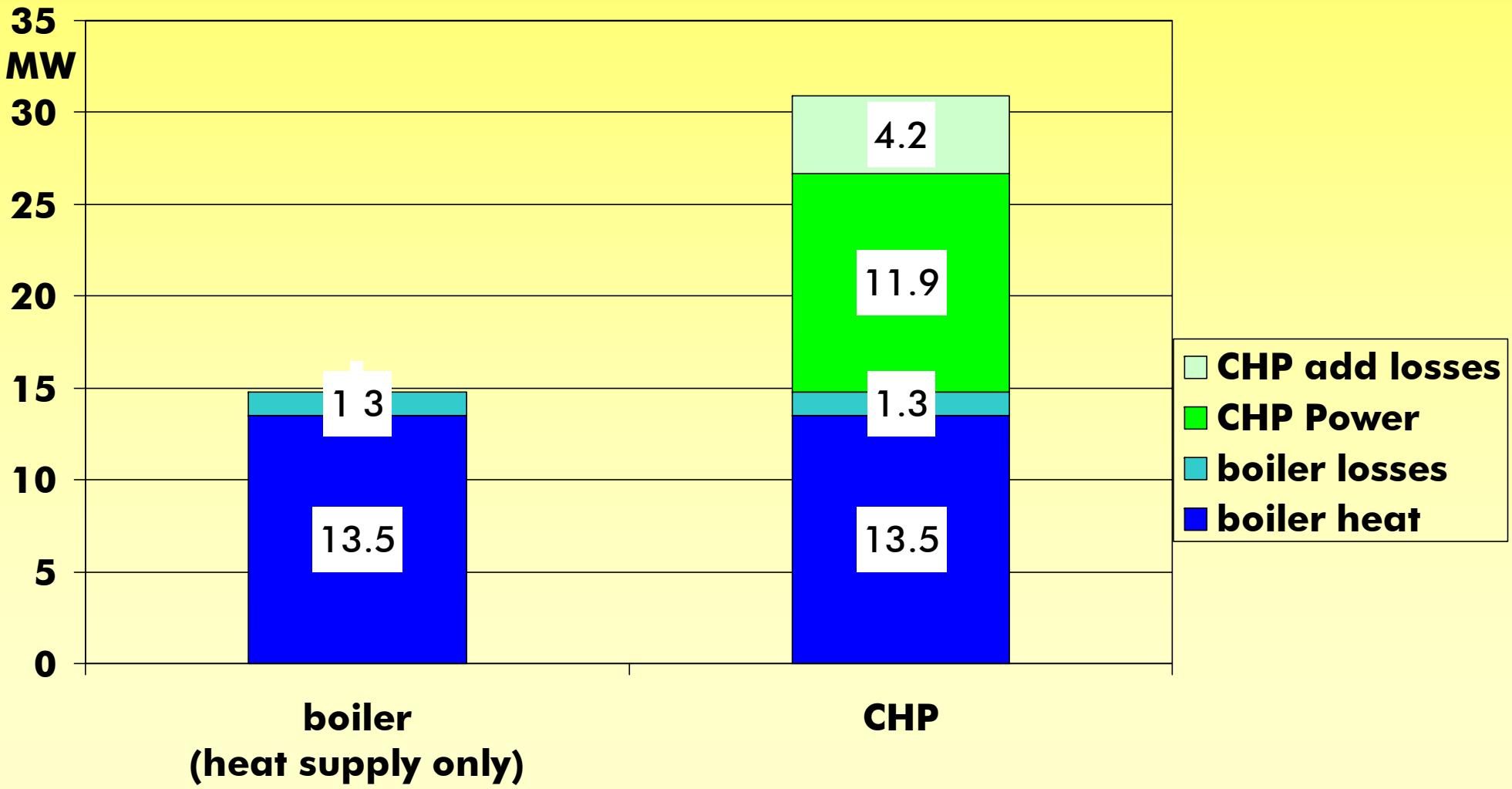
TOLLE ENERGY & ENVIRONMENT CONSULTING



Definition CHP-Efficiency

Efficiency of additional fuel for CHP power generation

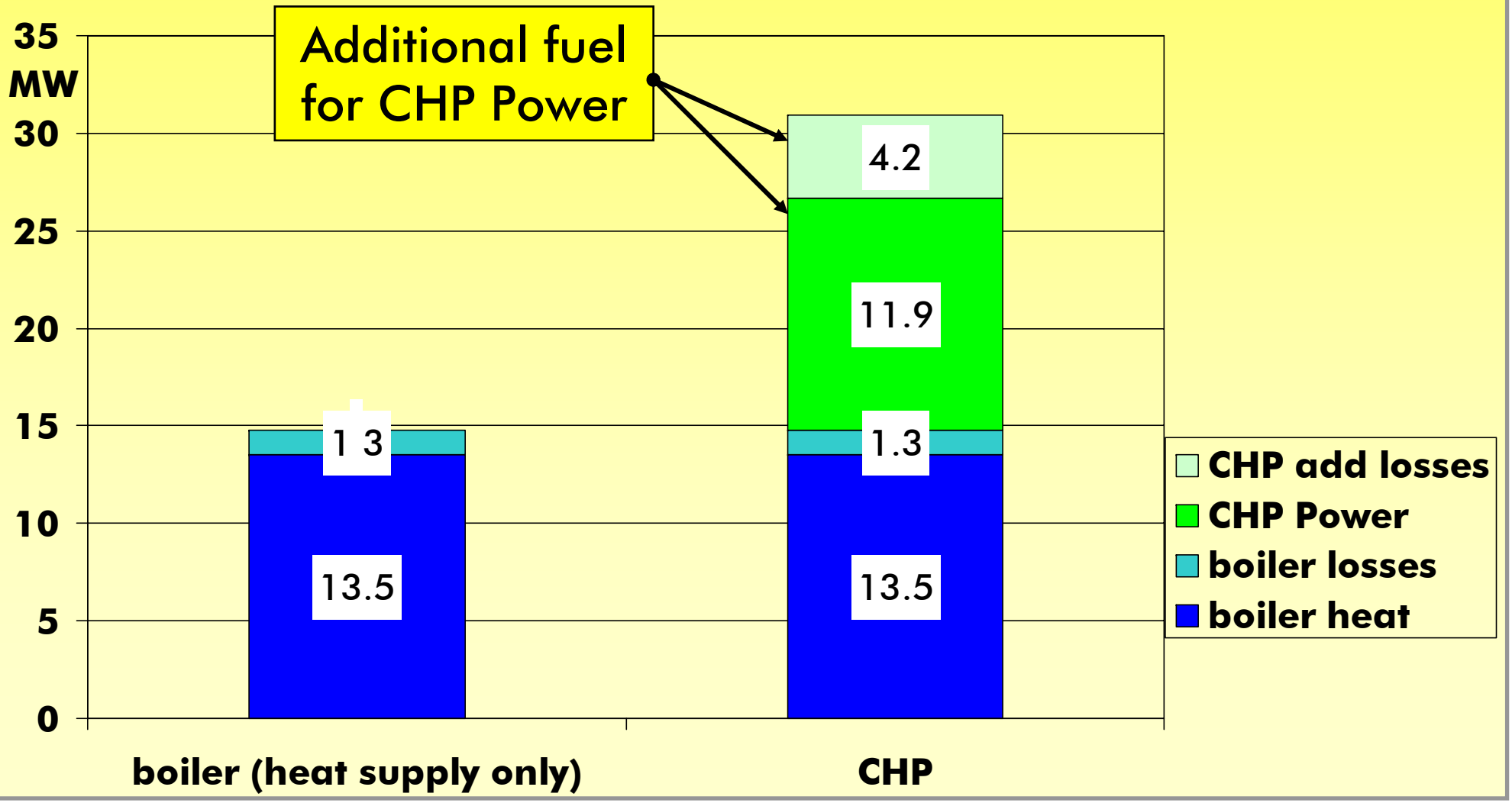
TOLLE ENERGY & ENVIRONMENT CONSULTING



Definition CHP-Efficiency

Efficiency of additional fuel for CHP power generation

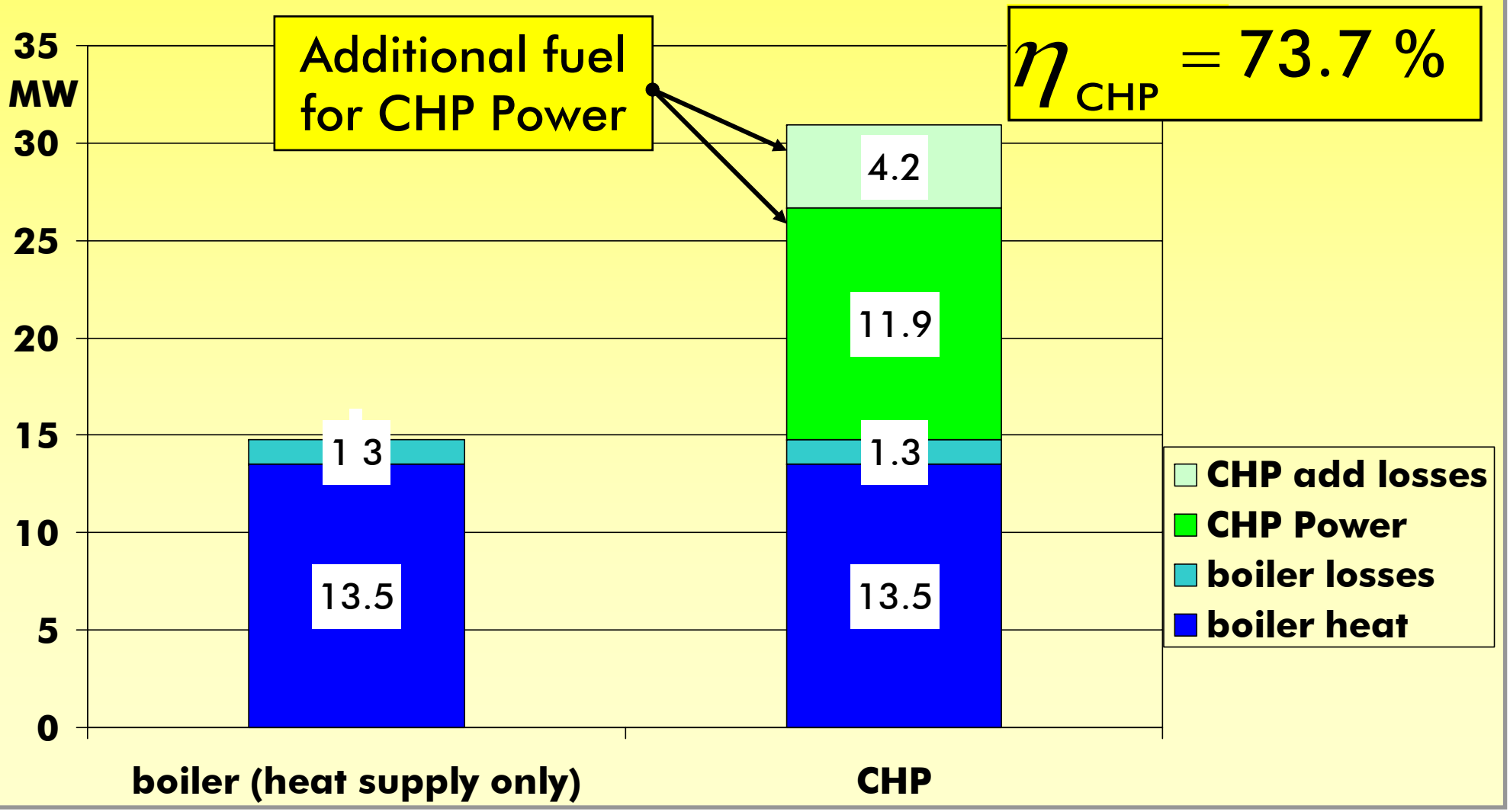
TOLLE ENERGY & ENVIRONMENT CONSULTING



Definition CHP-Efficiency

Efficiency of additional fuel for CHP power generation

TOLLE ENERGY & ENVIRONMENT CONSULTING



CHP Additional Fuel Efficiency

TOLLE ENERGY & ENVIRONMENT CONSULTING

efficiency of **additional** fuel required for generated (CHP) power

$$\eta_{CHP} = \frac{\dot{P}_{el\ CHP}}{\dot{F}_{CHP} - \frac{\dot{Q}_{CHP}}{\eta_{Boiler}}}$$

Specific emissions of CHP

Allows direct Comparison with other Power Plants

TOLLE ENERGY & ENVIRONMENT CONSULTING

$$y_{CO_2\ CHP} = \frac{y_{CO_2\ Fuel}}{\eta_{CHP}} \qquad \left[\frac{kg}{kWh}\right]$$

$y_{CO_2\ Fuel}$ specific CO_2 Fuel

η_{CHP} Efficiency Power Generation CHP

300-power Definition

TOLLE ENERGY & ENVIRONMENT CONSULTING

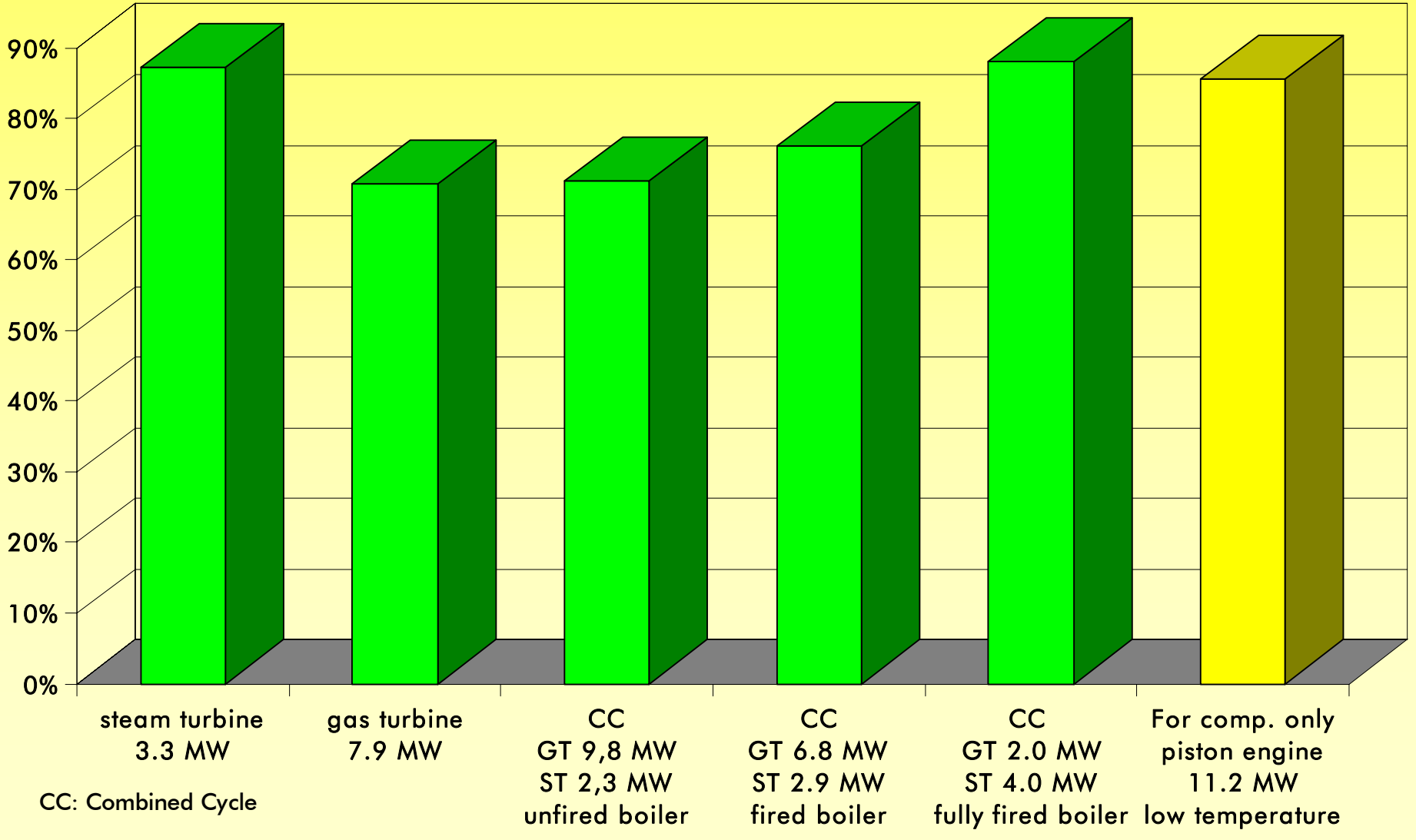
- Power with maximal CO_2-Emissions of

300 kg/MWh

Efficiency CHP Power Generation

Higher than in any other power plant

TOLLE ENERGY & ENVIRONMENT CONSULTING

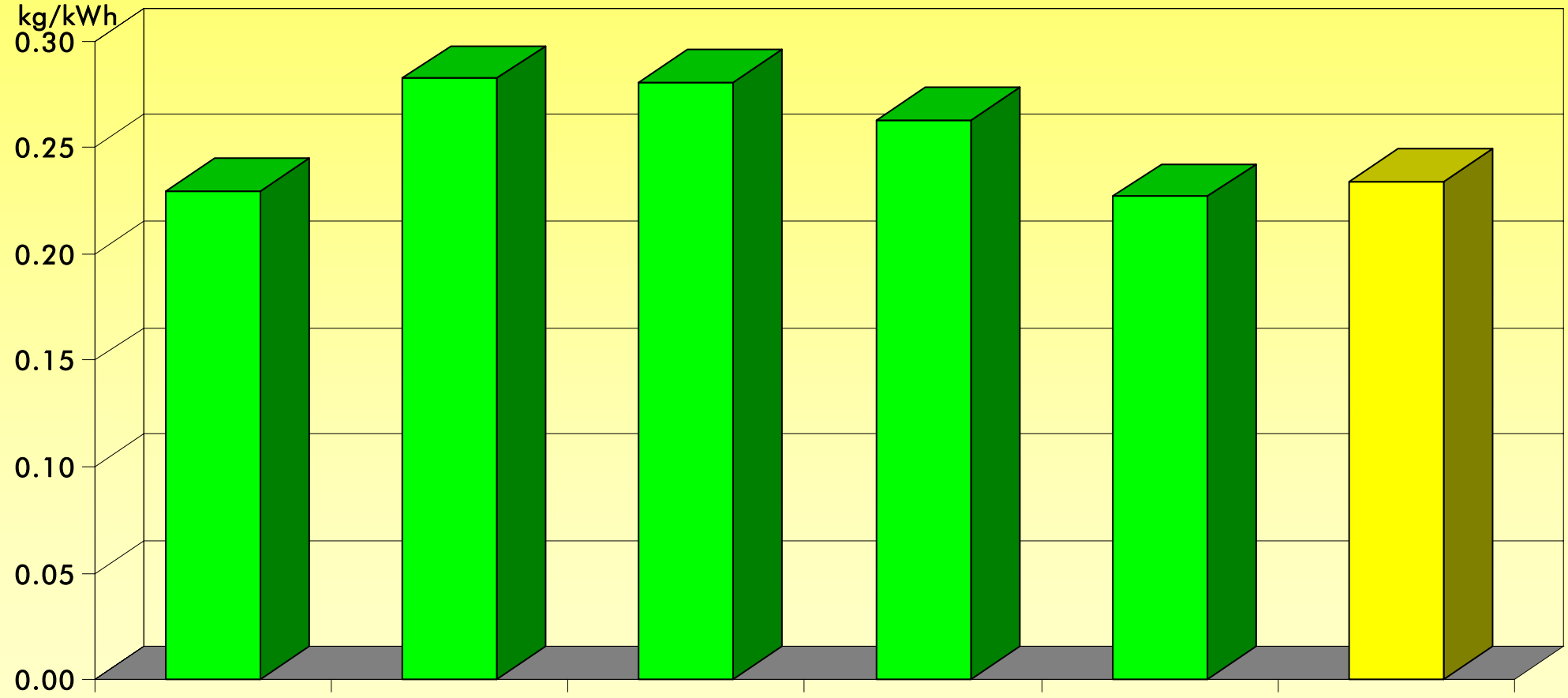


CC: Combined Cycle

CO_2-Emissions CHP Power Generation

Reduction potential primarily defined by heat to power ratio!

TOLLE ENERGY & ENVIRONMENT CONSULTING

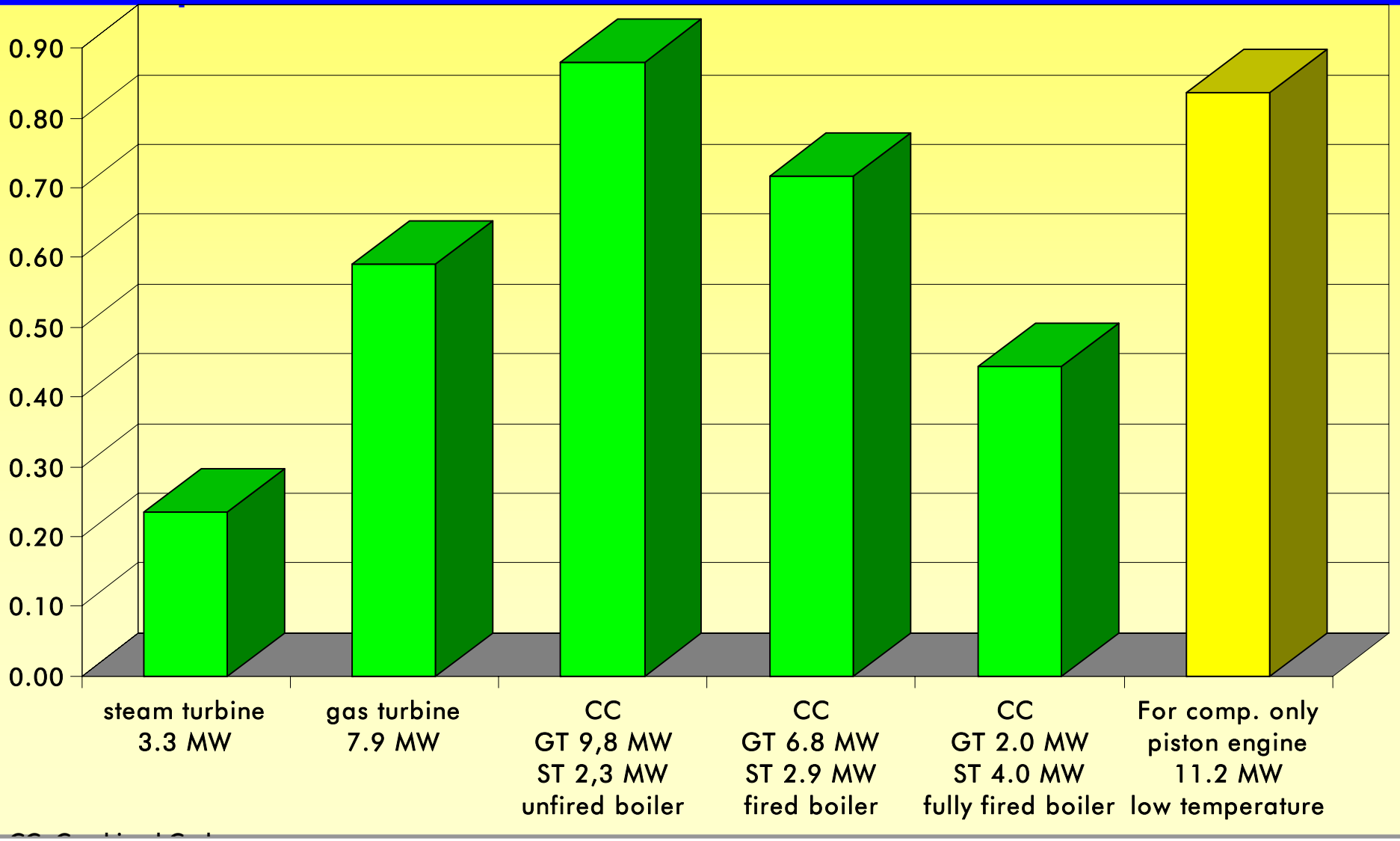


CC: Combined Cycle

Power to Heat Ratio of CHP

TOLLE ENERGY & ENVIRONMENT CONSULTING

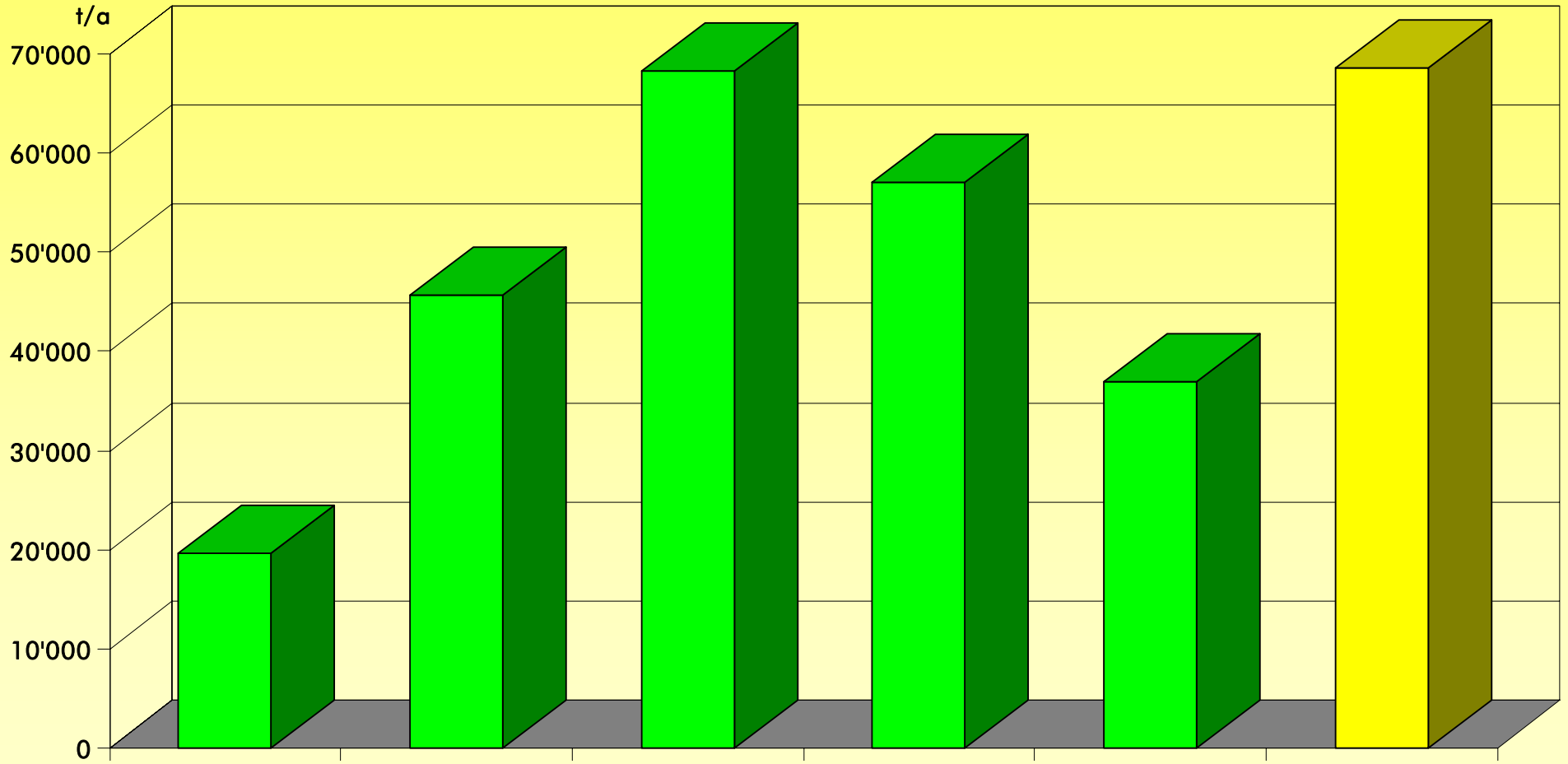
Defines potential for CO_2 reduction



CO_2 Reduction CHP Power Generation

TOLLE ENERGY & ENVIRONMENT CONSULTING

Here: 8000 h/a; steam 20 t/h; substituting coal power

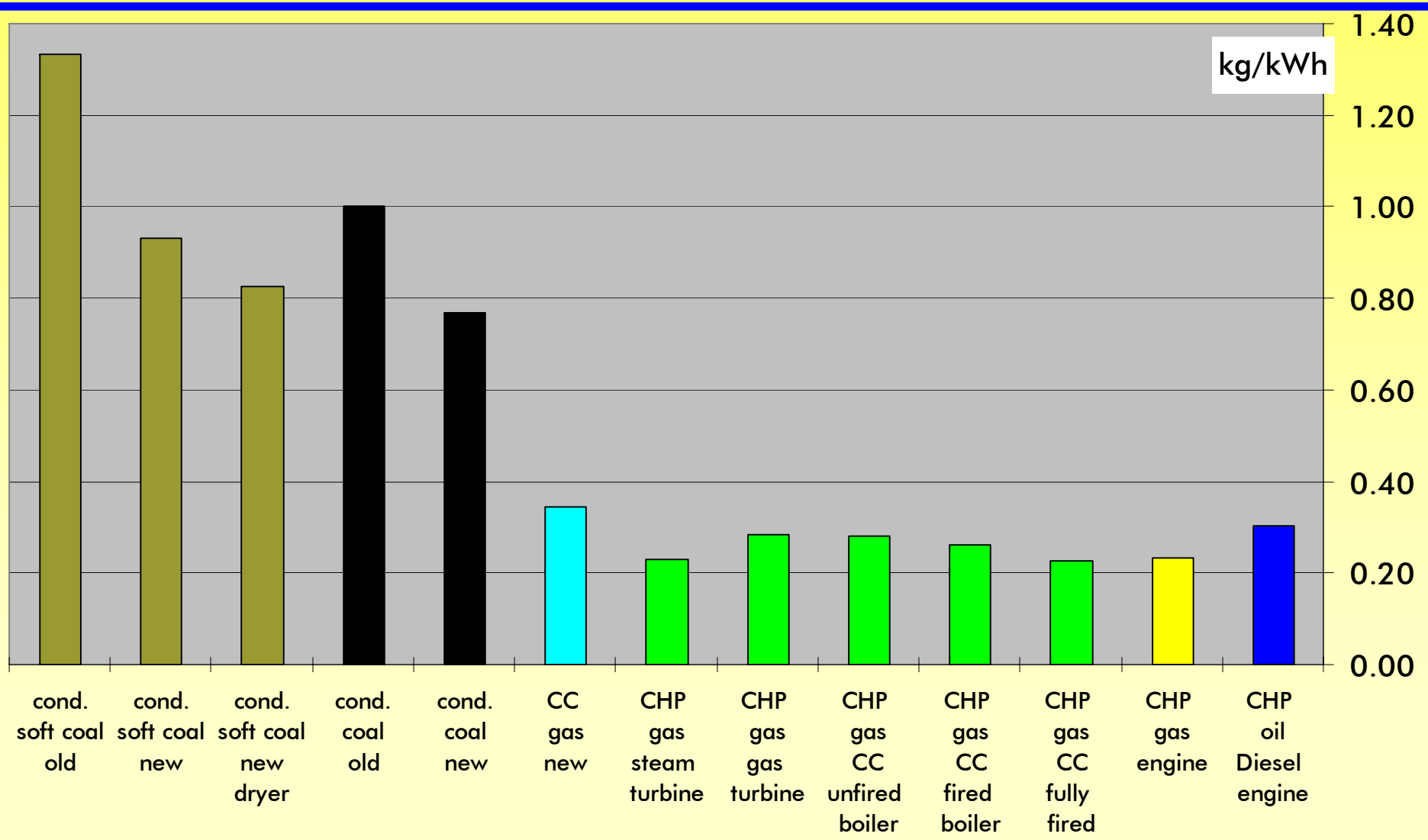


CC: Combined Cycle

CO_2 Emissions Power Generation

In CHP lower than in any other fossil fuel power plants

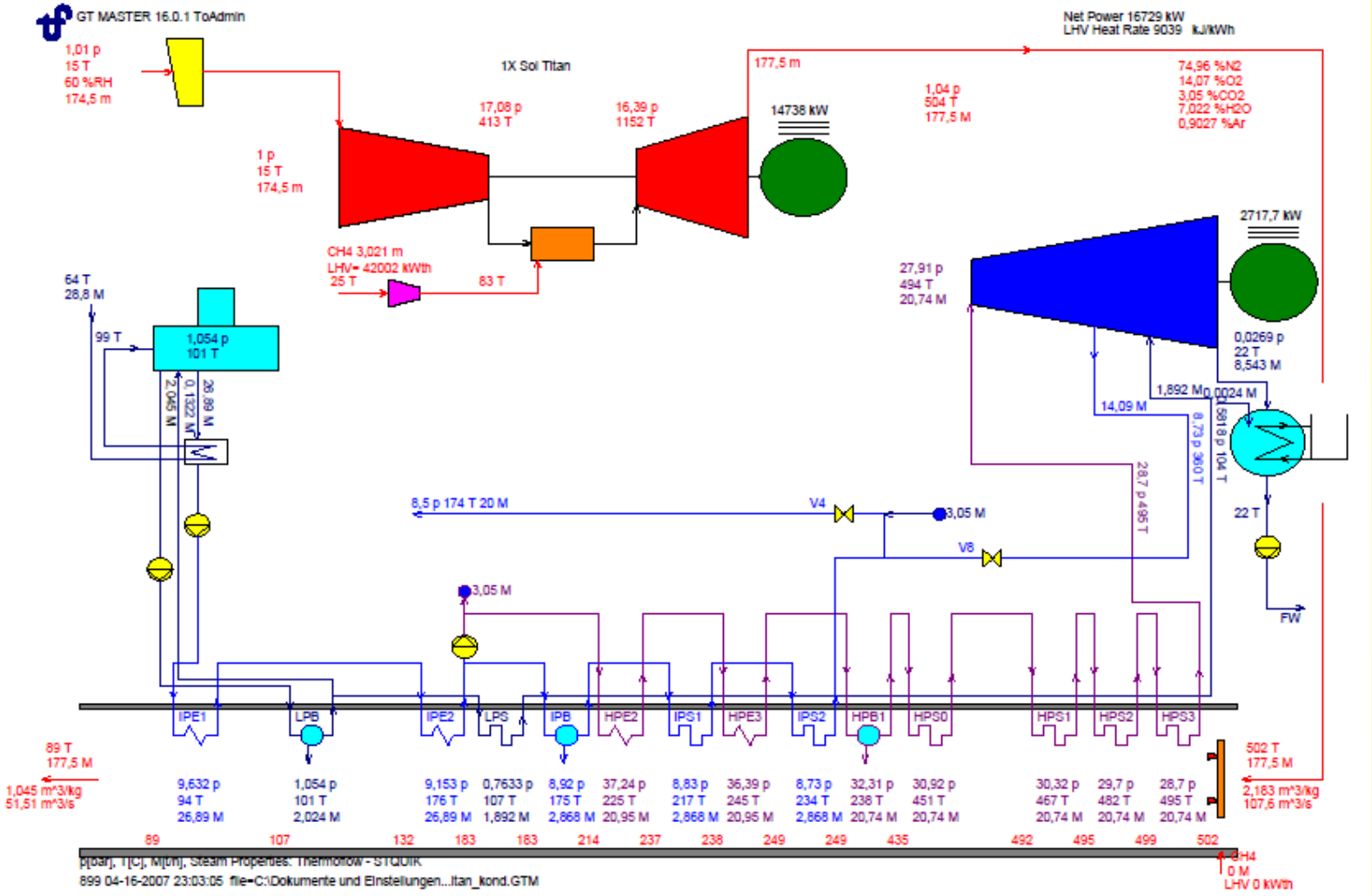
TOLLE ENERGY & ENVIRONMENT CONSULTING



GuD: Flexibilität und Versorgungssicherheit

durch Entnahmekondensationsturbine und Zusatzfeuerung

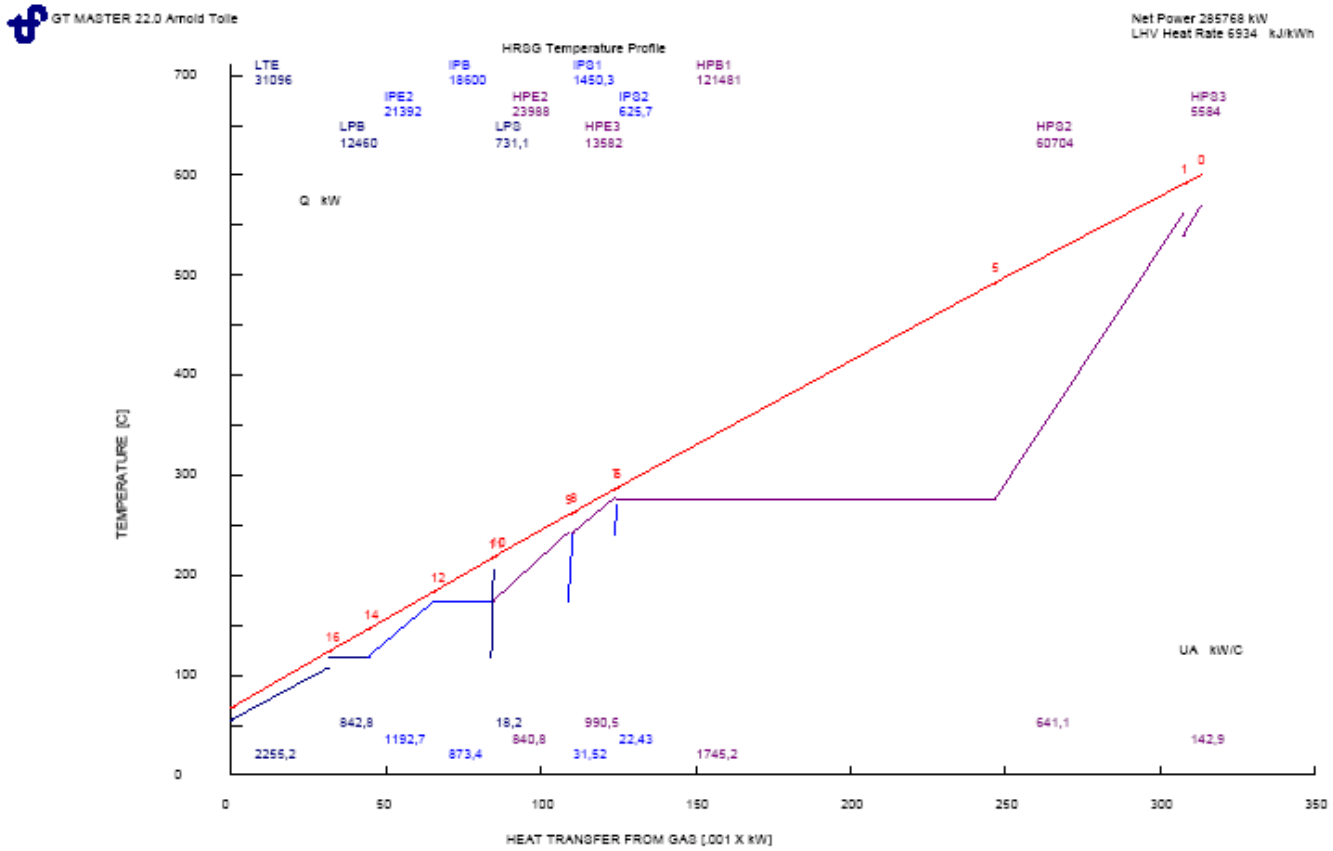
TOLLE ENERGY & ENVIRONMENT CONSULTING



GuD: Flexibilität und Versorgungssicherheit

durch Entnahmekondensationsturbine und Zusatzfeuerung

TOLLE ENERGY & ENVIRONMENT CONSULTING



899 06-20-2012 15:58:09 file=C:\Dokumente und Einstellungen\ToConsult\Desktop\Muster\V94.A_Flex_LP.GTM

300-power

Incentives necessary

TOLLE ENERGY & ENVIRONMENT CONSULTING

- Economic benefits of 300-power
  - ⇒ Lower specific fuel generating costs (at same fuel prize)
    - Due to higher efficiency of power generation
- Economic advantages of big combined cycle power plants (no CHP)
  - ⇒ Lower specific investment costs
  - ⇒ Lower fuel prizes
  - ⇒ Lower specific maintenance costs
  - ⇒ Lower labor costs
  - ⇒ Lower demands on internal rate of return
  - ⇒ **Independence of a long time heat sink**
- Incentives at CHP or Emissions Trading regime
  - ⇒ 300-power: 750 kg/MWh free certificates
    - @ 20 € / t CO_2: same incentive as current German CHP regime

300-power topping CHP
highest CO_2 reduction of fossil power plants

TOLLE ENERGY & ENVIRONMENT CONSULTING

- Significant bigger generation capacity (more than double) per heat sink
- Significant lower specific investment costs
- Lower specific fuel costs
- Higher efficiencies of gas turbines and steam turbines
- Higher live steam temperatures
- Often higher exhaust temperatures of gas turbines
  - ⇒ Higher efficiencies of waste heat boilers
- Additional heat extraction from boiler at 3rd pressure level
  - ⇒ usage in condensing part of steam turbine
- Additional generation of peak power - or - power reduction
  - ⇒ Active player in power market
- High flexibility at sudden load changes in steam demand
  - ⇒ f.e. starting or unloading a paper machine
- Increasing use of renewable fuels (second generation) possible

300-power and Biogas

TOLLE ENERGY & ENVIRONMENT CONSULTING

- Separate CH_4 and CO_2 from biogas generator
- Feed Bio-CH_4 into the gas distribution grid
- Generate power in 300-power plants
  - ⇒ Instead of gas engines at the 475 kg/MWh
    - Better in CHP (heat sink?)
- Power to Gas
  - ⇒ Use (locally stored) Bio-CO_2 with excess regenerative power to produce additionally CH_4
    - Feed it to the gas grid too
  - ⇒ Use CO_2 from 300-power
    - When shut down: from auxiliary boiler
- Use the existing natural gas storage capacities
  - ⇒ Even for seasonal storage

Dot Earth

ANDREW REVKIN

ENERGY November 5, 2012 6:11 PM 11 Comments

How Natural Gas Kept Some Spots Bright and Warm as Sandy Blasted New York City

By ANDREW C. REVKIN

As New York City and other communities buffeted, flooded or darkened by the remains of Hurricane Sandy consider steps beyond the immediate recovery,

Search This Blog
Search

Previous Post
Study Finds Fuel Thrift in U.S. Vehicles at All-Time High

FOLLOW THIS BLOG Twitter RSS

DOT EARTH

ANDY REVKIN
When you replace an "and" with "but" or "therefore," you're telling story, not simply stringing thoughts. @thebenshi channeling Trey Parker. about 4 hours ago

ANDY REVKIN
RT @SweetLou89: @AshAntonette @Revkin I think this is blog-worthy for you, Ash...60 years of political ads http://t.co/5wqcuWJr #paceblog about 4 hours ago

ANDY REVKIN
RT @thebenshi: NEW BENSHI: http://t.co

RECENT POSTS

November 05
11
How Natural Gas Kept Some Spots Bright and Warm as Sandy Blasted New York City
New York City's other grid, natural gas lines, allowed some places to stay warm and bright despite Sandy.

November 05
10
Study Finds Fuel Thrift in U.S. Vehicles at All-Time High

300-power

TOLLE ENERGY & ENVIRONMENT CONSULTING

Benefits: highest CO_2 reductions per heat sink

- Fossil power generation at lowest specific CO_2-emissions
- Very high flexibility
- Continued operation for peak power
  - ⇒ If heat sink is shut down
- Capacity Building: Excellent chance for advanced sustainability
  - ⇒ Build up capacity by incentives for low CO_2 power generation
    - Better than grants for non CHP power plants
- Reduced imports of gas for power generation
  - ⇒ Increased safety
- New players in power generation
  - ⇒ Competition and lower power prices
- Enhanced reliability of local area power grids
- Increasing use of Biogas: Transition to the regenerative energy System
- **Incentives necessary**: free certificates in the Emissions Trading regime

EUROPEAN BUSINESS COUNCIL FOR A SUSTAINABLE ENERGY FUTURE

TOLLE ENERGY & ENVIRONMENT CONSULTING

- EUROPEAN BUSINESS COUNCIL FOR A SUSTAINABLE ENERGY FUTURE

  $\Rightarrow e^5$ (e to the power of five)

  - ENERGY
  - EFFICIENCY
  - ENVIRONMENT
  - EMPLOYMENT
  - ECONOMY

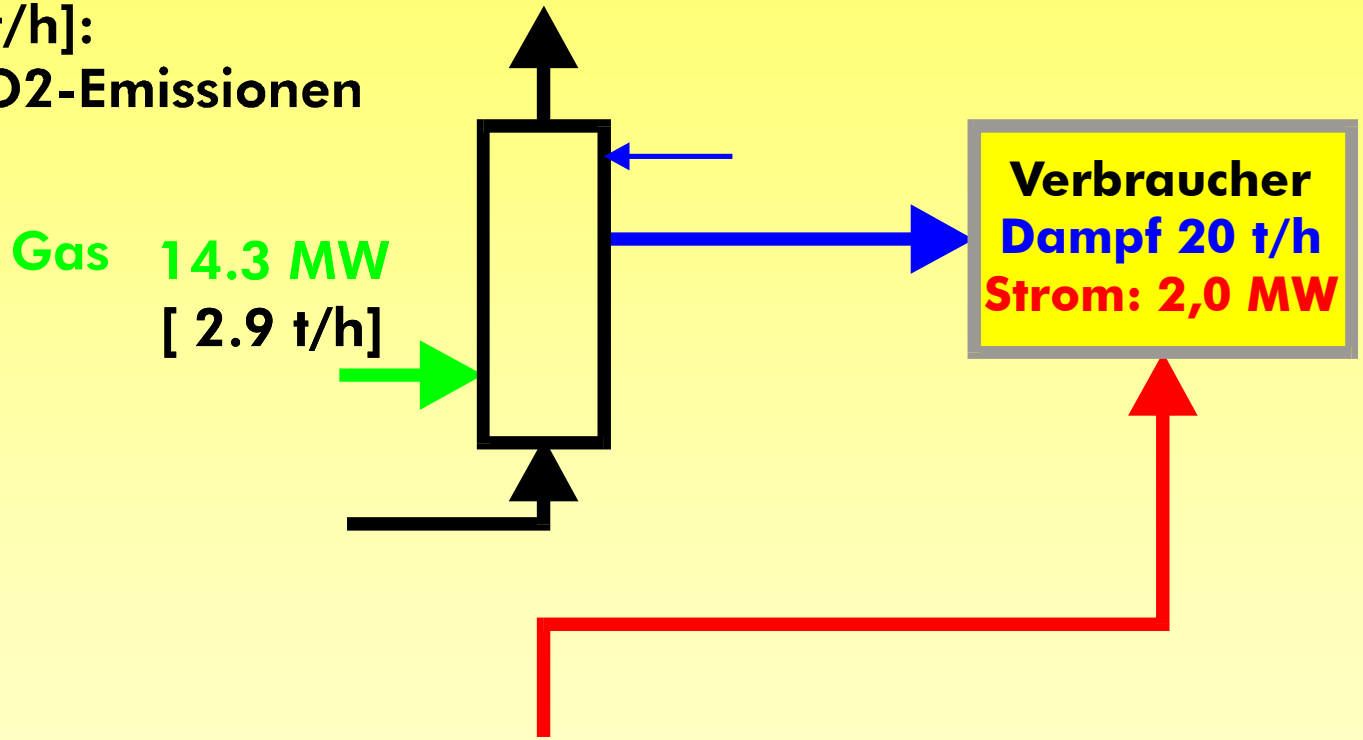
- www.e5.org

KWK Var. 1: Keine KWK

Basis für nachfolgende Vergleiche

TOLLE ENERGY & ENVIRONMENT CONSULTING

In Klammern [t/h]:
Verursachte CO2-Emissionen

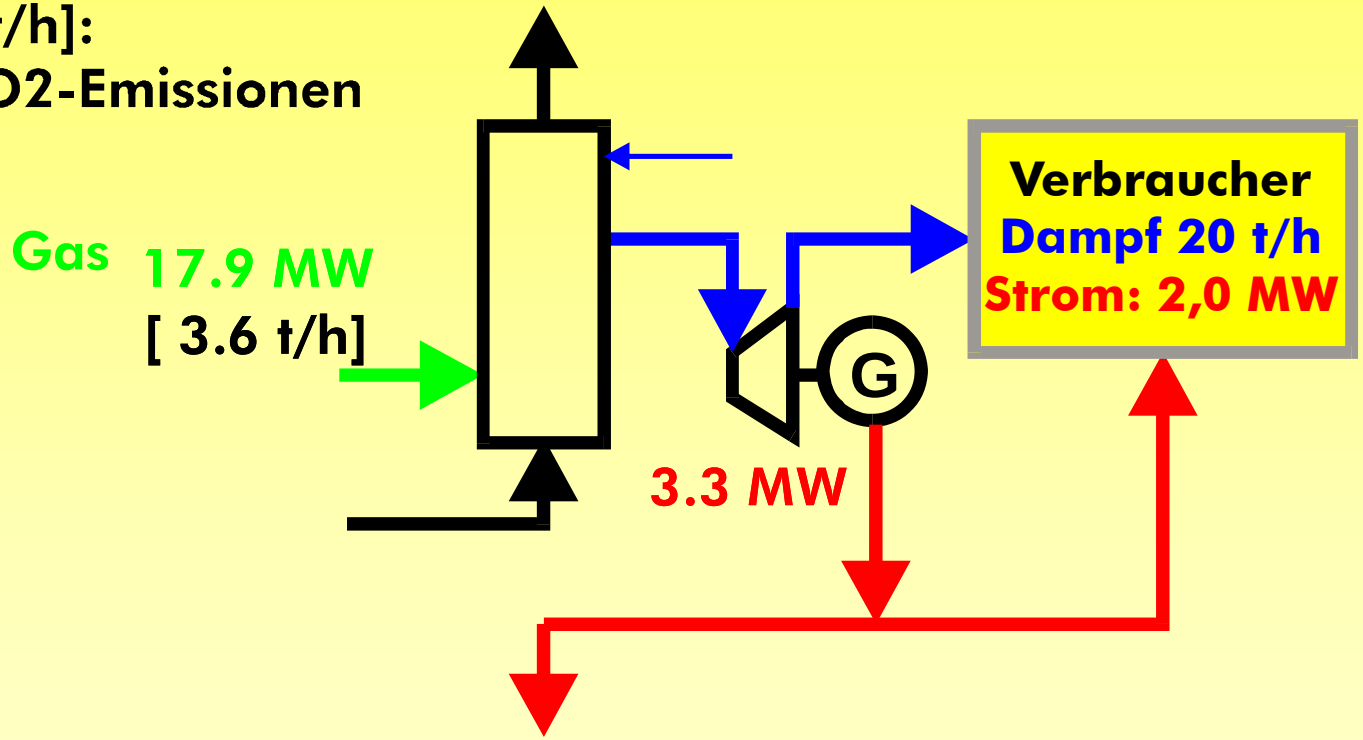


KWK Var. 2: Dampfturbine

Klassische Schaltung, seit vielen Jahrzehnten bewährt

TOLLE ENERGY & ENVIRONMENT CONSULTING

In Klammern [t/h]:
Verursachte CO2-Emissionen

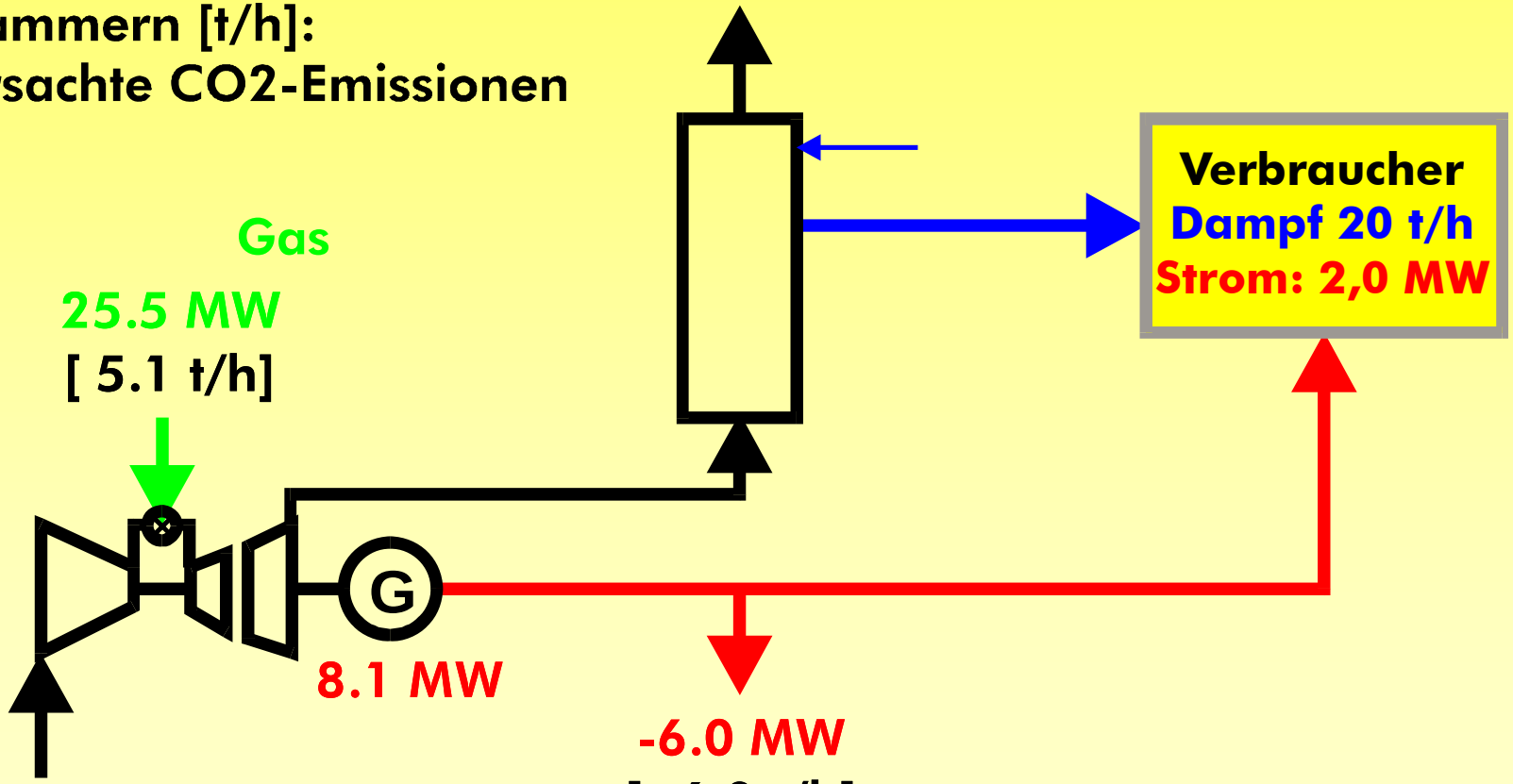


KWK Var. 3: Gasturbine

Gasturbine mit ungefeuertem Abhitzekessel

TOLLE ENERGY & ENVIRONMENT CONSULTING

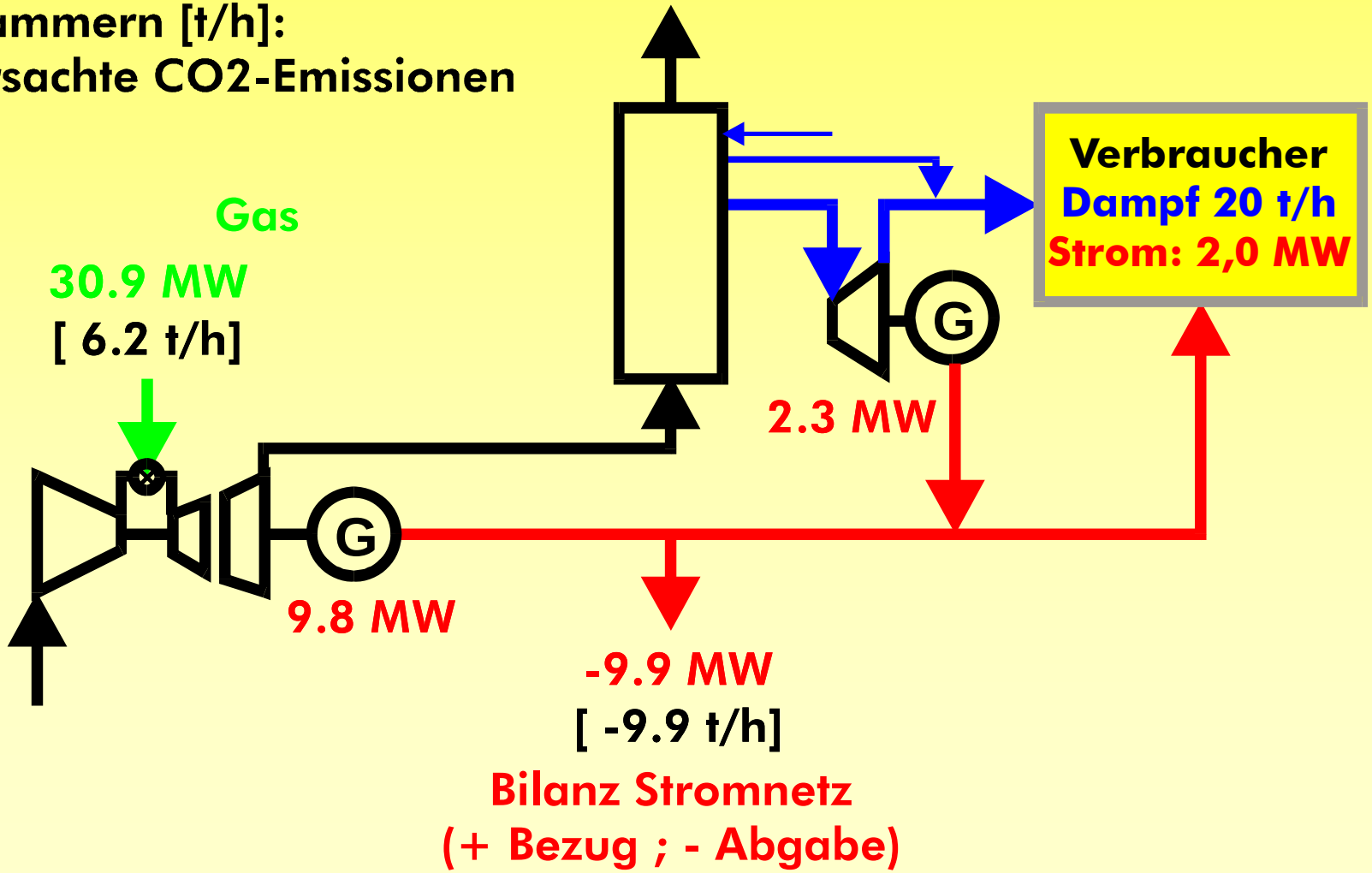
In Klammern [t/h]:
Verursachte CO2-Emissionen



KWK Var. 4: Höchste Stromkennzahl

Gas- und Dampfturbine, ungefeuerter Abhitzekessel

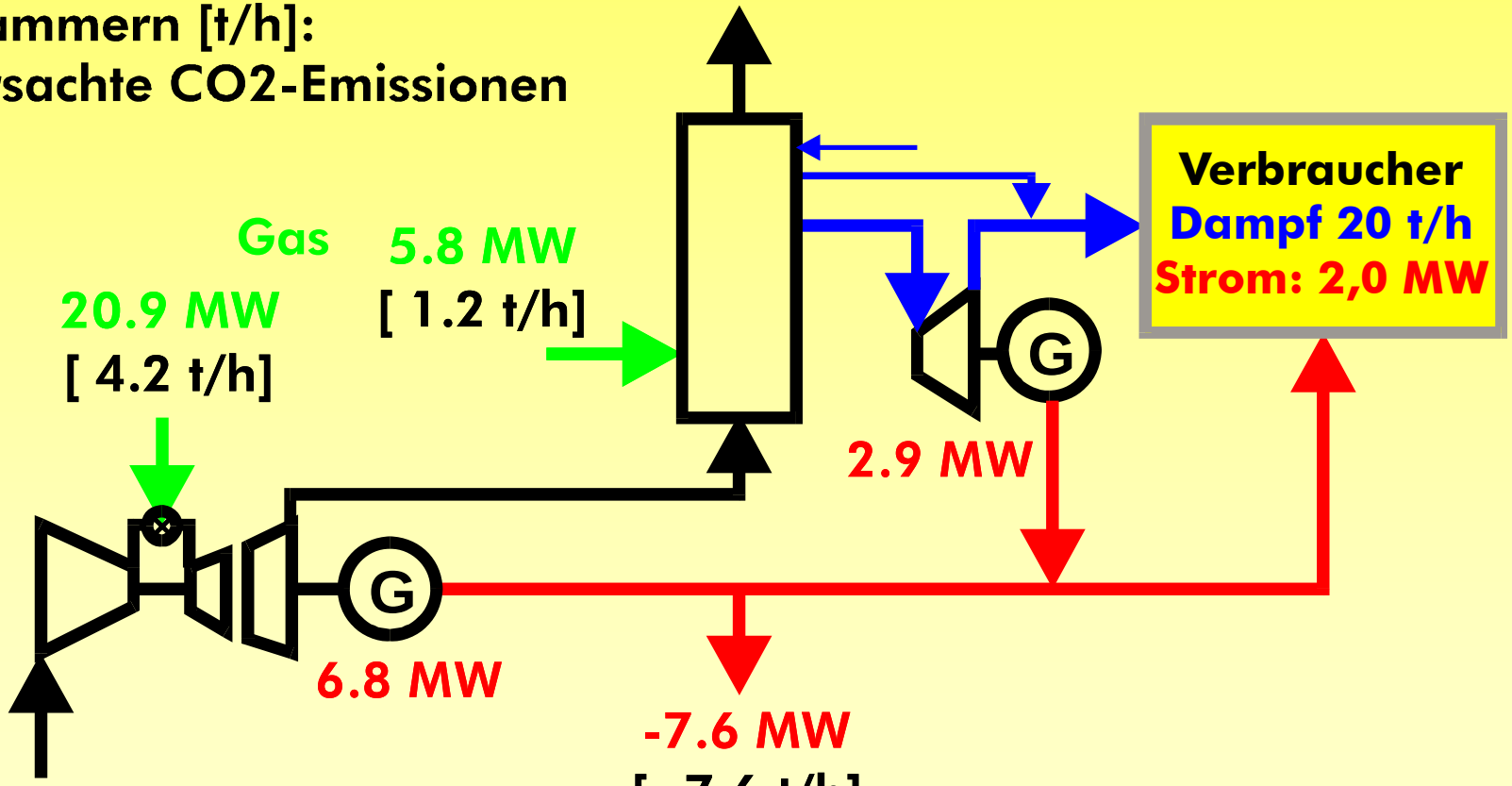
TOLLE ENERGY & ENVIRONMENT CONSULTING



KWK Var. 5: Gut regelbar

Gasturbine, Dampfturbine, Kessel mit Zusatzfeuerung

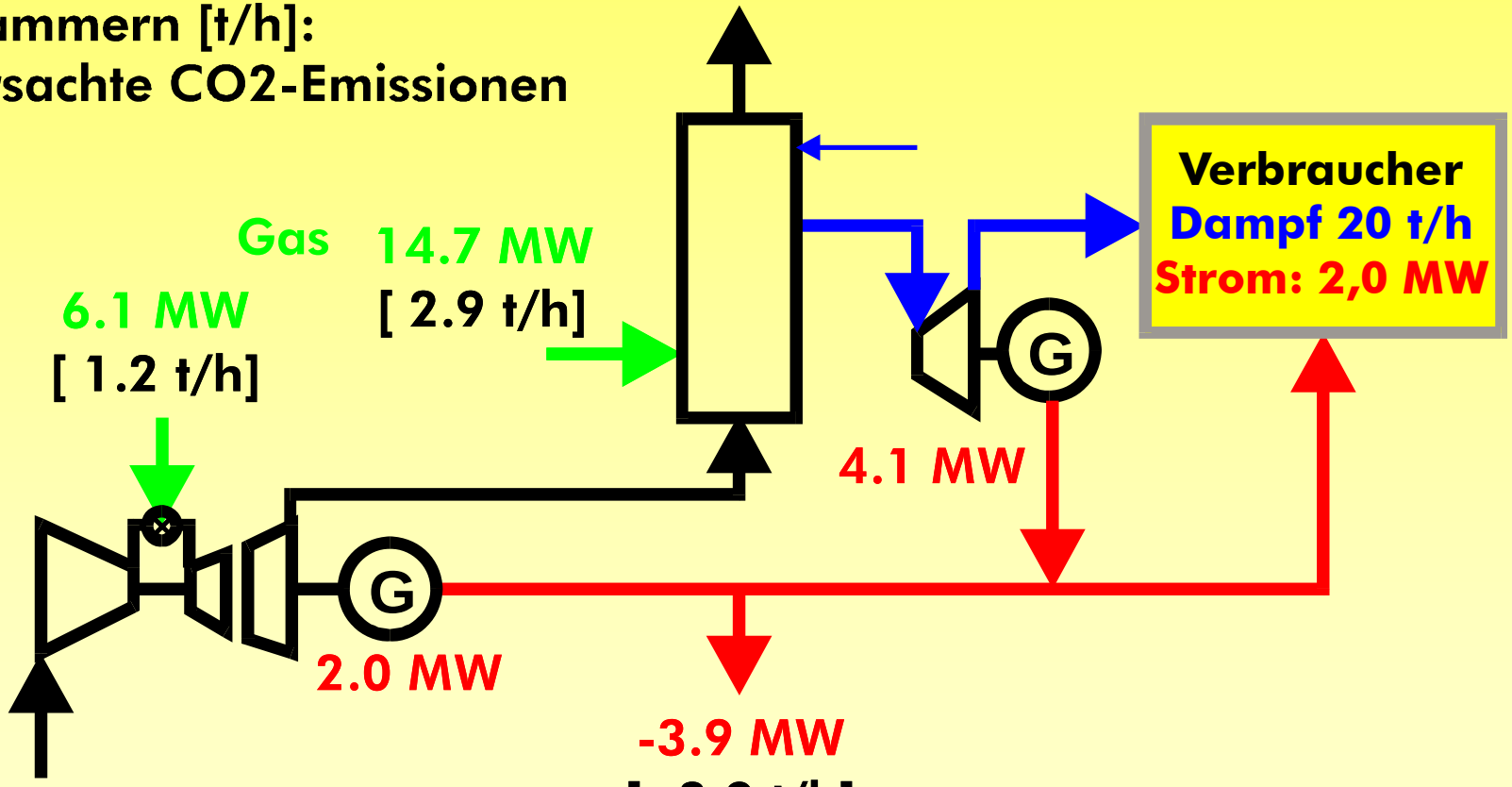
TOLLE ENERGY & ENVIRONMENT CONSULTING



KWK Var. 6: Vorschalt-Gasturbine

Gasturbine, Dampfturbine, volle Zusatzfeuerung

TOLLE ENERGY & ENVIRONMENT CONSULTING



KWK Vergleich: CO_2-Emissionen

Basis: Dampfbedarf 20 t/h, Nutzungsdauer 8000 h/a

TOLLE ENERGY & ENVIRONMENT CONSULTING