Benchmarking Energy Efficiency
a basis for allocation of CO2 allowances

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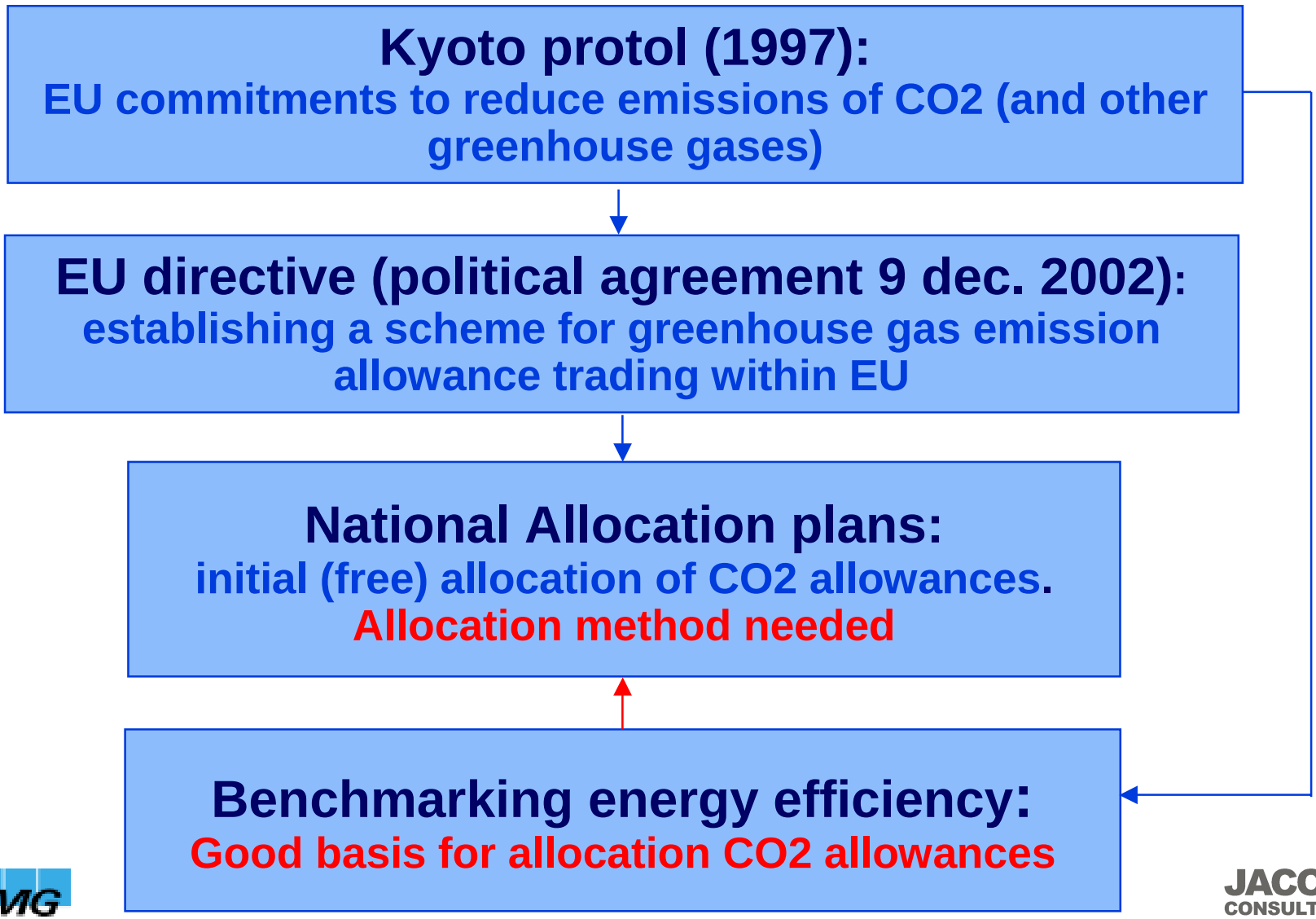
Maastricht, April 2003

Background



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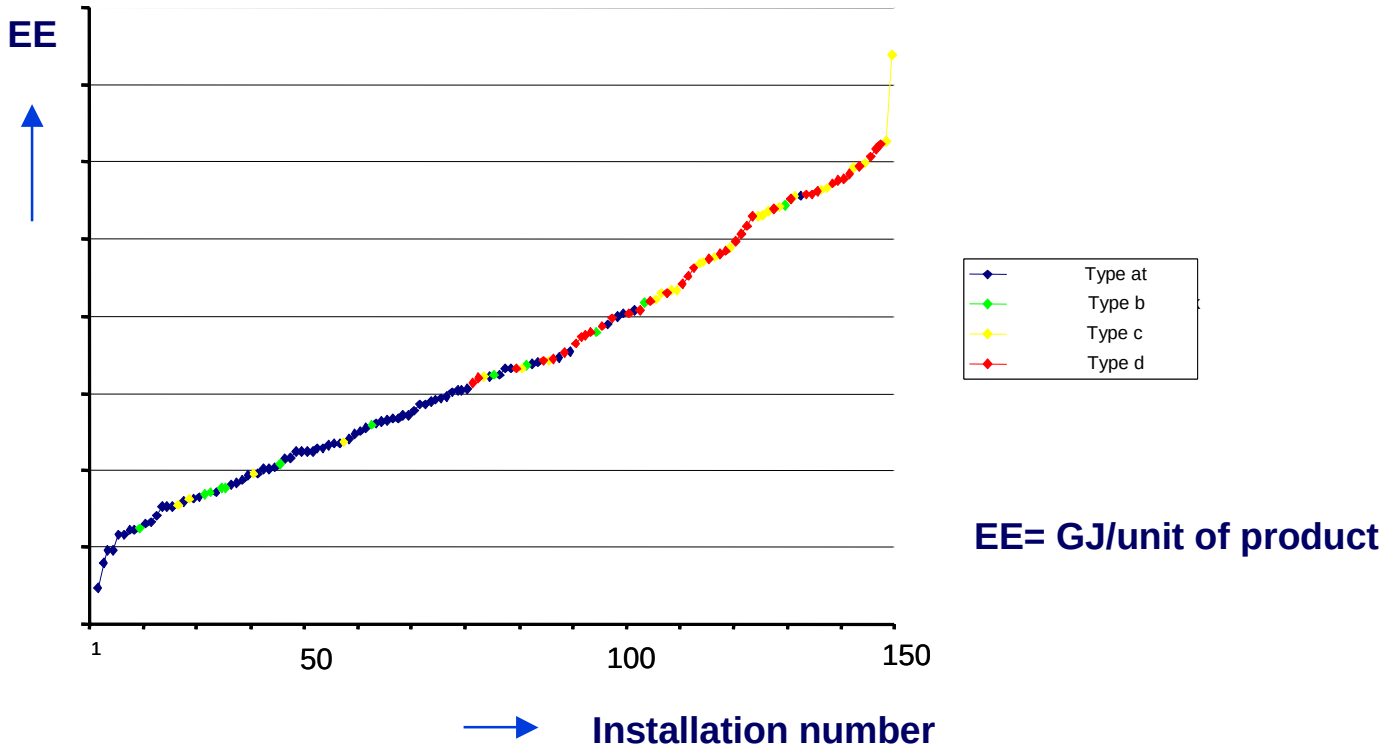
Benchmarking energie-efficiency
How does it work?



EE= GJ/unit of product

Benchmarking:

- **Uniform EE performance reference level / target**
- **fair base for CO_2 allocation**

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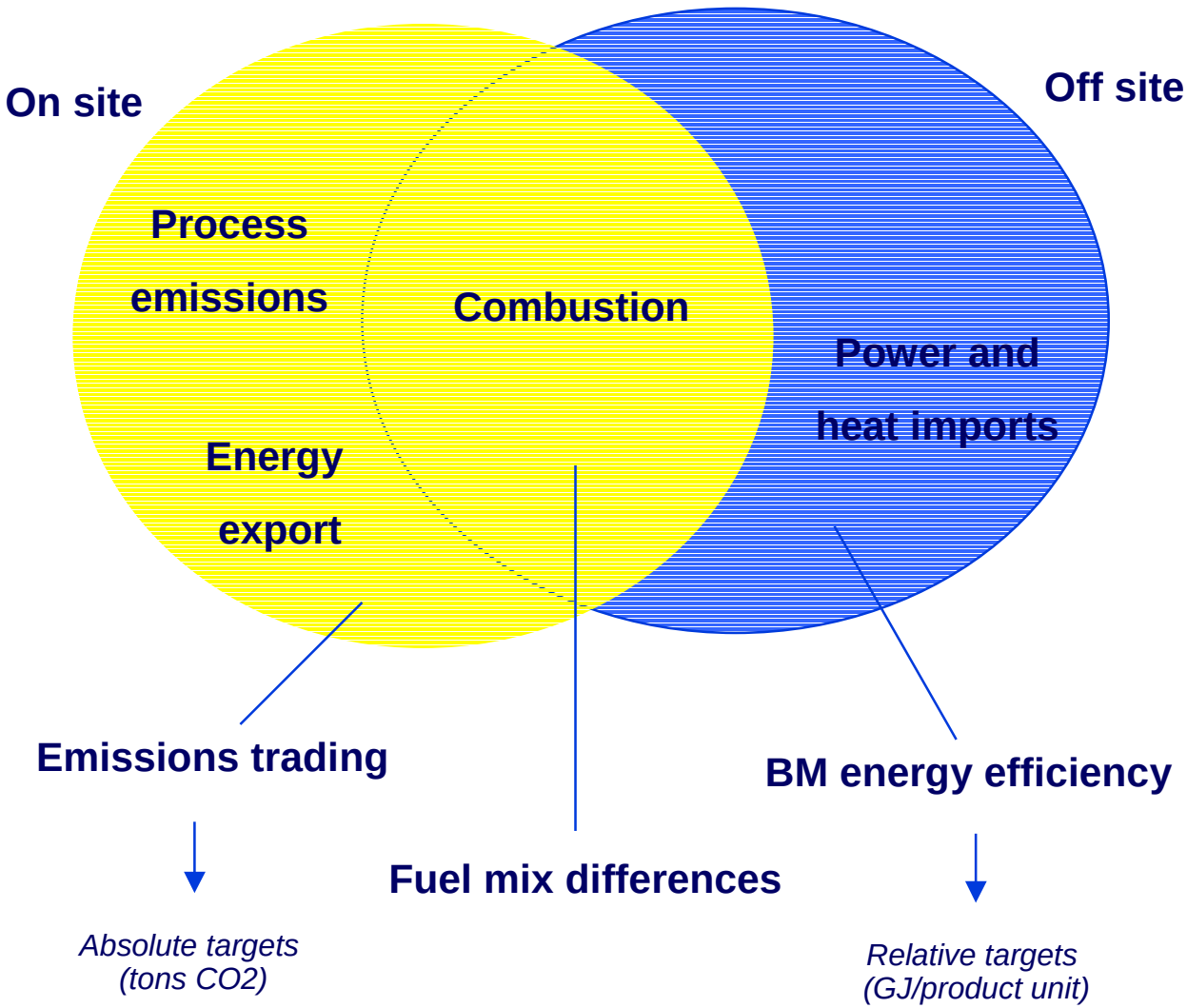
Energy and emissions: scope differences



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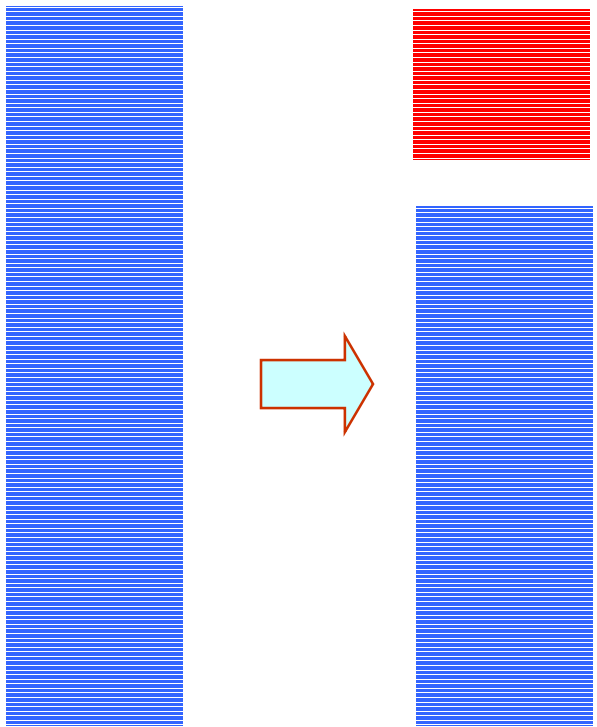
Translating benchmark results in C02 allocation



Present Energy Efficiency

Benchmark Energy Efficiency

Gap between benchmark and actual EE

Possibility Allocation CO2 =

$$\frac{\text{EE Benchmark}}{\text{Actual EE}} * \text{Actual CO2}$$

Relation EE-CO2 Electricity production sector

Within the E-production sector:

- **All emissions are direct emissions**
- **All emissions come from combustion (no process emissions)**

Therefore:

- **direct relation between EE and CO2 emissions (per fuel).**
- **benchmark EE certainly seems a suitable basis for allocation of CO2 allowance.**

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Conditions for reliable benchmarking

- Comparability (installations)
- Completeness
  all required data of all comparable installations
- Reliability of data
- Up to date data

Furthermore:

- Feasibility
- As simple as possible
- Transparent
- Auditable

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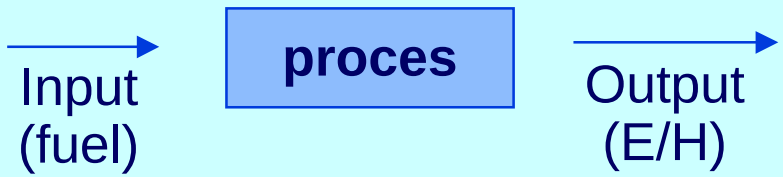
Benchmark E-production units
1. Comparability

- **How many benchmarks**
  - Based on comparability of installations (input/output)



  - Separate benchmark for coal and gas fired installations and
  - Separate approach for CHP.

- **Selection participating installations per benchmark**
  Selection based on comparability installations, available data etc.

	Number Worldwide	Number in benchmark
Coal fired installations	>5000	2770
Gas fired installations	>5000	1992

- **Definition of efficiency**
  Actual efficiency versus design efficiency.

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Benchmark E-production units
2. Completeness

- No actual performance data available from all selected installations.
- International E-production companies reluctant to give these data.
- Two international data bases available with worldwide data of almost all individual E-productions installations:
  - the UDI database: data on coal- and gas fired installations
  - the IEA database: data on coal fired installations.
- For most of the installations worldwide, the required data were available in these databases to calculate the design efficiency.

UDI data base in principal selected as the basis for the benchmark of coal- and gas fired installations.

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Benchmark E-production units
3. Reliability data

Data sources UDI

- Direct surveys and queries sent out on a continuing basis to the plants.
- Annual reports, statistical supplements, web pages provided by electrical utilities.
- Data from major suppliers and vendors of power plant equipment.
- Trade and business press.

Reliability check data UDI

- Check data UDI coal fired installation with IEA data
- Check data UDI with data suppliers
- Check data IDI with data Dutch installations

Conclusion: good match in general

Reliable benchmark possible, based on design efficiency

Benchmark E-production units
4. Up to date data

Data base is up dated regularly

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Benchmark E-production
5 Other aspects

Benchmark answers requirements with respect to

- Feasibility
- As simple as possible
- Transparent
- Auditable (verifiable)

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Benchmark E-production
Execution

Ranking on Energy Efficiency

- Specific characteristics of E-production
- Separate benchmarks for gas and coal fired installations
- Define selections
- Define energy efficiency
- CHP

From benchmark to CO_2 allocation

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Benchmark E-production
Specific characteristics of E-production

- Product is energy
- No storage possible
- Large fluctuations in demand
- Security of supply
- Transport via grid

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Benchmark E-production
Separate benchmarks for coal and gas fired plants

- Different input
- Different technical possibilities
- EE of coal and gas installations are not comparable
- No differentiation between: base load, part load and peak load

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Benchmark E-production
Define selections

- **First selection: all gas/coal units larger than 10 MWe**
- **Reduction based on comparability**
  - No auto producers
  - No CHP (separate treatment)
  - No installations smaller 50 MWe
  - No installations with insufficient information
- **Final selection**
  - comparable in terms of size, constitution and operational objectives

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Benchmark E-production
Define Energy Efficiency

- **Option 1: Actual Energy Efficiency**
  - Annual production / Annual fuel consumption
- **Option 2: Design Energy Efficiency**
  - Production / fuel consumption at defined conditions
- **Benchmark E-production: Design Energy Efficiency**
  - Advantages: Comparability, Accuracy, Reproducibility, Transparency, Feasibility
  - Disadvantage: operational aspects

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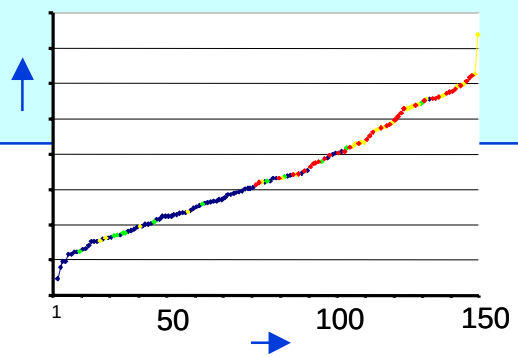
Benchmark E-production
Define Energy Efficiency 2

- **Actual Energy Efficiency**:
  - Actual input/output data from installations
  - Determination of energy efficiency
  - Apply corrections to enable reliable comparison
  - A lot of data necessary concerning external factors
- **Design Energy Efficiency**
  - Design data from data base
  - Determination of energy efficiency



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Benchmark E-production
Combined Heat and Power

- **Option 1: reference separate generation**:
  - Power production reference: benchmark efficiency E-production
  - Heat production reference: 90%
- **Option 2: Reference Best practice**
  - Best practice with EE depending on heat to power ratio
- **In Benchmark Best Practice is chosen**
  - preference for separate generation but not feasible because of current lack of information.
  - Desire to come to method more in line with industry

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Benchmark E-production

From benchmark to CO_2 allocation

$$\frac{\text{EE Benchmark}}{\text{Actual EE}} \times \text{Actual CO2}$$

- **Issues**
  - Bottum-up, total may be larger than fixed target. Several options possible.
  - Change in production
  - Production shift from coal to gas or vice versa
  - Biomass co-firing

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