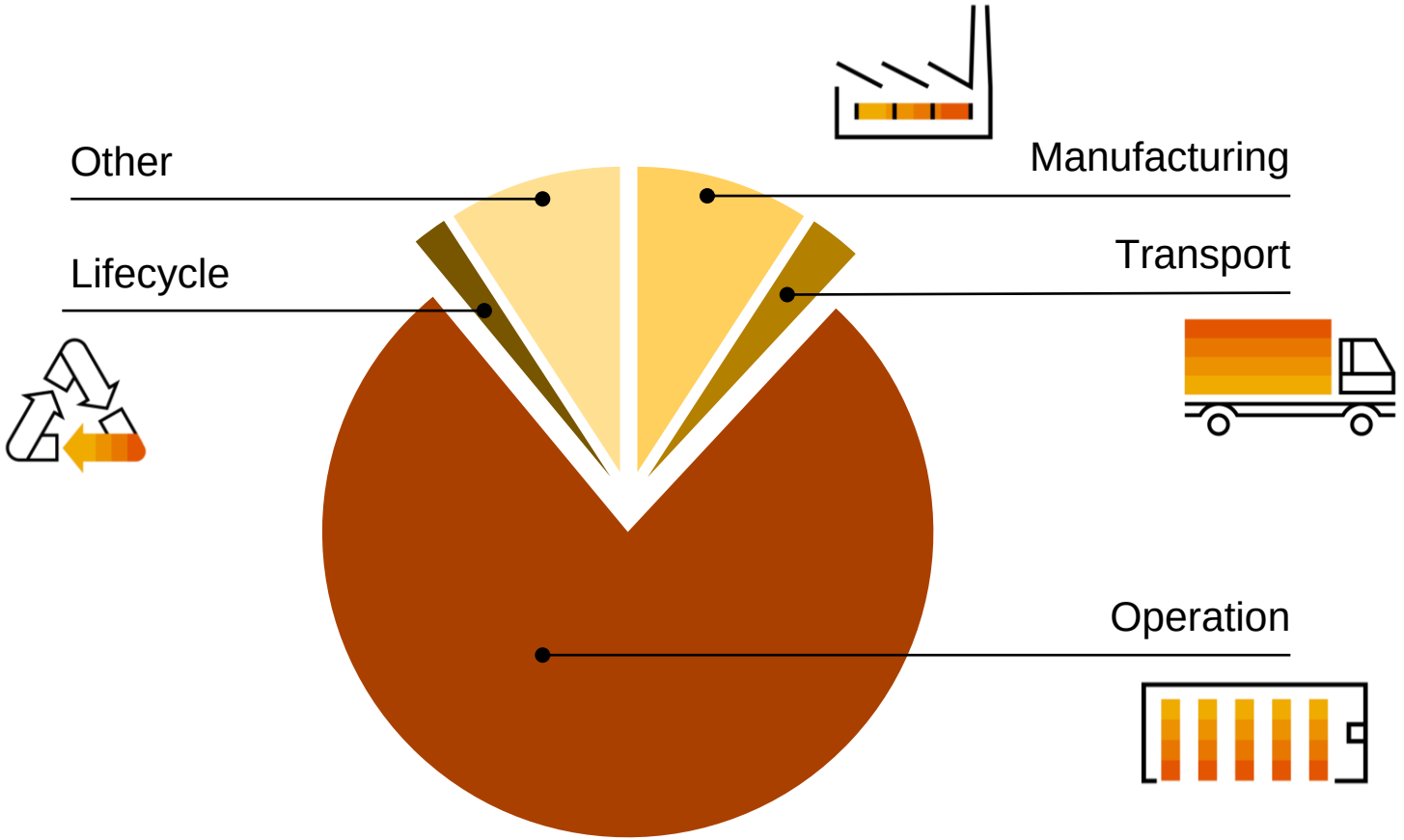
Carbon Calculation Basics

Rudolf Meier, SAP
Detlef Thoms, SAP

Carbon footprint of software usage: symbolic overview

Contributions to carbon footprint

- Manufacturing
- Transport
- Operation
- Lifecycle
- Other



Carbon Calculation Basics

Power consumption to carbon footprint

Direct consumption: compute and storage servers provide resources, require electrical energy

- CPU, Memory, Disk I/O, Network

Indirect consumption: data center infrastructure

- Cooling, lighting, other

Step 1: From data center power consumption to carbon footprint

Step 2: From hardware power consumption to carbon footprint

Step 3: From business requirements to carbon footprint

Step 4: Into the cloud

Step 1: From data center power consumption to carbon footprint

Carbon Emission Intensity (CEI)

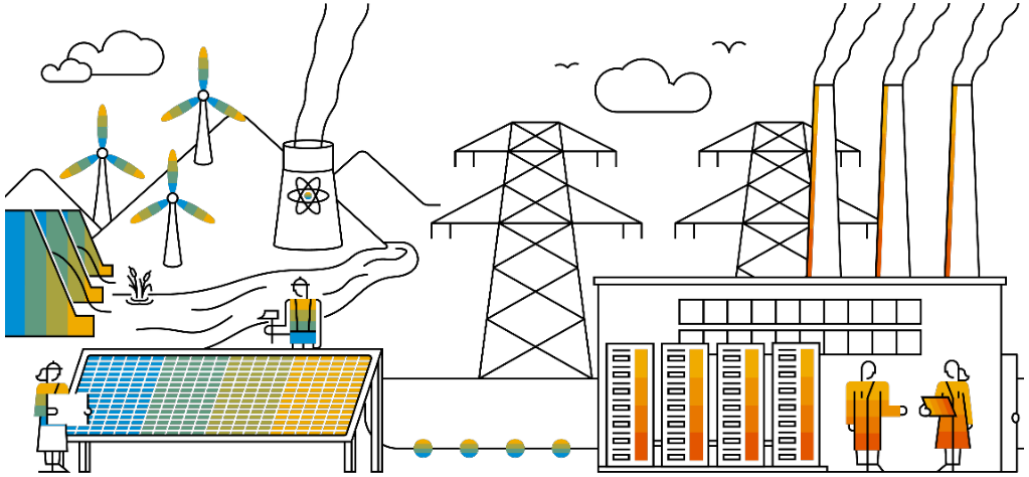
- Exclusive data center usage; data center electric energy consumption E_{total} is known

Carbon footprint [g] = E_{total} [kWh] x (carbon emission intensity (CEI) [g/kWh])

- The value of the carbon emission intensity is determined from the mix of conventional and renewable energy sources used by the electricity provider

Global average*: 475 g/kWh

SAP data centers: 0 g/kWh by use of 100% renewable electricity:



* IEA (International Energy Agency) https://www.iea.org/reports/global-energy-co2-status-report-2019/emissions

Step 2: From hardware power consumption to carbon footprint

Power Usage Effectiveness (PUE)

- Dedicated hardware; the dedicated electric energy consumption Eraw is known

> Total electric energy consumption Etotal [kWh] = Eraw [kWh] x (power usage effectiveness PUE)
>
> Carbon footprint [g] = Etotal [kWh] x (electricity provider-specified carbon emission intensity [g/kWh])

- Power usage effectiveness (PUE) describes how efficiently a computer data center uses energy*
- Power usage effectiveness (PUE) = Total facility energy / IT equipment energy

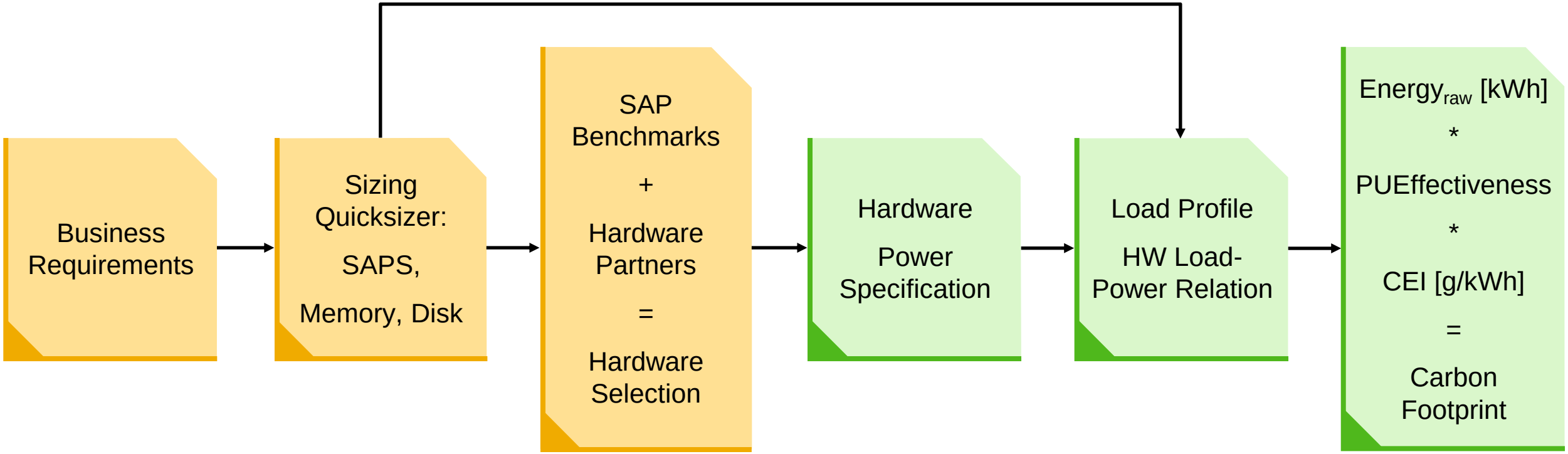
PUE was published in 2016 as a global standard under ISO/IEC 30134-2:2016 as well as a European standard under EN 50600-4-2:2016.

Values depend on many factors, e.g. location. Typical values are around 1.5

* https://en.wikipedia.org/wiki/Power_usage_effectiveness

Step 3: From business requirements to carbon footprint

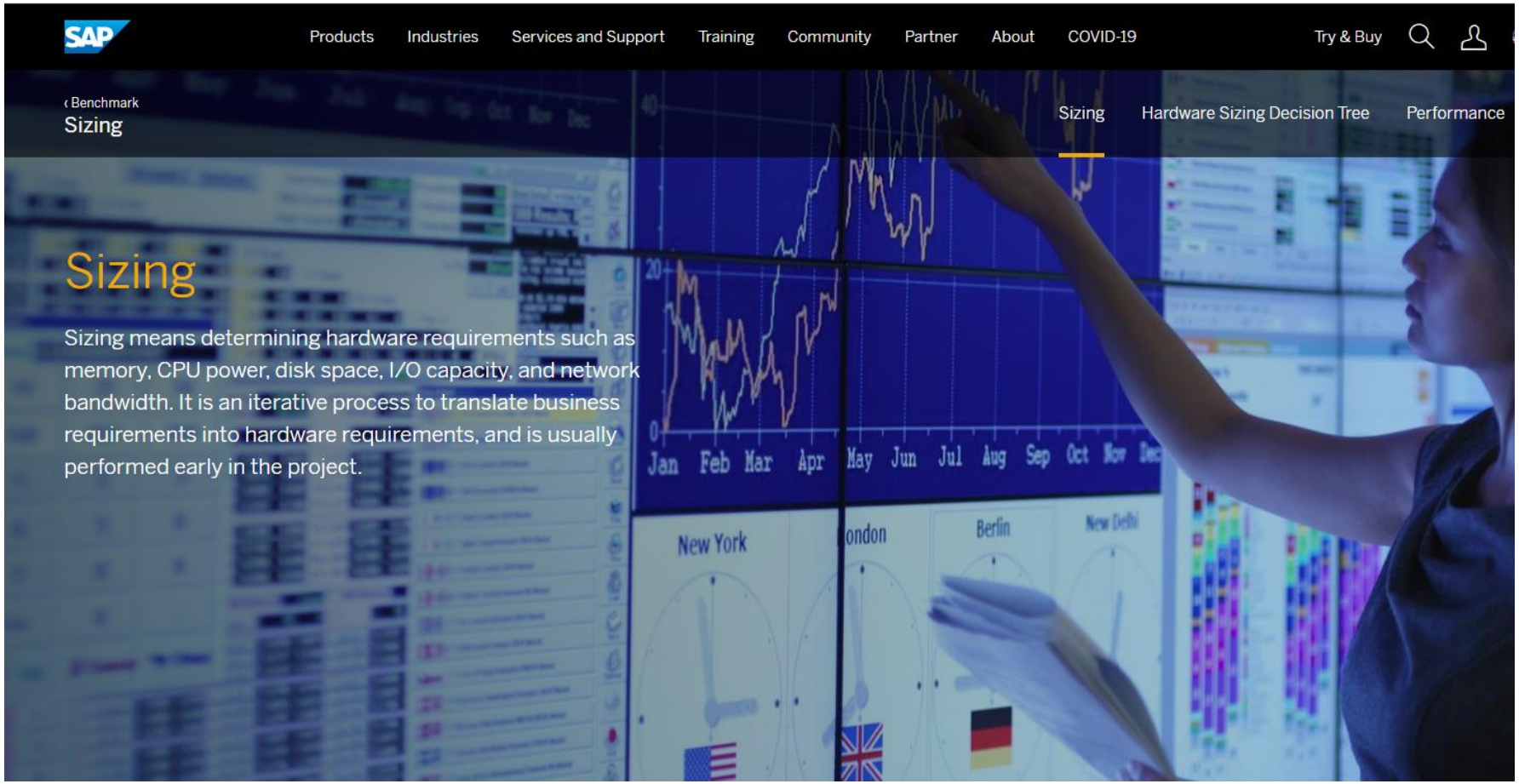
Business requirements are known. Carbon footprint estimate based on sizing information.



Translating business to hardware requirements

Translating hardware usage to carbon footprint

Step 3: From business requirements to carbon footprint – SAP sizing resources



https://www.sap.com/about/benchmark/sizing.html

Step 3: From business requirements to carbon footprint – Quicksizer online tool

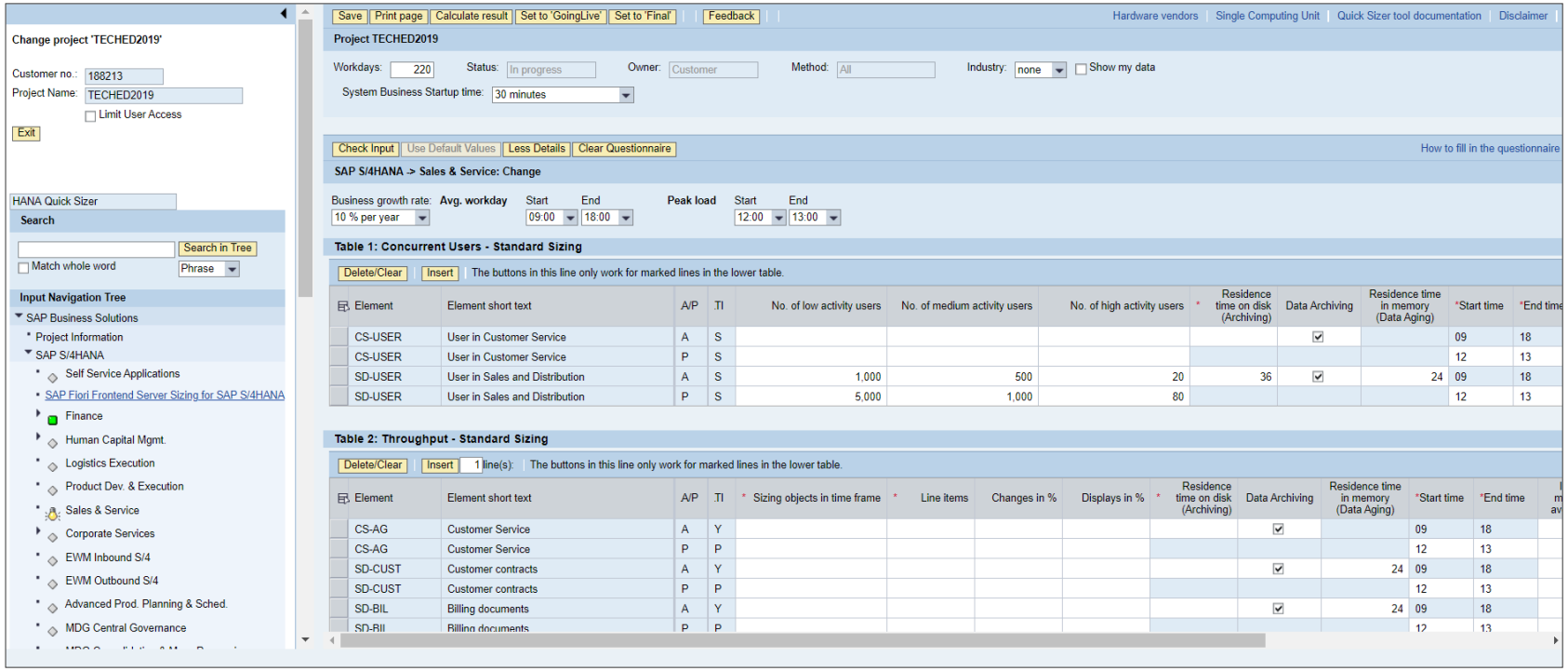
Input:

- Business requirements

Output:

- Compute power in **SAPS**
- Memory, disk I/O
- Daily usage profile

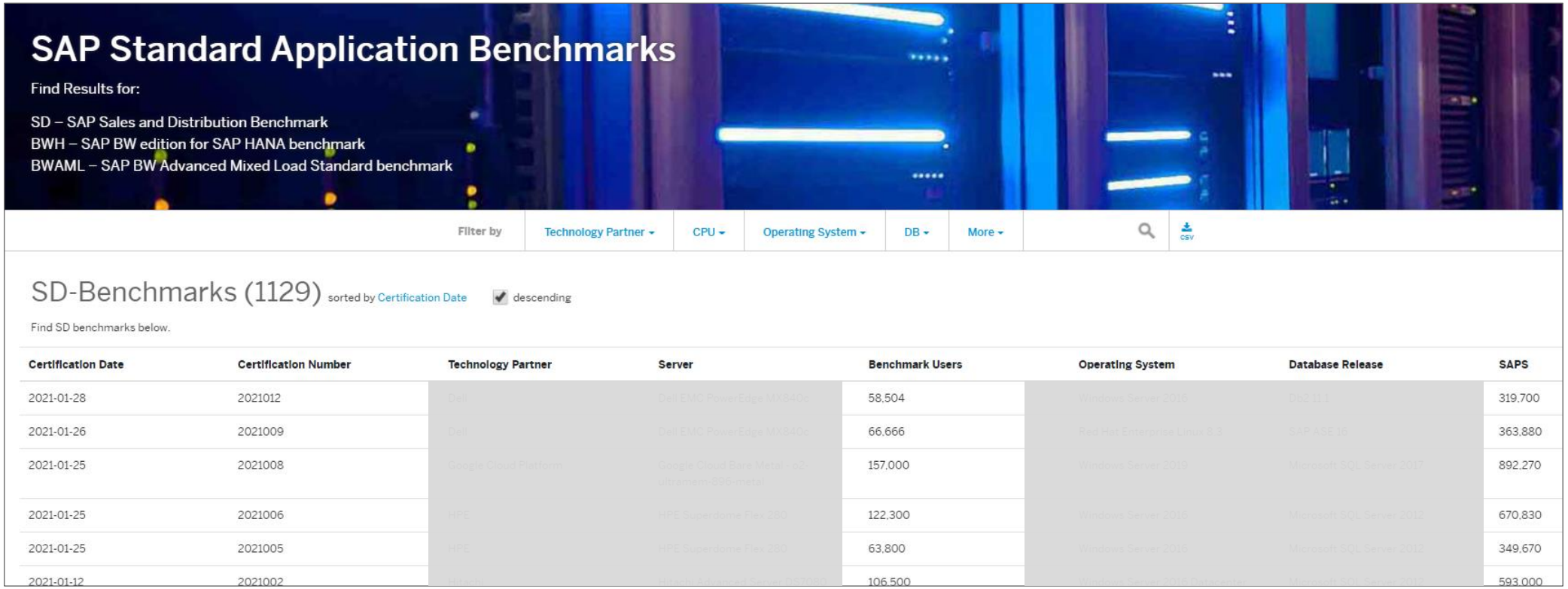
SAP **A**pplication **P**erformance **S**tandard (**SAPS**), hardware-independent unit of measure



[Link: Sizing for SAP S/4HANA, SAP TechEd Lecture]

Step 3: From business requirements to carbon footprint – Hardware selection

SAP benchmark certification gives **SAPS** for tested hardware or IAAS server

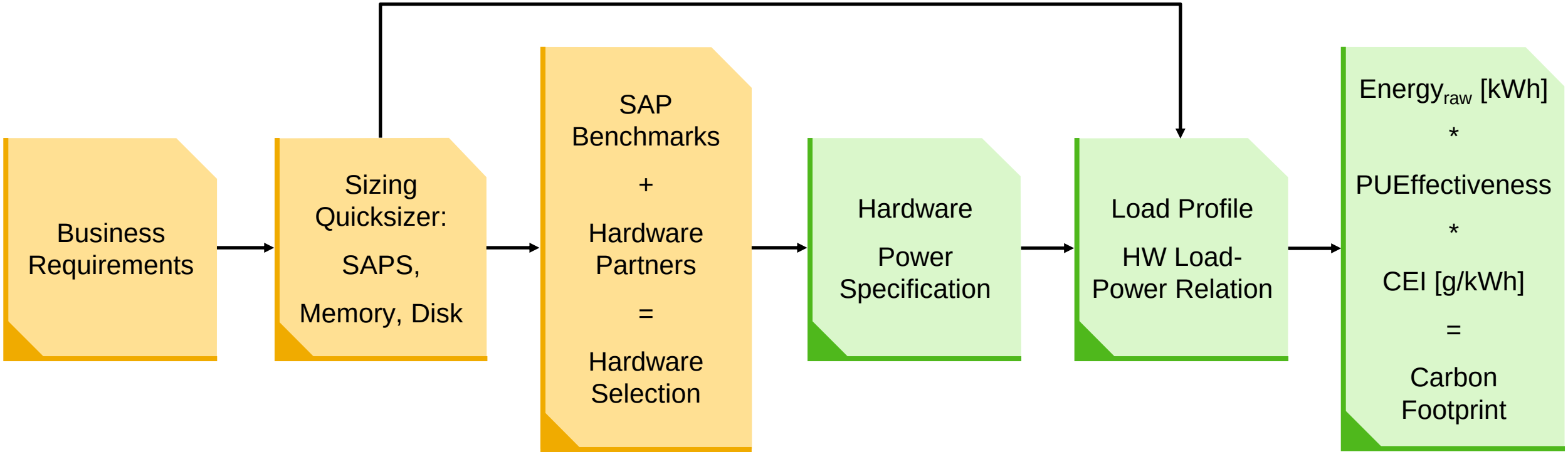


Certification Date	Certification Number	Technology Partner	Server	Benchmark Users	Operating System	Database Release	SAPS
2021-01-28	2021012	Dell	Dell EMC PowerEdge MX840c	58,504	Windows Server 2016	Db2 11.1	319,700
2021-01-26	2021009	Dell	Dell EMC PowerEdge MX840c	66,666	Red Hat Enterprise Linux 8.3	SAP ASE 16	363,880
2021-01-25	2021008	Google Cloud Platform	Google Cloud Bare Metal - u2-ultramem-896-metal	157,000	Windows Server 2019	Microsoft SQL Server 2017	892,270
2021-01-25	2021006	HPE	HPE Superdome Flex 280	122,300	Windows Server 2016	Microsoft SQL Server 2012	670,830
2021-01-25	2021005	HPE	HPE Superdome Flex 280	63,800	Windows Server 2016	Microsoft SQL Server 2012	349,670
2021-01-12	2021002	Hitachi	Hitachi Advanced Server DS7000	106,500	Windows Server 2016 Datacenter	Microsoft SQL Server 2012	593,000

https://www.sap.com/dmc/exp/2018-benchmark-directory/#/sd

Step 3: From business requirements to carbon footprint

Business requirements are known. Carbon footprint estimate based on sizing information.

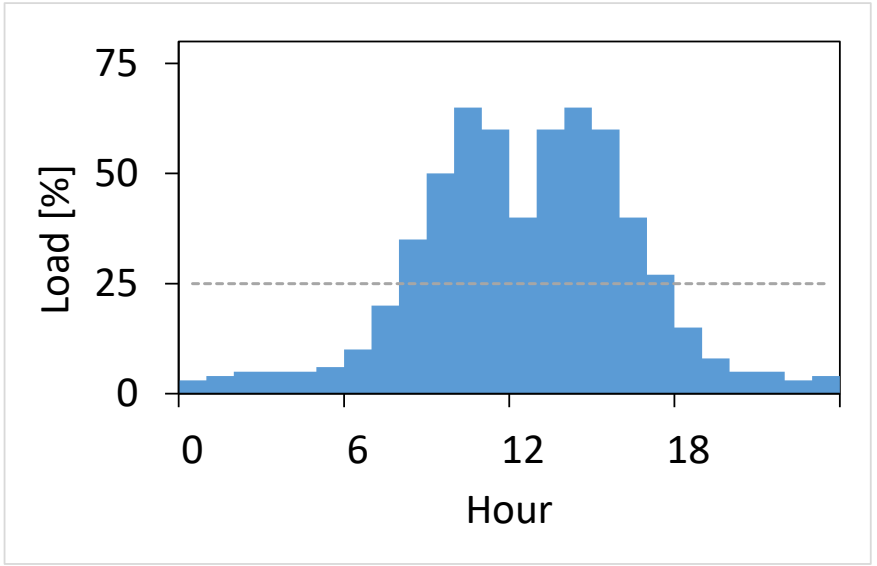


Translating business to hardware requirements ✓ Translating hardware usage to carbon footprint

Step 3: From business requirements to carbon footprint – Load profile

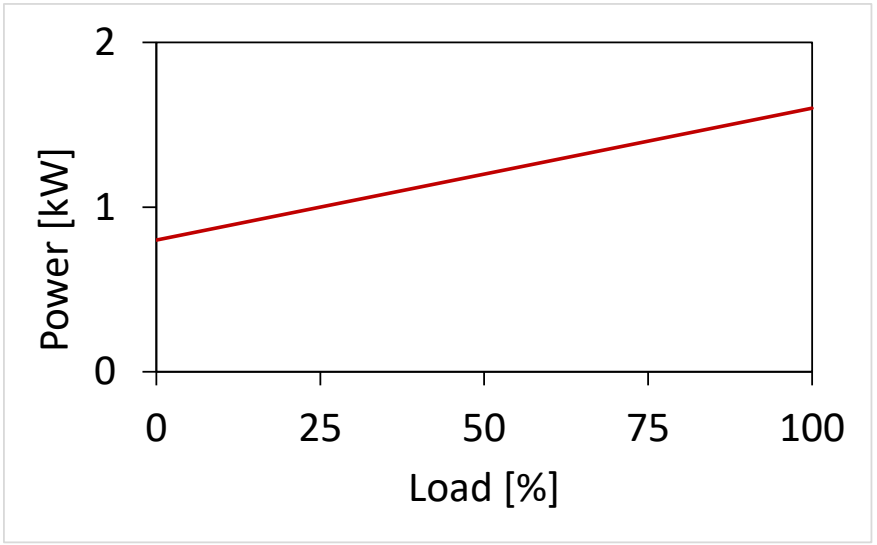
Load profile

- Example daily load distribution
- Business profile reflected in QS output
- In this example: avg. daily load = 25%



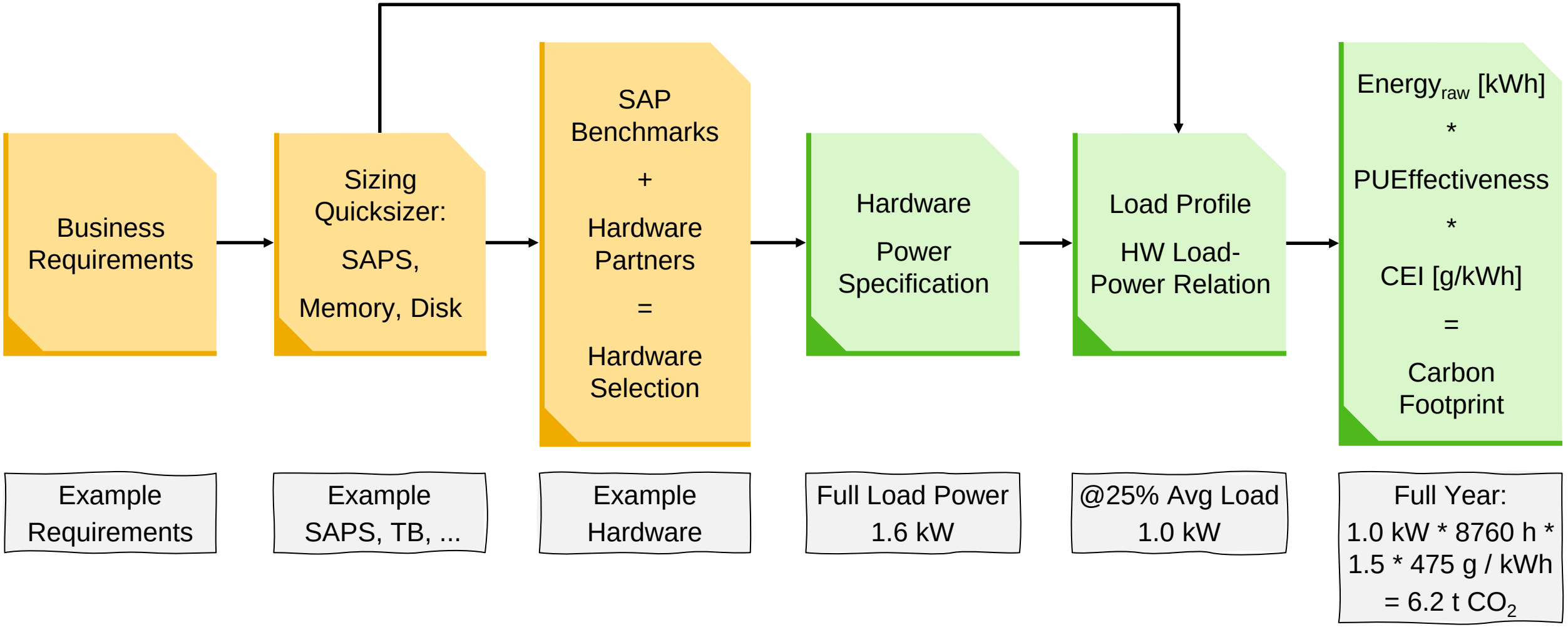
Power-load relation

- Example relation shown
- Linear within reasonable accuracy
- Constant and increasing contributions
- Specific relation depends on type and number of CPUs, type and amount of memory, and other factors



Carbon Calculation Basics

Step 3: From business requirements to carbon footprint



Carbon Calculation Basics

Step 4: Into the cloud

Advantage of scale: sharing of resources

- Higher, more uniform utilization can be reached
- Net energy saving for service consumers

Advantage of choice: cloud provider sustainability

- In SAP Cloud, carbon footprint is 0 by use of 100% renewable electricity

Power consumption to carbon footprint

Step 1: From data center power consumption to carbon footprint – Carbon emission intensity CEI

Step 2: From hardware power consumption to carbon footprint – Power usage effectiveness PUE

Step 3: From business requirements to carbon footprint – Carbon sizing

Step 4: Into the cloud – Advantage of scale

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