#KNGS
Knowledge Network Green Software

*–Connecting the Green Software world–*

Software Improvement Group

# Groene IT Systemen

## Masterclass Duurzaam Digitaal 2017, RVO

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# Searching energy



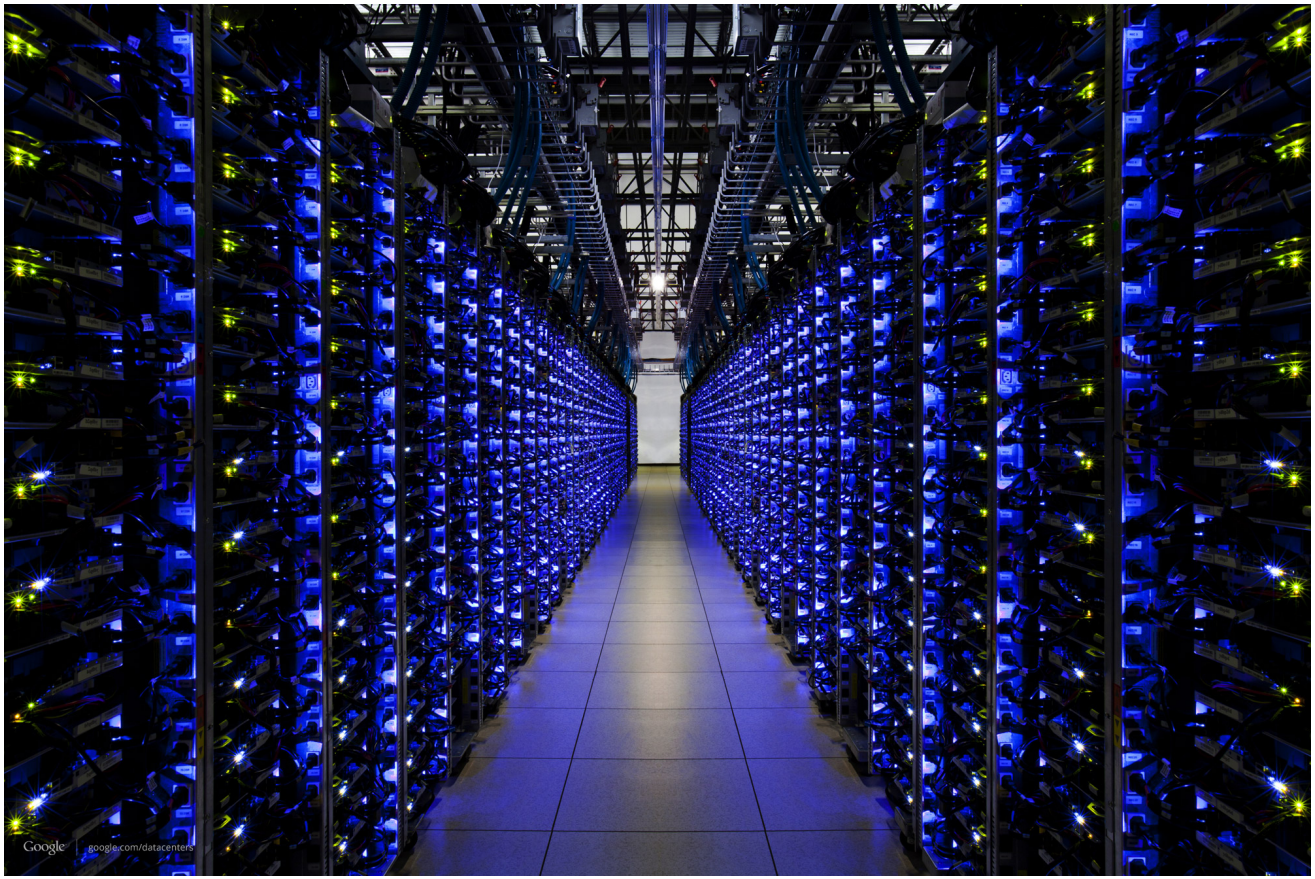
## Google builds new datacenter in Groningen (news 23 sept 2014)

**600**
mio €

**150**
jobs

**960**
GWh

**400,000**
households



# IT electricity consumption grows faster (6.6%/y) than general consumption (3.5%/y)



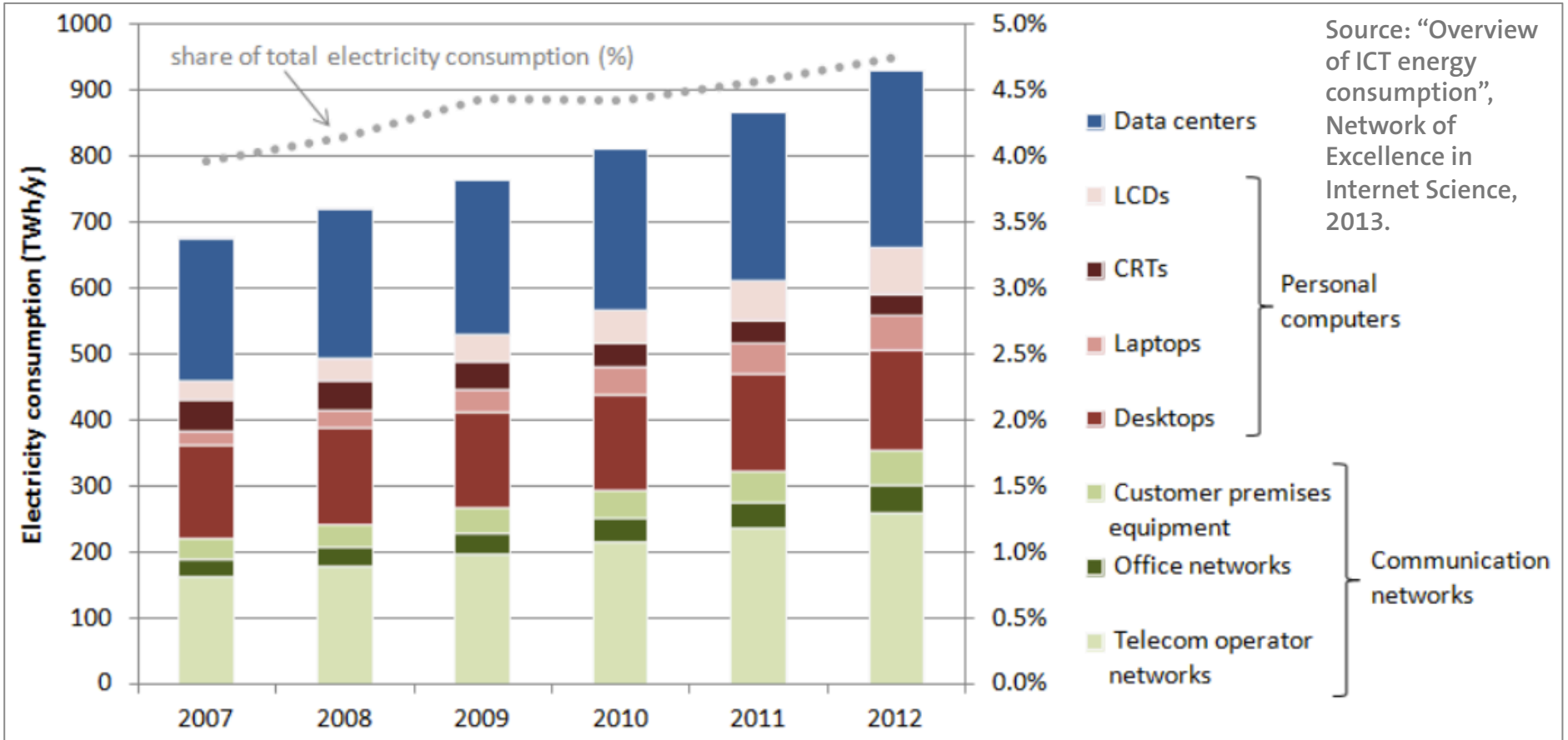



Figure 3-1: Worldwide use phase electricity consumption of communication networks, personal computers and data centers. Their combined share in the total worldwide electricity consumption has grown from about 4% in 2007 to 4.7% in 2012.

# Some questions



Is the rapid digitalization of our society sustainable?

What is the role of software in Green IT?

How can energy-consumption of software systems be controlled?

Is there a business case for Green Software?

# Efficiency is up, but so is consumption



## Increase in demand outpaces increase in efficiency

Table 3-4: Personal computers and computer monitors: average power consumption per device (taking into account active and inactive times) and worldwide electricity use per type of equipment.

| | Power/device, 2007 (W) | Power/device, 2012 (W) | Electricity use, 2007 (TWh) | Electricity use, 2012 (TWh) |
|---|---|---|---|---|
| Office desktops | 17.0 | 15.7 | 51.4 | 46.2 |
| Household desktops | 26.4 | 24.3 | 91.2 | 105.9 |
| Office laptops | 5.2 | 4.4 | 4.1 | 8.3 |
| Household laptops | 7.9 | 6.7 | 17.7 | 45.2 |
| CRT monitors | 20.0 | 20.0 | 46.6 | 31.9 |
| LCD monitors | 8.0 | 8.0 | 27.9 | 69.6 |
| Total | | | 238.9 | 307.1 |

Source: “Overview of ICT energy consumption”, Network of Excellence in Internet Science, 2013.

# A Claim



## Software is key to Green IT

Hardware consumes energy

Because software tells it to.

# Wirth's Law

*a.k.a. the great Moore's Law compensator*



"Software is getting slower more rapidly than hardware becomes faster."

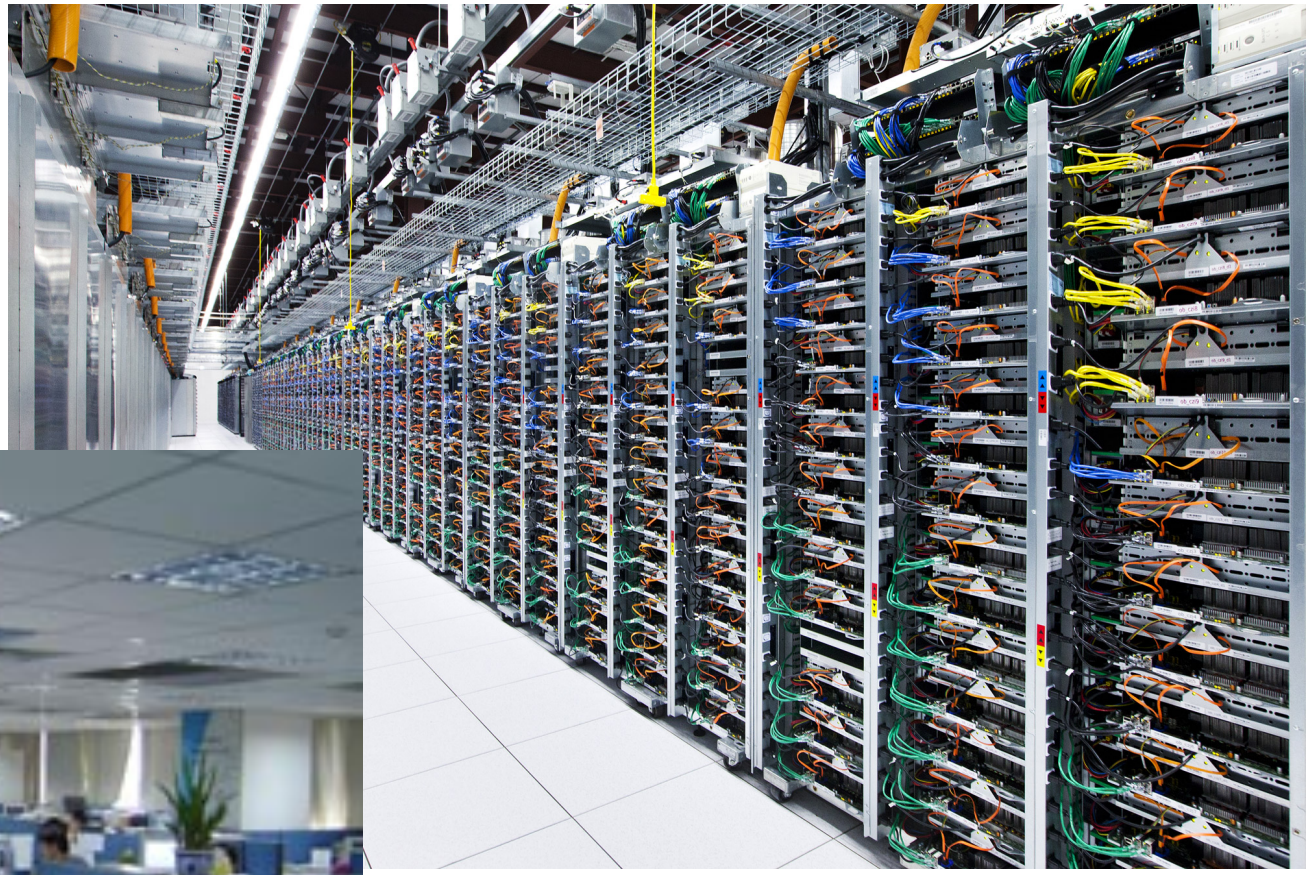
Niklaus Wirth, "A Plea for Lean Software", Computer 28, 1995

# Software Development
## *1964 – resource aware*



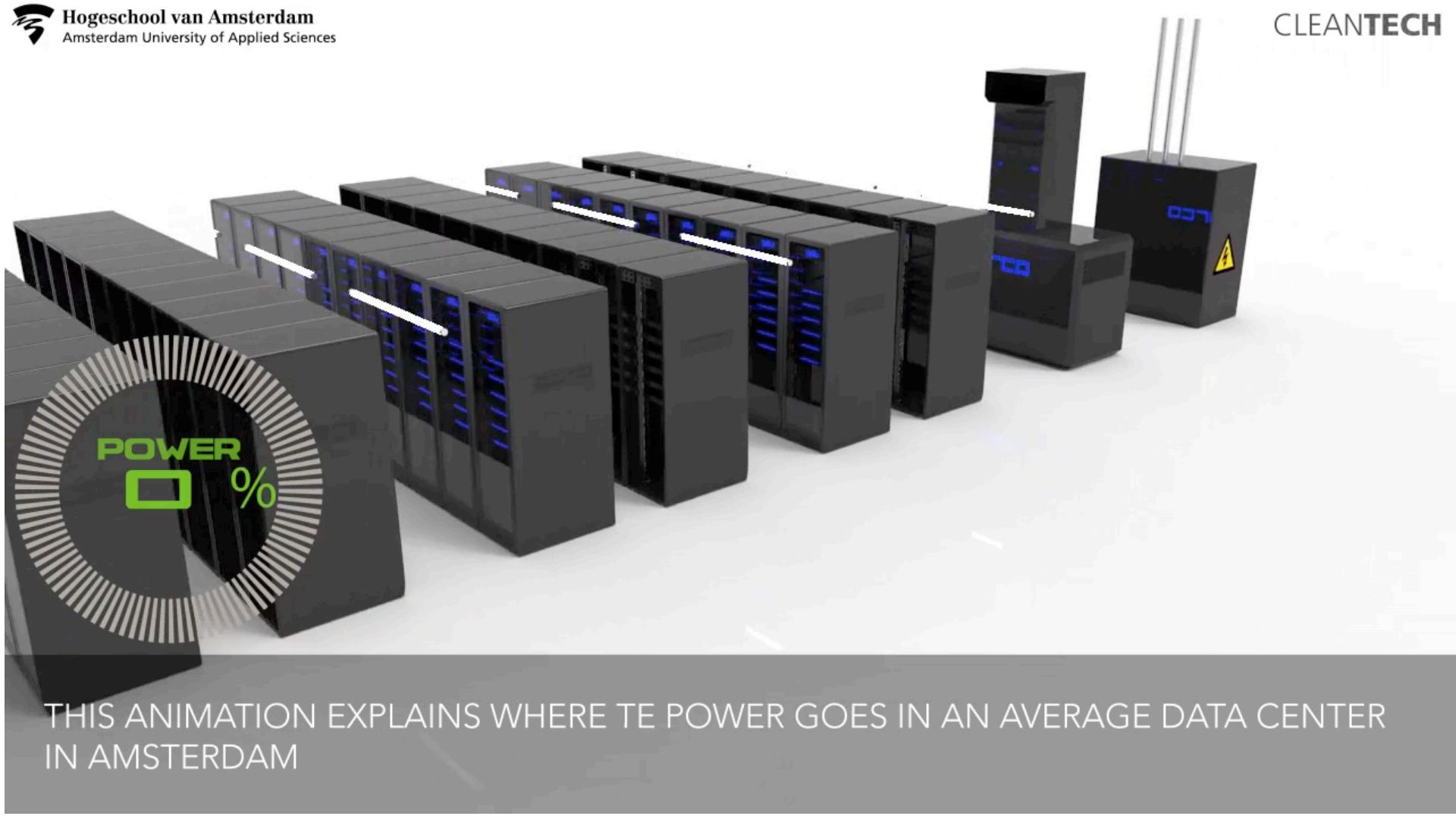
# Software development
## *Now – resource agnostic*





# Datacenter energy loss chain





# The economics of Green Software

*Is there a business case?*



## What does a kWh cost in a datacenter?

€ 0.10

## What does a server cost per month in a datacenter?

€600 - €2000 per month

## What does a software developer cost per year?

€ 50,000 - €150,000 per year

## Base line

10 servers in datacenter

Energy: 200 Watt per server

Rent: € 1,200 per server per month

## What if?

Spend 1 additional month of development effort.

Reduce the number of servers by 2.

## What is the payback time?

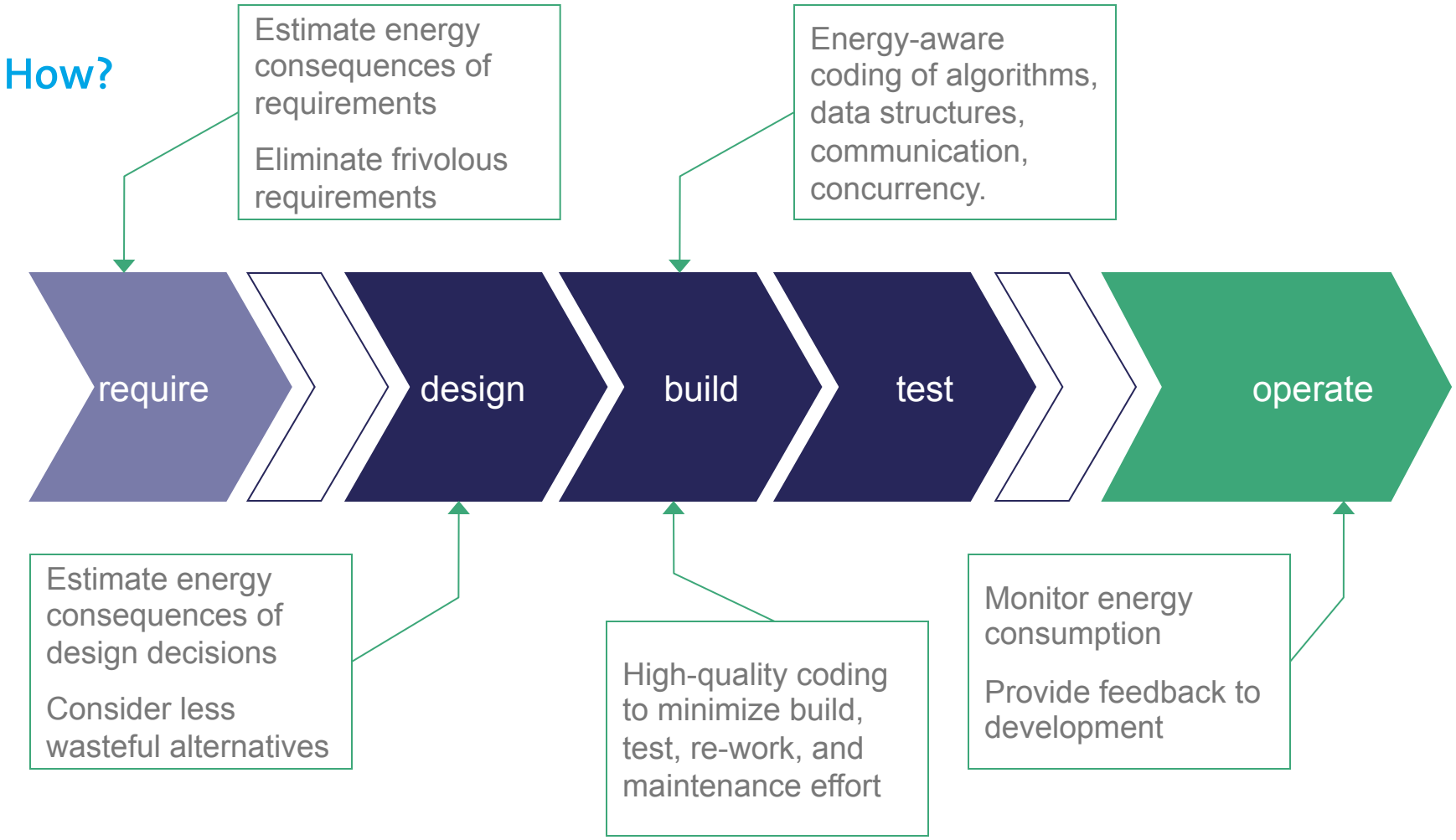
## Assumptions

€ 0.10 per kWh, €100,000 per developer per year

# Application-level energy efficiency

## *Throughout the life-cycle*





# Reality is more complex

*Parties and interests in the software ecosystem*



## End-user organization

- Deliver reliable, competitive services against reasonable costs.
- High availability, usability,. Happy and productive users.

## Software and hardware suppliers

- Sell as many licenses as possible, also when they are not needed or used.
- Sell as many devices as possible, including maintenance contracts.

## Software developer

- Deliver good software in terms of functionality, but also performance, reliability, security, etc.
- Spend and declare as many hours as possible

## Datacenter

- Rent out as much rack space as possible, including service contracts

# Reality is dynamic

*Some forces in the field of green software*



## Positive forces

- Replacing old by new hardware.
- Cloud computing allows dynamic scaling of capacity.
- DevOps established feedback from operations to development.
- Operational cost goes down with green computing.
- High-quality software is easy to adapt and redeploy.

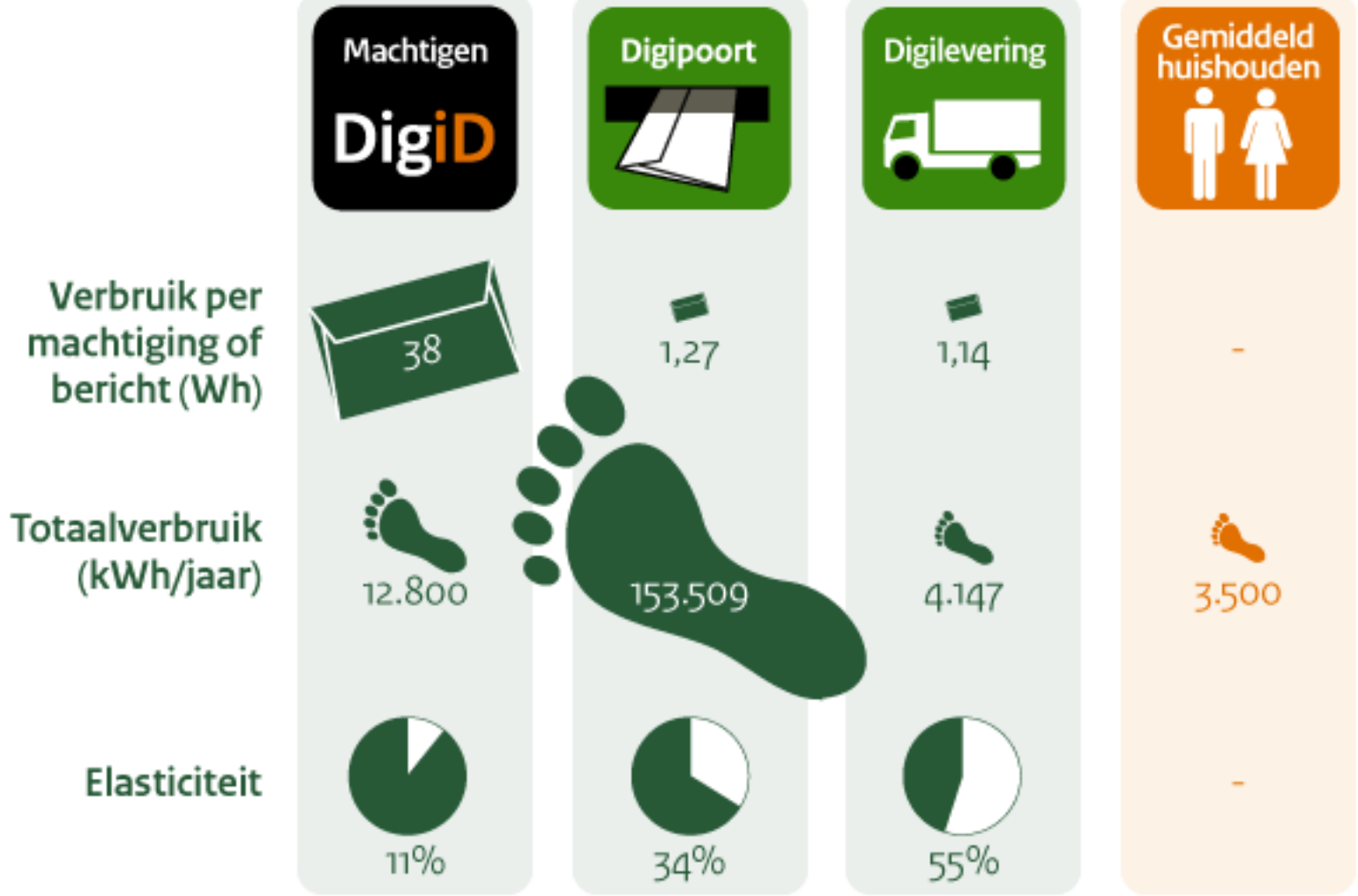
## Negative forces

- Energy is cheap.
- Adapting operation (legacy) software is costly and risky.
- Datacenters earn more with more hardware and more energy.
- Inflated availability requirements lead to waste.
- Attribution of (energy) costs to applications or services is difficult.

# Software Energy Footprints

## *Transparency*






Logius
*Ministerie van Binnenlandse Zaken en Koninkrijksrelaties*

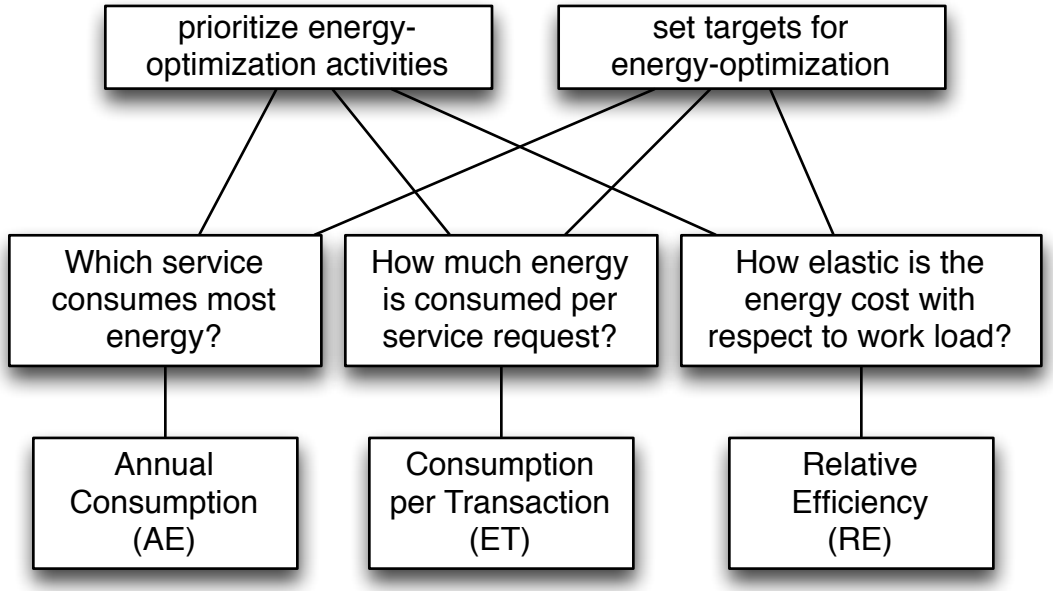
# Software Energy Footprints

## *Indicators for energy-efficiency of e-services*



ICT Milieu Award 2013

www.sefindex.org




| | | | |
|---|---|---|---|
| Digipoort (Logius) | 153,509 kWh | 1.27 Wh | 34% |
| DigiD Machtigen (Logius) | 12,800 kWh | 38 Wh | 11% |
| Mailfilter (SURFnet) | 38,397 kWh | 0.044 Wh | 24% |

Software energy footprint user group

See also: “Energy-Efficiency Indicators for e-Services”, J. Arnoldus, J. Gresnigt, K. GrossKop, J. Visser, GREENS 2013.

# Ongoing research

## *Towards standardized measurement*



★★★★☆

Cluster Green Software

Software Energy Footprint Lab

Greening the Cloud

Hogeschool van Amsterdam

Universiteit van Amsterdam

VU VRIJE UNIVERSITEIT AMSTERDAM

# 10 Best Practices for Green Software

*Practical guidelines for energy-efficient IT systems*



| | | | |
|---|---|---|---|
| Virtualize all components of the system to allow sharing of the hardware infrastructure. | **Virtualize** | **Use energy settings** | Use energy-efficiency settings offered by hardware and virtualization layer. |
| Put measurement infrastructure in place to determine energy KPIs in operation. | **Measure** | **Experiment** | Dare to experiment with alternative designs and configurations. |
| Replace older hardware by new hardware that offers higher capacity at lower consumption. | **Refresh hardware** | **Limit over-dimensioning** | Dimension the system to actual current needs, not to hypothetical future needs. |
| Consider tuning down availability requirements that lead to under-utlisation. | **Reconsider availability** | **Deactivate environments** | Activate test and fail-over environments only on demand, not continuously. |
| Optimize the system for performance to reduce capacity demands at peak workload. | **Optimize performance** | **Match workload** | Know thy workload and dynamically scale the system to match it. |

# *Groene digitale infrastructuur?*



Gemeente Amsterdam

Dienst Uitvoering Onderwijs
*Ministerie van Onderwijs, Cultuur en Wetenschap*

Belastingdienst

Wetgeving

Afnemers / klanten

BZK (beleid)

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties

ICTU (systeem ontwikkeling)

ICTU

Logius (beheer)

Logius
*Ministerie van Binnenlandse Zaken en Koninkrijksrelaties*

Infrastructuur beheer

Applicatiebeheer

# Thank you



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# Background



## Application Footprint User Group

- The 10 best practices for Green Software were compiled in the context of the Application Footprint User Group of RVO (Netherlands Enterprise Agency).
- Supported by Knowledge Network Green Software (KNGS).
- Supported by Cluster Green Software.

Cluster Green Software

Netherlands Enterprise Agency

# About

*The speaker*

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### Head of Research
### Software Improvement Group
### based in Amsterdam, The Netherlands

MSc, PhD in computer science

MA in philosophy

Professor of “Large Scale Software Systems” at Radboud University Nijmegen

Chairman of Knowledge Network Green Software

# About

*Software Improvement Group*



## Who are we?

international advisory firm for cost, quality and risks of software

## What do we do?

help organizations to master the software-intensive systems they depend on

## How do we do this?

perform measurement-based inspections
and translate findings into actionable recommendations