

The role of **data** in **Green Software**

A challenge for every business

The image features a silhouette of an oil pumpjack against a clear blue sky at dusk. The pumpjack is positioned on the right side of the frame, with its long arm extending towards the left. The sky transitions from a deep blue at the top to a lighter, orange-tinged glow near the horizon. A white rectangular box is superimposed over the center of the image, containing the text "Data is the new oil!".

Data is the new oil!

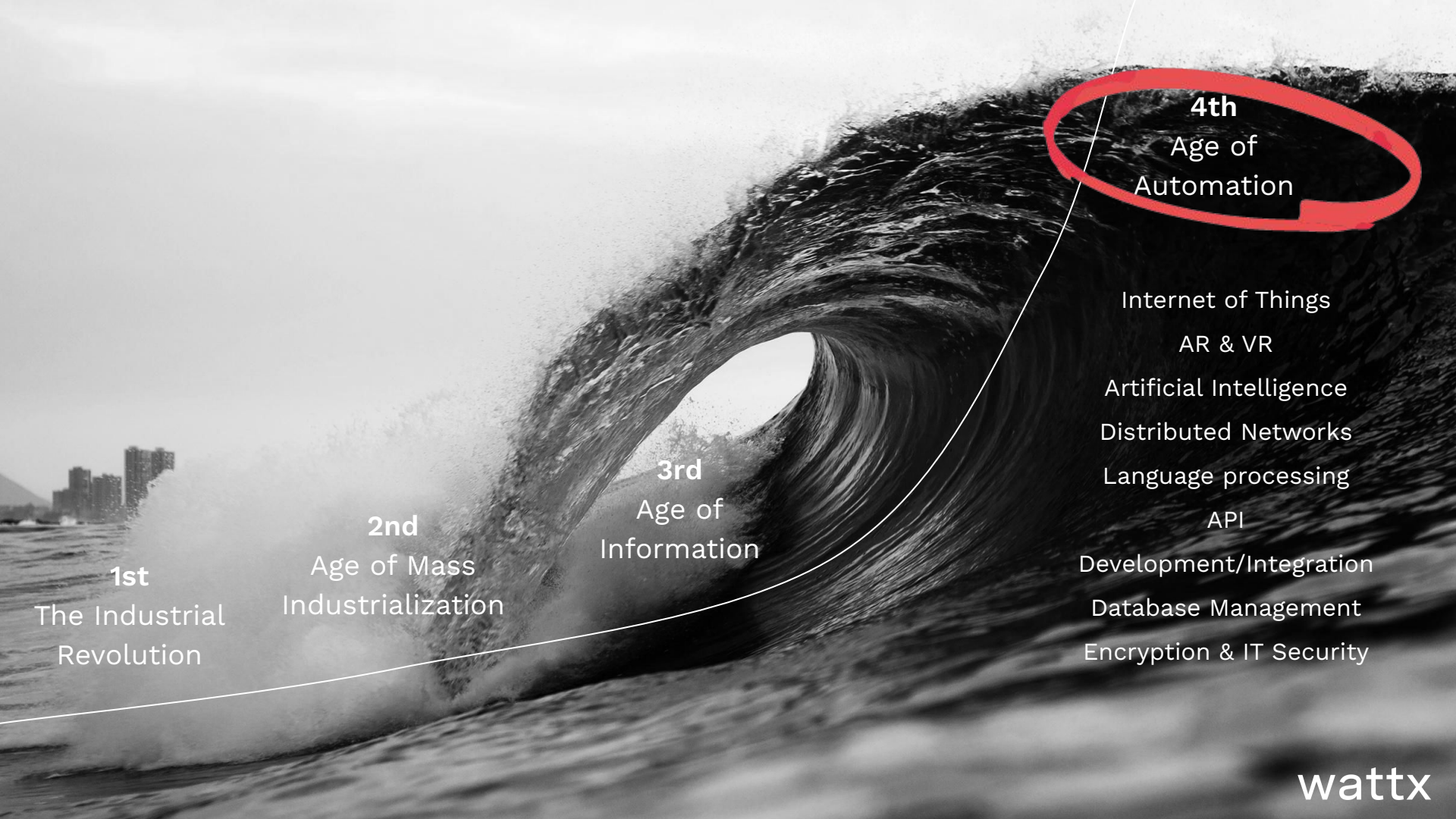
An aerial, black and white photograph of a large oil tanker ship sailing on the ocean. The ship is dark and has several large, rounded tanks along its length. In the distance, a smaller vessel is visible. The water shows some whitecaps and a wake. A black rectangular box with white text is overlaid on the center of the image.

Data is the new oil!

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~200 TWh



1st
The Industrial
Revolution

2nd
Age of Mass
Industrialization

3rd
Age of
Information

4th
Age of
Automation

- Internet of Things
- AR & VR
- Artificial Intelligence
- Distributed Networks
- Language processing
- API
- Development/Integration
- Database Management
- Encryption & IT Security

1. ELIMINATE

2. UTILIZE

3. ALLOCATE



1. **ELIMINATE**

70–90%

”dark data”

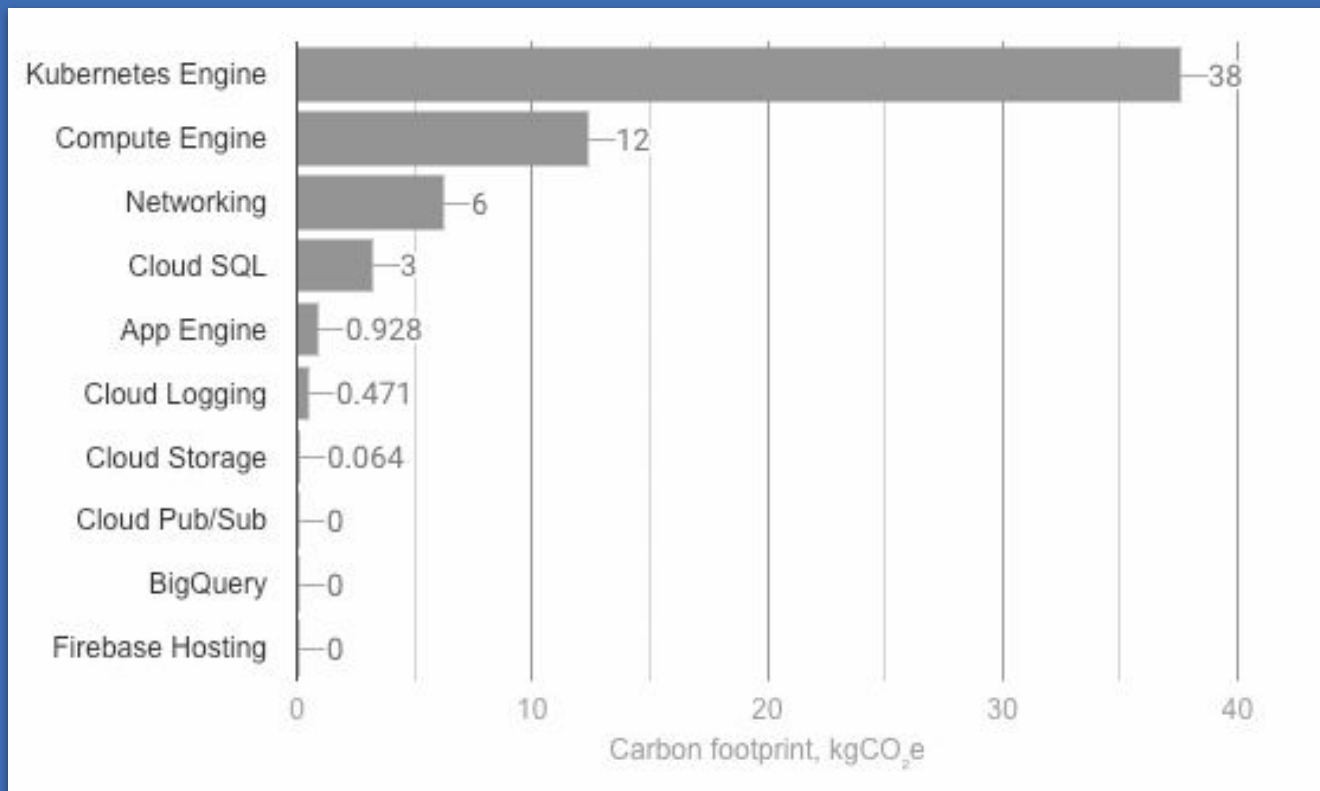
A large iceberg floats in a blue ocean. The tip of the iceberg is above the water, while the much larger base is submerged. The sky is a pale, overcast blue. The water is a deep, clear blue.

20% Causes
80% Effects






2. UTILIZE



3. ALLOCATE



Carbon data across GCP regions

Google Cloud Region	Location	Google CFE%	Grid carbon intensity (gCO ₂ eq/kWh)	Google Cloud net operational GHG emissions
europa-central2	Warsaw	20%	576	0
europa-north1	Finland	91%	127	0  Low CO ₂
europa-southwest1	Madrid	*	121	0  Low CO ₂
europa-west1	Belgium	82%	110	0  Low CO ₂
europa-west2	London	57%	172	0
europa-west3	Frankfurt	60%	269	0
europa-west4	Netherlands	53%	282	0
europa-west6	Zurich	85%	86	0  Low CO ₂
europa-west8	Milan	*	298	0
europa-west9	Paris	*	59	0  Low CO ₂

1. ELIMINATE

2. UTILIZE

FOR LEADS:
3. ALLOCATE

4. EDUCATE

Sustainability in Tech

Checklist for wattx projects

Sustainability in Tech	1
Definition	3
Planning	4
Life-cycle Assessment (LCA) for digital solutions	4
Product specification for the Sustainability Assessment	4
Overall assessment and metrics	8
Direct metrics: Sustainability measurement	8
Proxy metrics	8
Infrastructure	8
2.1 Architecture	9
2.2 Implementation	9
2.3 Interfaces	10
2.4 Measurement	11
2.4.0 Customer Devices	11
2.4.1 Sustainability report	11
Backend	12
3.1 Architecture	12
3.1.1 Language	12
3.1.2 Database	12
3.1.3 Frameworks	13
3.2 Implementation	13
3.2.1 Database	13
3.2.2 Storage	13
3.2.3 Backups	14
3.2.4 Algorithms	15
3.2.5 Dependency	15
3.3 Interfaces	16
3.3.1 Product team / tester is your friend	16
3.3.2 FE is your friend	16
3.3.3 Public API	17

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INSIGHTS

July 2022

Building Sustainable Digital Products



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DISCUSS



Example: Languages & Algorithms

	Energy
(c) C	1.00
(c) Rust	1.03
(c) C++	1.34
(c) Ada	1.70
(v) Java	1.98
(c) Pascal	2.14
(c) Chapel	2.18
(v) Lisp	2.27
(c) Ocaml	2.40
(c) Fortran	2.52
(c) Swift	2.79
(c) Haskell	3.10
(v) C#	3.14
(c) Go	3.23
(i) Dart	3.83
(v) F#	4.13
(i) JavaScript	4.45
(v) Racket	7.91
(i) TypeScript	21.50
(i) Hack	24.02
(i) PHP	29.30
(v) Erlang	42.23
(i) Lua	45.98
(i) Jruby	46.54
(i) Ruby	69.91
(i) Python	75.88
(i) Perl	79.58

	Time
(c) C	1.00
(c) Rust	1.04
(c) C++	1.56
(c) Ada	1.85
(v) Java	1.89
(c) Chapel	2.14
(c) Go	2.83
(c) Pascal	3.02
(c) Ocaml	3.09
(v) C#	3.14
(v) Lisp	3.40
(c) Haskell	3.55
(c) Swift	4.20
(c) Fortran	4.20
(v) F#	6.30
(i) JavaScript	6.52
(i) Dart	6.67
(v) Racket	11.27
(i) Hack	26.99
(i) PHP	27.64
(v) Erlang	36.71
(i) Jruby	43.44
(i) TypeScript	46.20
(i) Ruby	59.34
(i) Perl	65.79
(i) Python	71.90
(i) Lua	82.91

	Mb
(c) Pascal	1.00
(c) Go	1.05
(c) C	1.17
(c) Fortran	1.24
(c) C++	1.34
(c) Ada	1.47
(c) Rust	1.54
(v) Lisp	1.92
(c) Haskell	2.45
(i) PHP	2.57
(c) Swift	2.71
(i) Python	2.80
(c) Ocaml	2.82
(v) C#	2.85
(i) Hack	3.34
(v) Racket	3.52
(i) Ruby	3.97
(c) Chapel	4.00
(v) F#	4.25
(i) JavaScript	4.59
(i) TypeScript	4.69
(v) Java	6.01
(i) Perl	6.62
(i) Lua	6.72
(v) Erlang	7.20
(i) Dart	8.64
(i) Jruby	19.84

The Computer Language Benchmarks Game

Node js versus TypeScript fastest programs

vs C++ vs Dart vs Java **vs TypeScript**

Always look at the source code.

These are only the fastest programs. Look at the other programs. They may seem more-like a *fair* comparison to you.

spectral-norm

source	secs	mem	gz	busy	cpu load
<u>Node js</u>	1.68	62,068	999	6.05	89% 90% 91% 90%
<u>TypeScript</u>	5.38	32,860	441	5.43	100% 0% 0% 0%

JavaScript:

source code

```
/* The Computer Language Benchmarks Game
http://benchmarksgame.alioth.debian.org/

contributed by Isaac Gouy, 2008-11-14
*/

const cluster = require('cluster');
const numCPUs = require('os').cpus().length * 2;
var fs = require('fs');

const d = parseInt(process.argv[2])
```

TypeScript:

source code

```
/* The Computer Language Benchmarks Game
http://benchmarksgame.alioth.debian.org/

direct transliteration of Greg Buchholz's C program
contributed by Isaac Gouy
*/

/* reference path="./Include/node/index.d.ts" */

const w = +process.argv[2]
const h = w

let bit_num = 0, i = 0, byte_acc = 0
```

More insights from...

Communities

 climateaction.tech

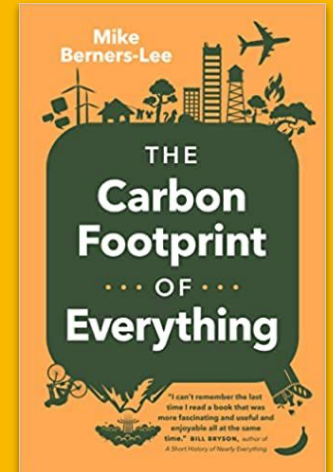
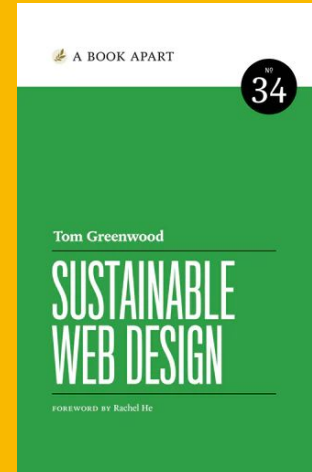
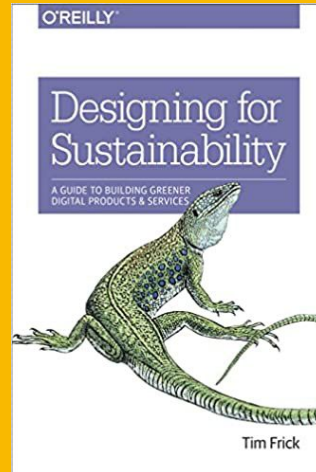
 greensoftware.foundation

 climatechange.ai

 lfca.earth

 climatedesigners.org

Books



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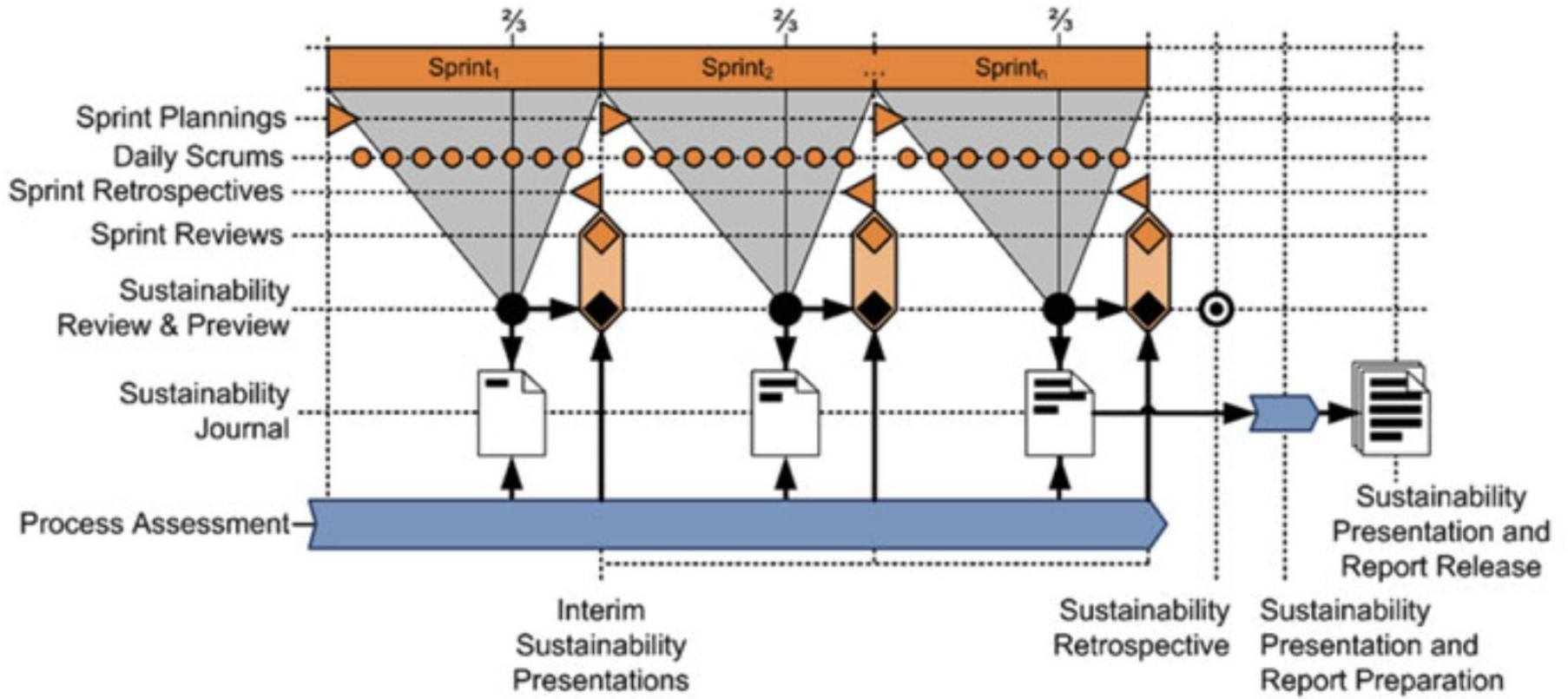
**Let's NOT just build
refineries again!**

Talk to me about details!

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Source: "Processes for Green and Sustainable Software Engineering", Kern et al. 2015