The digitalisation of daily life and its impacts on climate change

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Oxford Martin School & Oxford Energy Network
8 March, 2022

iDODDLE

idoddle.org

European Research Council

eci UNIVERSITY OF OXFORD

Environmental *Change* Institute
SCHOOL OF GEOGRAPHY AND THE ENVIRONMENT

Digitalisation and climate change are two 'megatrends' that will shape our lives over the coming decades.

EXECUTIVE SUMMARY

Report of the UN Economist Network for the UN 75th Anniversary Shaping the Trends of Our Time

SEPTEMBER 2020

United Nations

UN75 2020 AND BEYOND · SHAPING OUR FUTURE TOGETHER

Digital technology and the planet

Harnessing computing to achieve net zero

THE ROYAL SOCIETY

WBGU
German Advisory Council on Global Change

Flagship Report

Towards Our Common Digital Future

Digitalisation = collecting, exchanging, storing, analysing **data**: *cheaply, quickly, connectively*

Digitalisation is 'just' the latest generation of information system.

Image: Marie-Lan Nguyen @Wikipedia.

Image: http://museum.ipsj.or.jp/en//heritage/bibun.html

Digital applications and infrastructures are expanding rapidly.

Yearly growth of users and time needed to reach one billion users
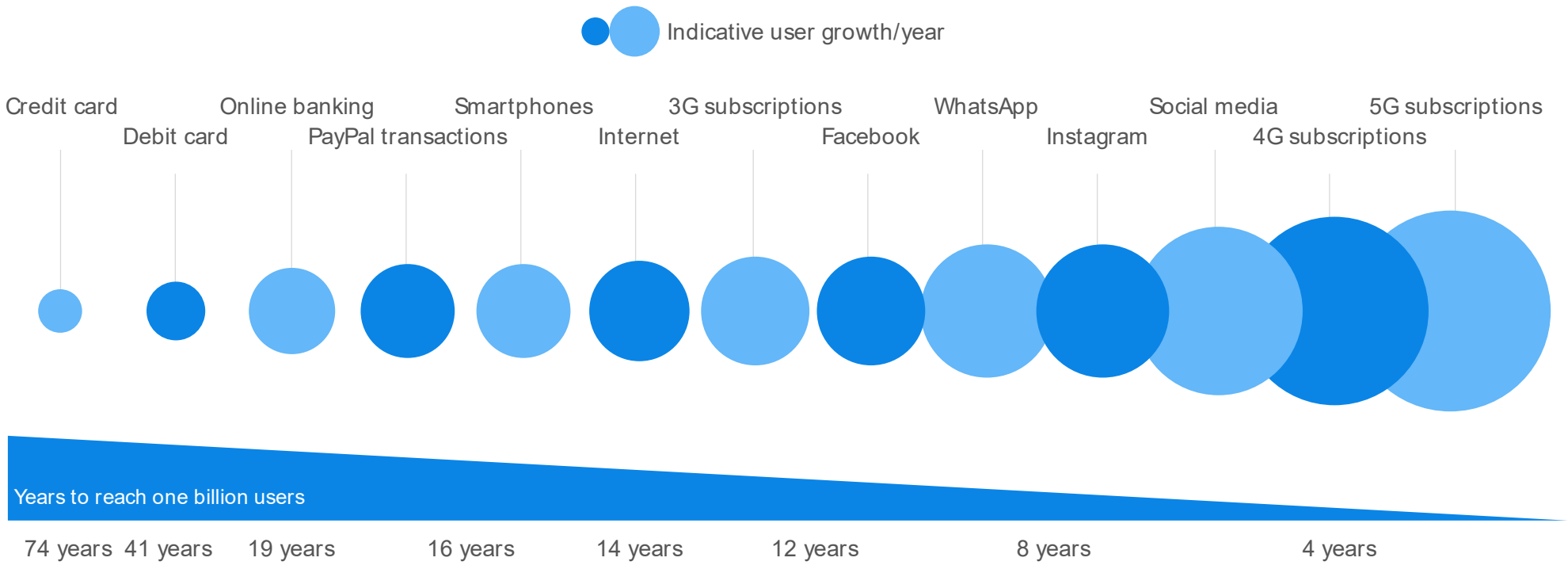
● ● Indicative user growth/year

Credit card | Online banking | Smartphones | 3G subscriptions | WhatsApp | Social media | 5G subscriptions
Debit card | PayPal transactions | Internet | Facebook | Instagram | 4G subscriptions

Years to reach one billion users

74 years 41 years 19 years 16 years 14 years 12 years 8 years 4 years

statista

Source: p115, Statista (2020). Digital Economy Compass 2020.

The pandemic further accelerated digitalisation trends.

Changes in consumer behavior during COVID-19

44%

increase of in-house social media consumption[1, 2]

70%

of people spent more time on their smart-phone/mobile phone[1, 3]

80%

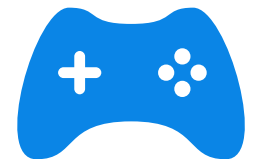higher traffic on media sites[4]

67%

of people watched more news coverage[1]

28%

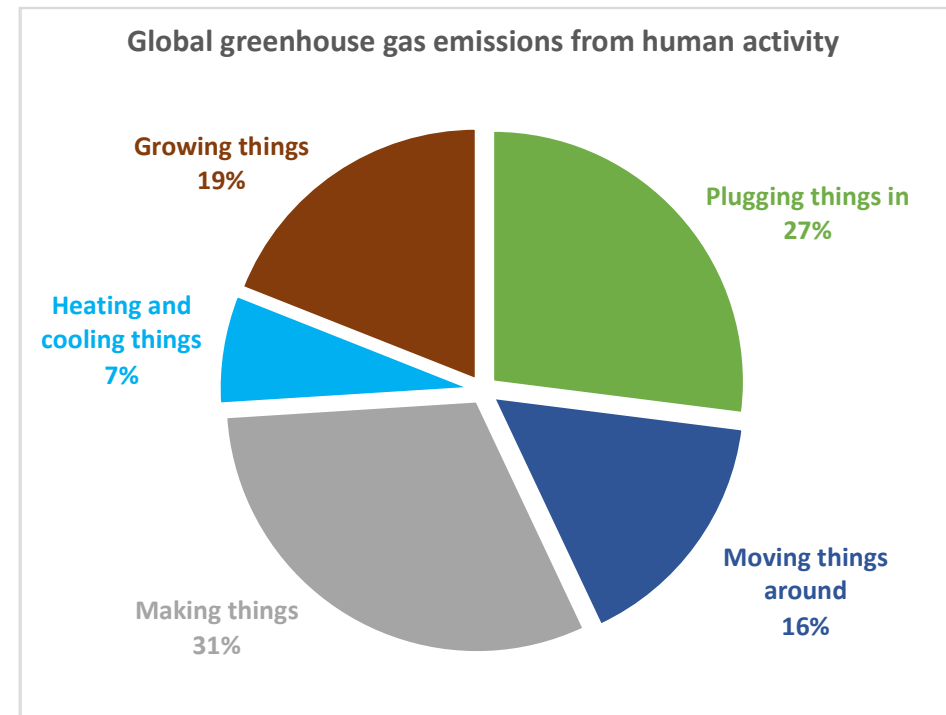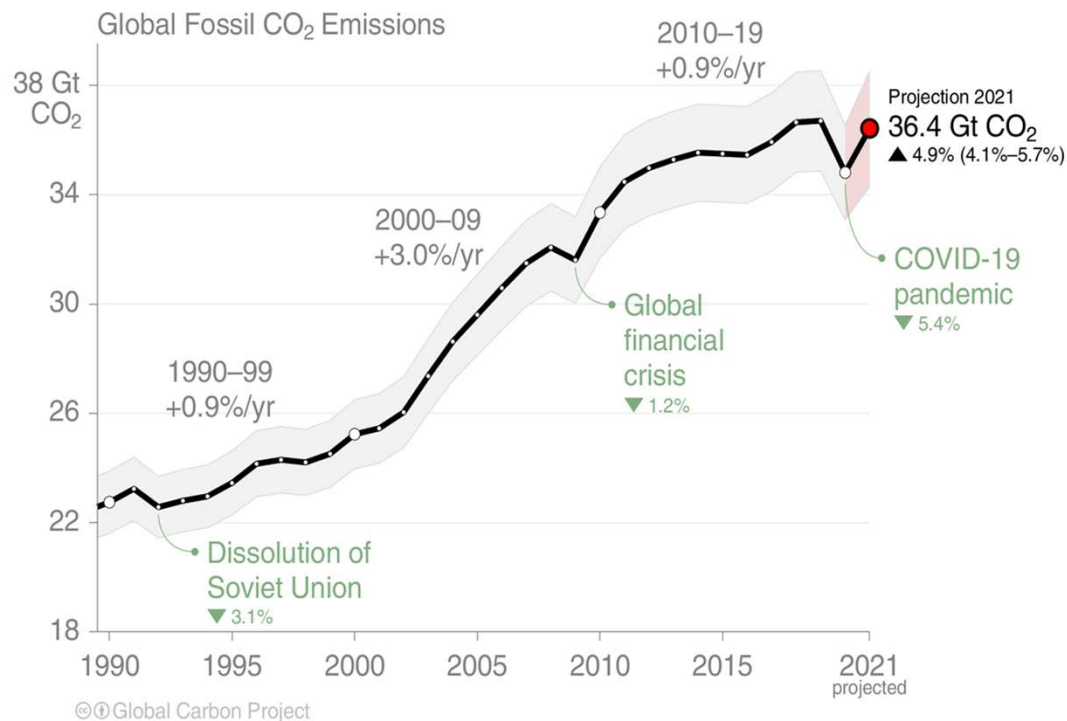more video streaming users for key players in 2020
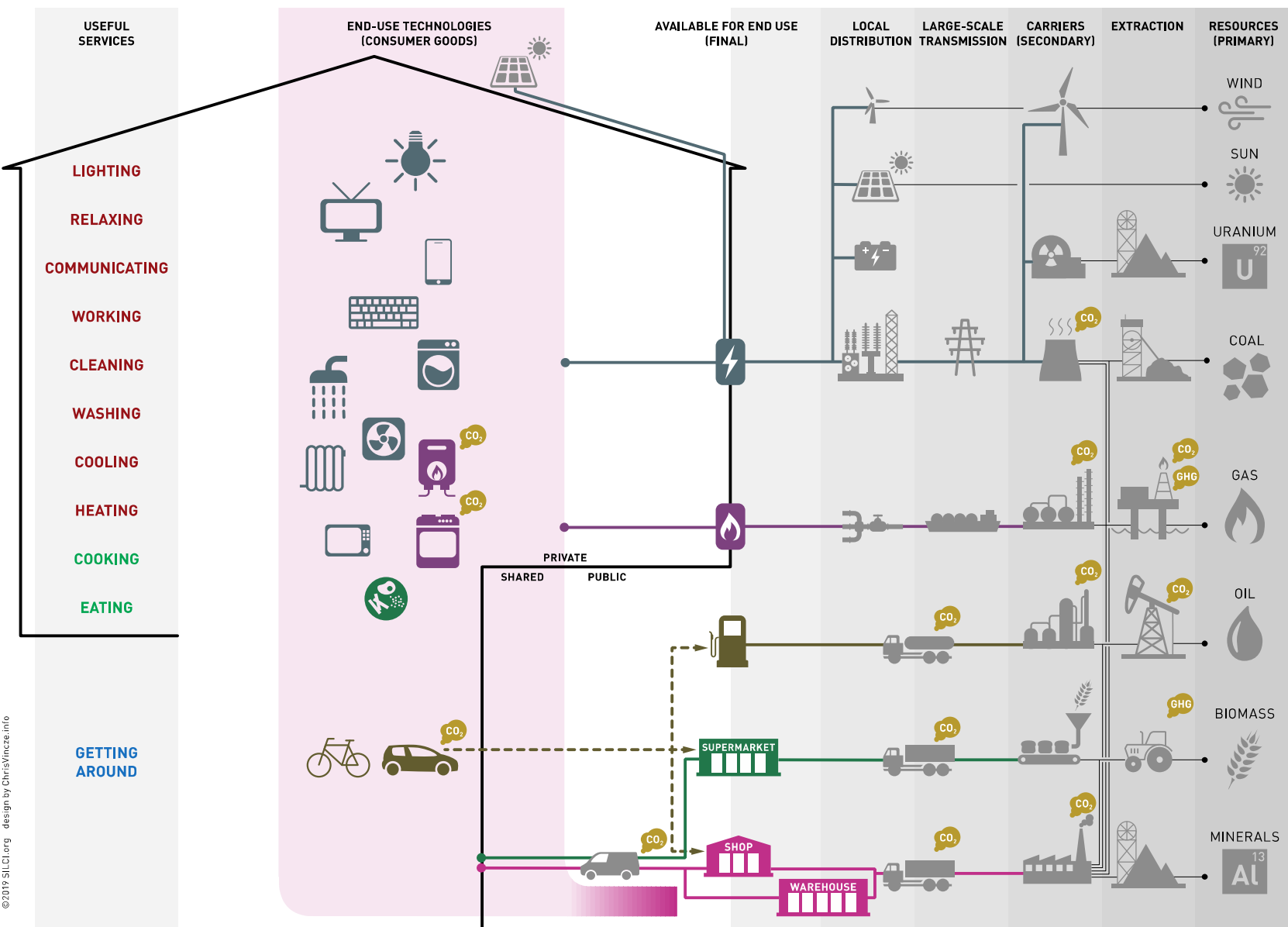
39%

increase in U.S. video game sales in 2020[5]

statista

Carbon emissions need to be close to zero by 2050 … impacting all aspects of our daily lives.

Source: Global Carbon Project (2021) Global Carbon Budget.
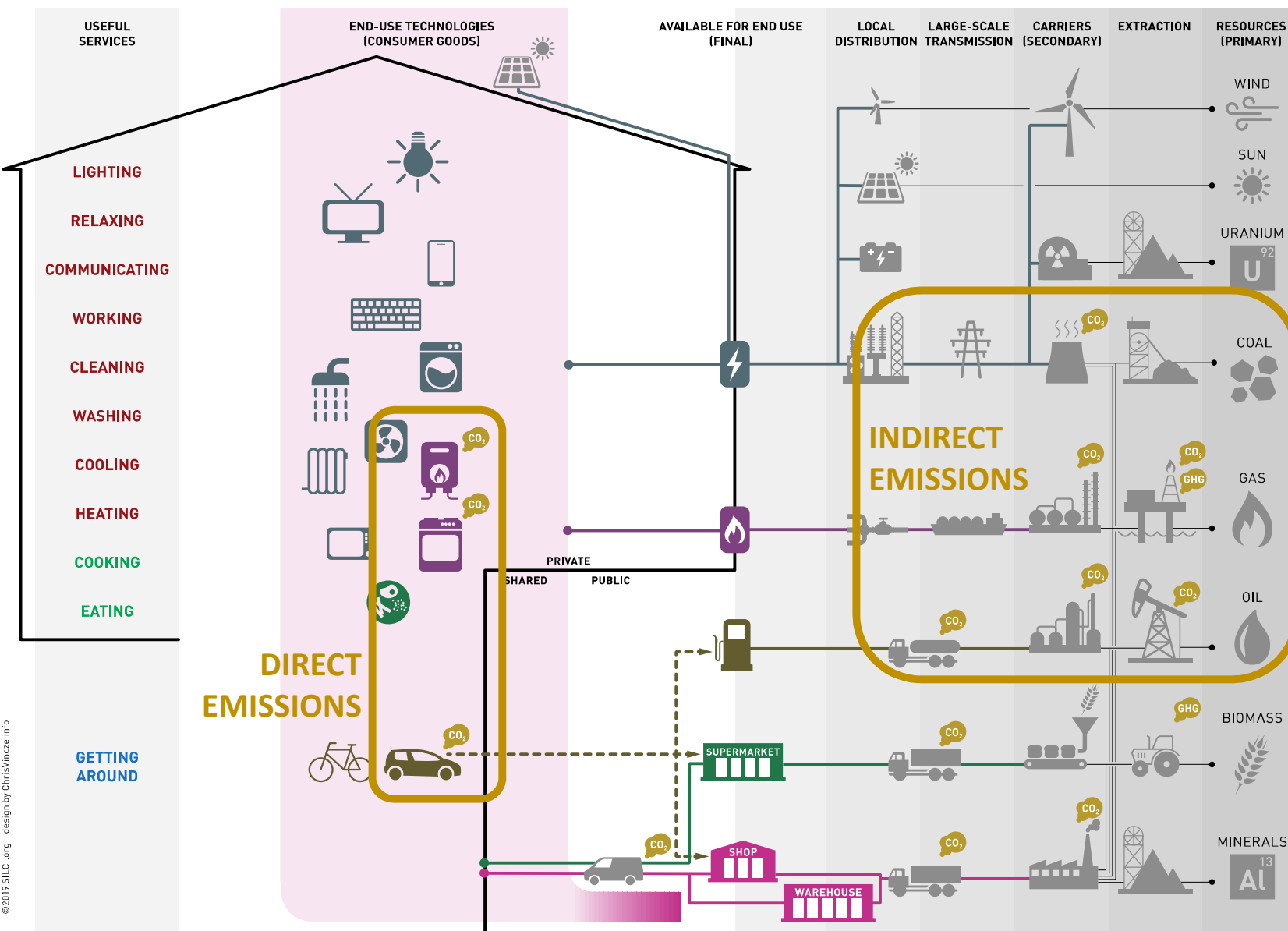https://www.globalcarbonproject.org/carbonbudget/21/presentation.htm

Source: Adapted from Breakthrough Energy.
[https://www.breakthroughenergy.org/our-challenge/the-grand-challenges]

USEFUL SERVICES

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END USE (FINAL)

LOCAL DISTRIBUTION

LARGE-SCALE TRANSMISSION

CARRIERS (SECONDARY)

EXTRACTION

RESOURCES (PRIMARY)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

GETTING AROUND

PRIVATE

SHARED   PUBLIC

SUPERMARKET

SHOP

WAREHOUSE

WIND

SUN

URANIUM

COAL

GAS

OIL

BIOMASS

MINERALS

CO₂   GHG

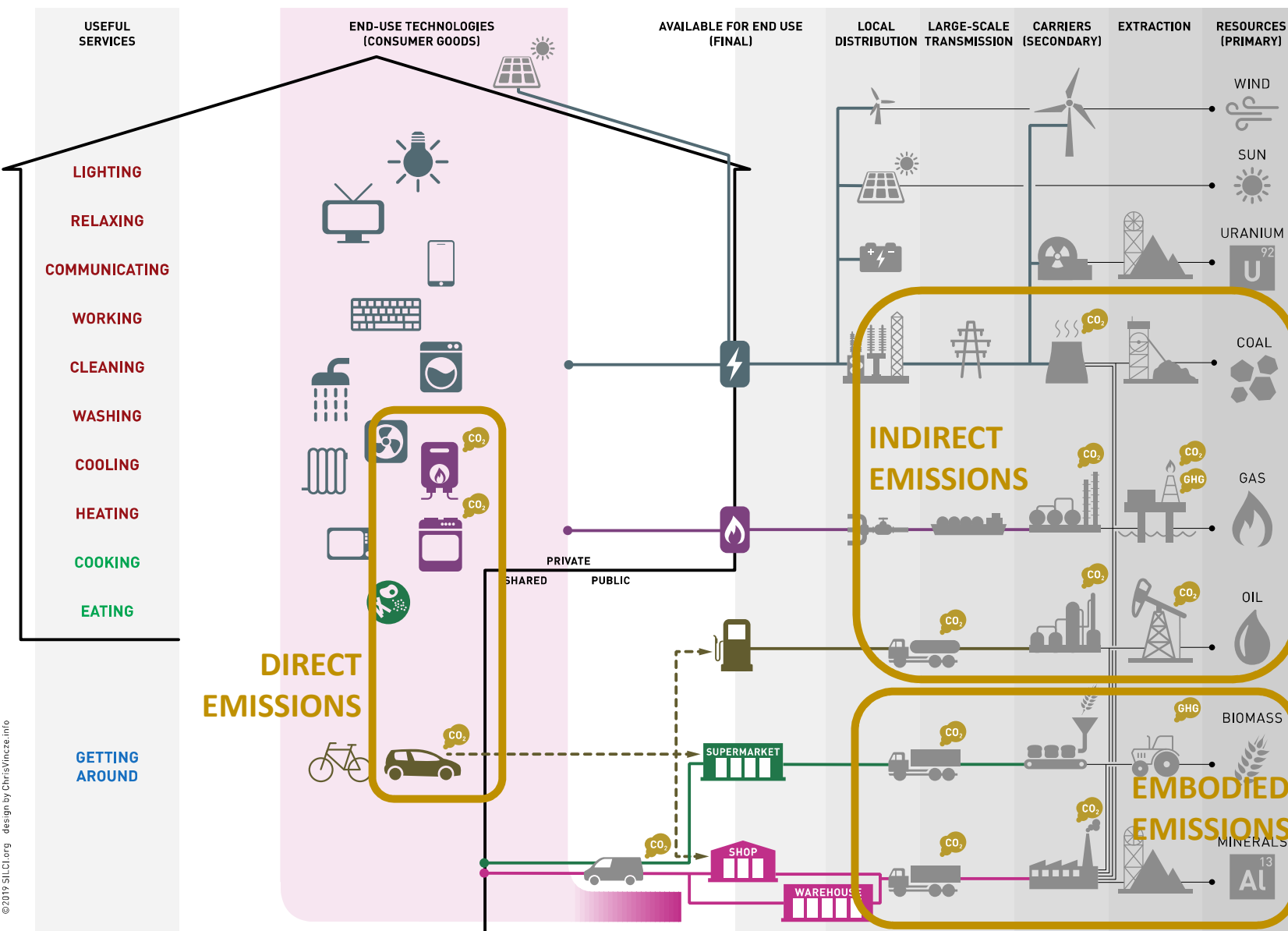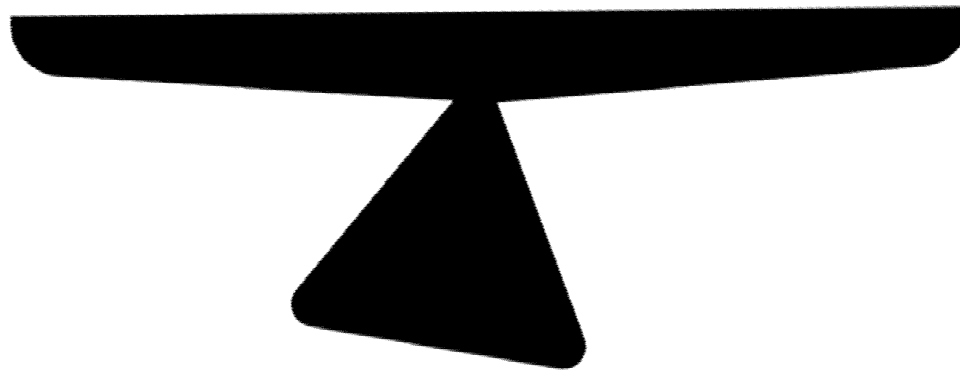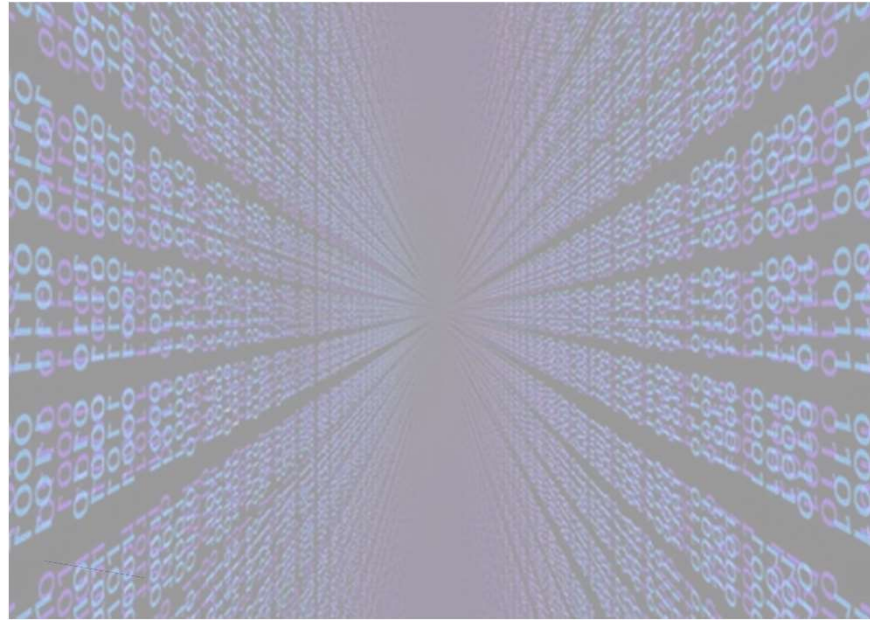©2019 SILCI.org   design by ChrisVincze.info

Source: Wilson et al. (2020). "Potential climate benefits of digital consumer innovations." *Annual Review of Environment and Resources* 45:113-144. doi.org/10.1146/annurev-environ-012320-082424

USEFUL SERVICES	END-USE TECHNOLOGIES (CONSUMER GOODS)	AVAILABLE FOR END USE (FINAL)	LOCAL DISTRIBUTION	LARGE-SCALE TRANSMISSION	CARRIERS (SECONDARY)	EXTRACTION	RESOURCES (PRIMARY)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

GETTING AROUND

DIRECT EMISSIONS

PRIVATE
SHARED   PUBLIC

SUPERMARKET

SHOP

WAREHOUSE

WIND

SUN

URANIUM
U 92

COAL

GAS

OIL

BIOMASS

MINERALS
Al 13

CO₂

GHG

USEFUL SERVICES

- LIGHTING
- RELAXING
- COMMUNICATING
- WORKING
- CLEANING
- WASHING
- COOLING
- HEATING
- COOKING
- EATING
- GETTING AROUND

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END USE (FINAL)

LOCAL DISTRIBUTION

LARGE-SCALE TRANSMISSION

CARRIERS (SECONDARY)

EXTRACTION

RESOURCES (PRIMARY)

WIND

SUN

URANIUM

COAL

GAS

OIL

BIOMASS

MINERALS

DIRECT EMISSIONS

INDIRECT EMISSIONS

PRIVATE
SHARED   PUBLIC

SHOP
WAREHOUSE
SUPERMARKET

CO_2
GHG

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Source: Wilson et al. (2020). "Potential climate benefits of digital consumer innovations." *Annual Review of Environment and Resources* 45:113-144. doi.org/10.1146/annurev-environ-012320-082424
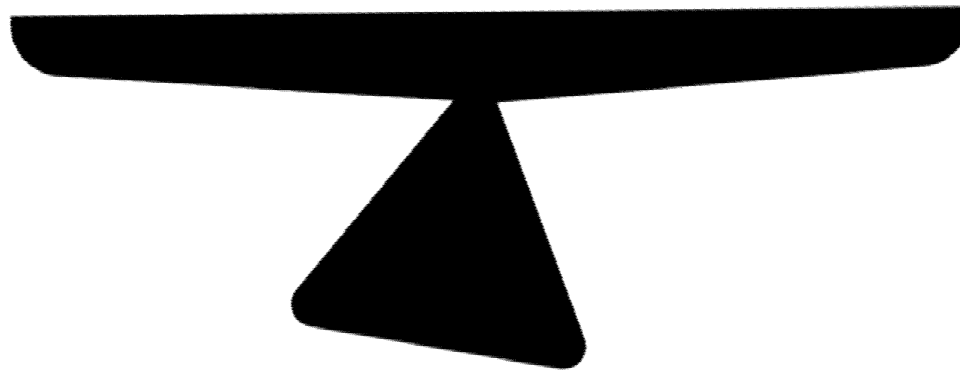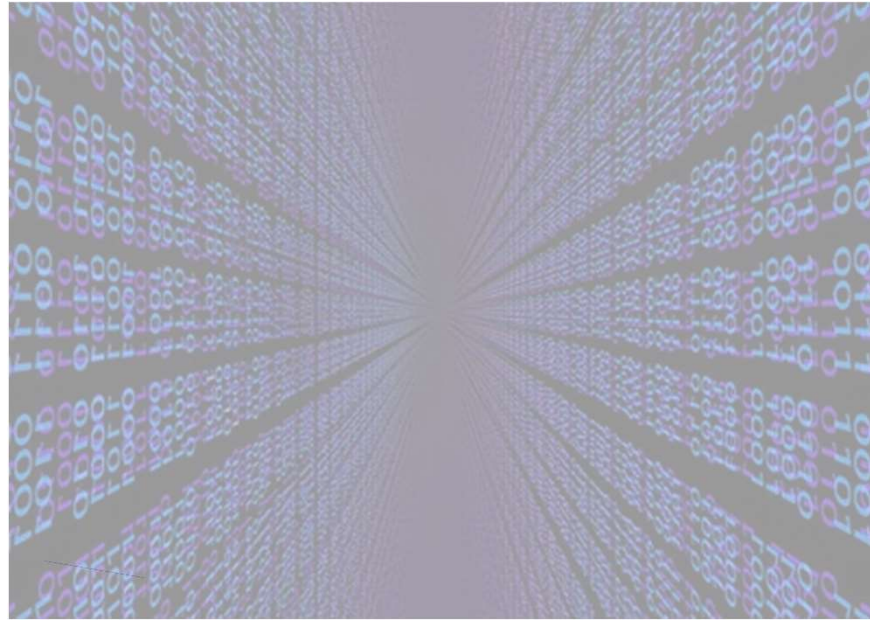
| USEFUL SERVICES | END-USE TECHNOLOGIES (CONSUMER GOODS) | AVAILABLE FOR END USE (FINAL) | LOCAL DISTRIBUTION | LARGE-SCALE TRANSMISSION | CARRIERS (SECONDARY) | EXTRACTION | RESOURCES (PRIMARY) |

LIGHTING
RELAXING
COMMUNICATING
WORKING
CLEANING
WASHING
COOLING
HEATING
COOKING
EATING

GETTING AROUND

DIRECT EMISSIONS

INDIRECT EMISSIONS

EMBODIED EMISSIONS

PRIVATE
SHARED   PUBLIC

WIND
SUN
URANIUM
COAL
GAS
OIL
BIOMASS
MINERALS

SUPERMARKET
SHOP
WAREHOUSE
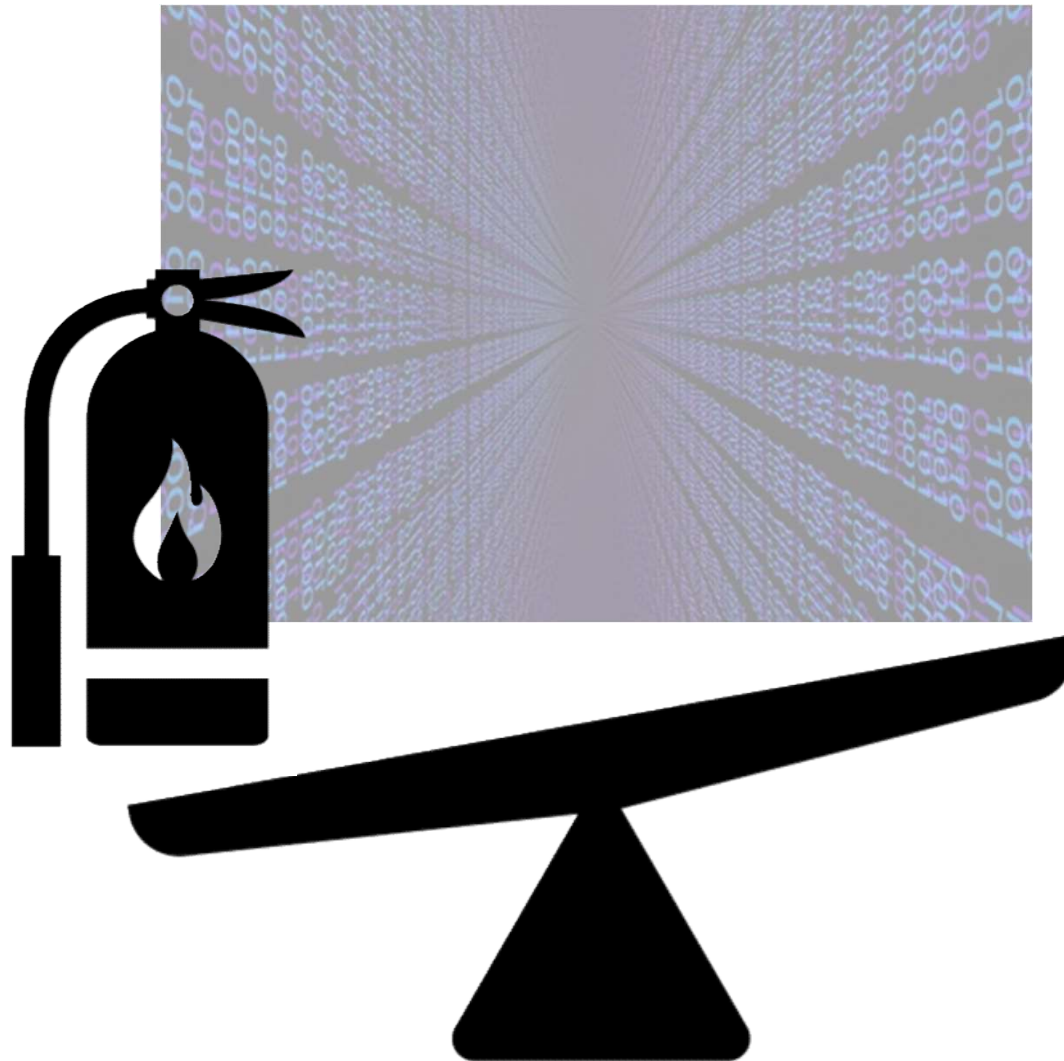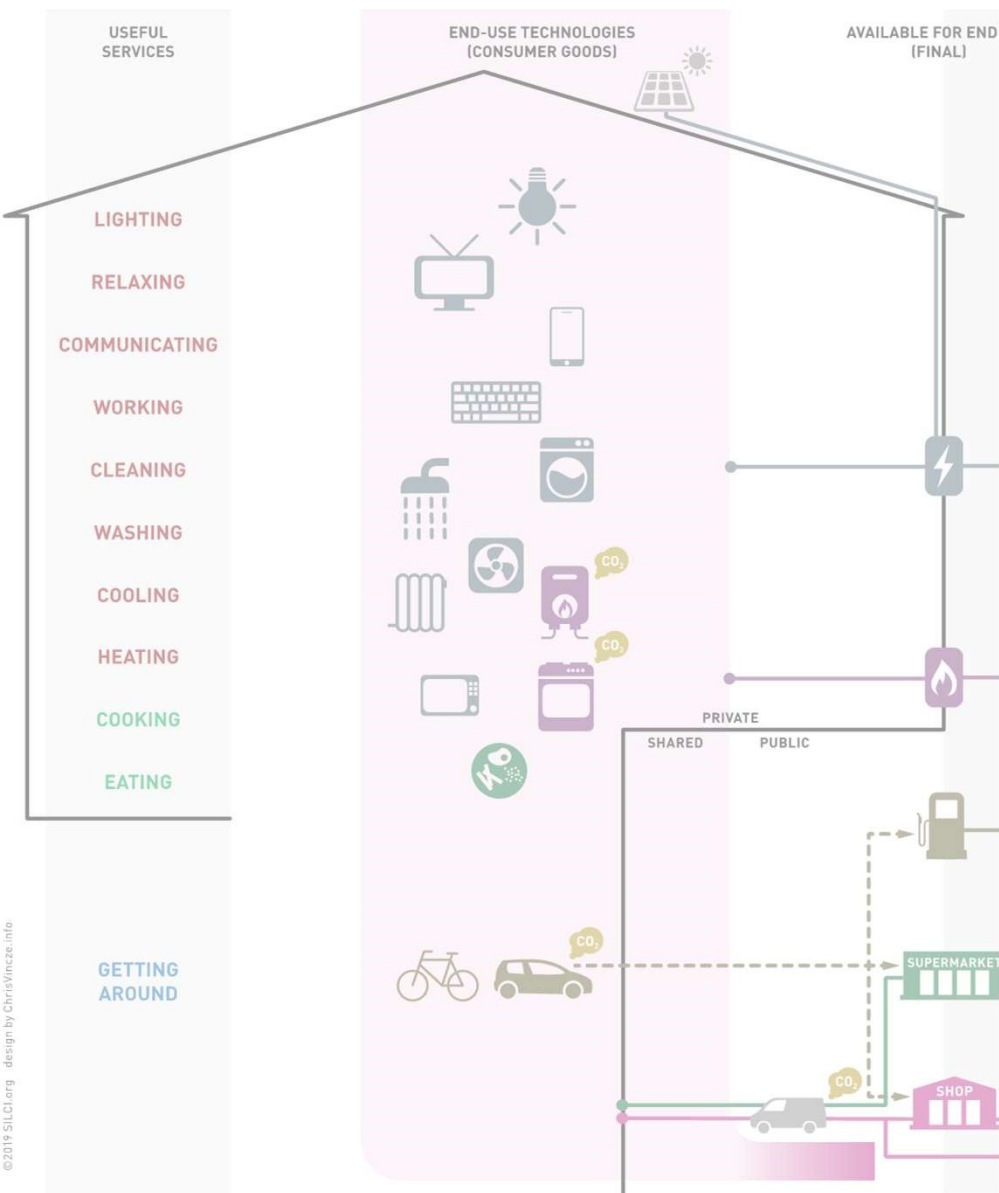
Substitute

Access

Coordinate

Exchange

Control

Integrate

Track

substitute
physical activity for digital activity
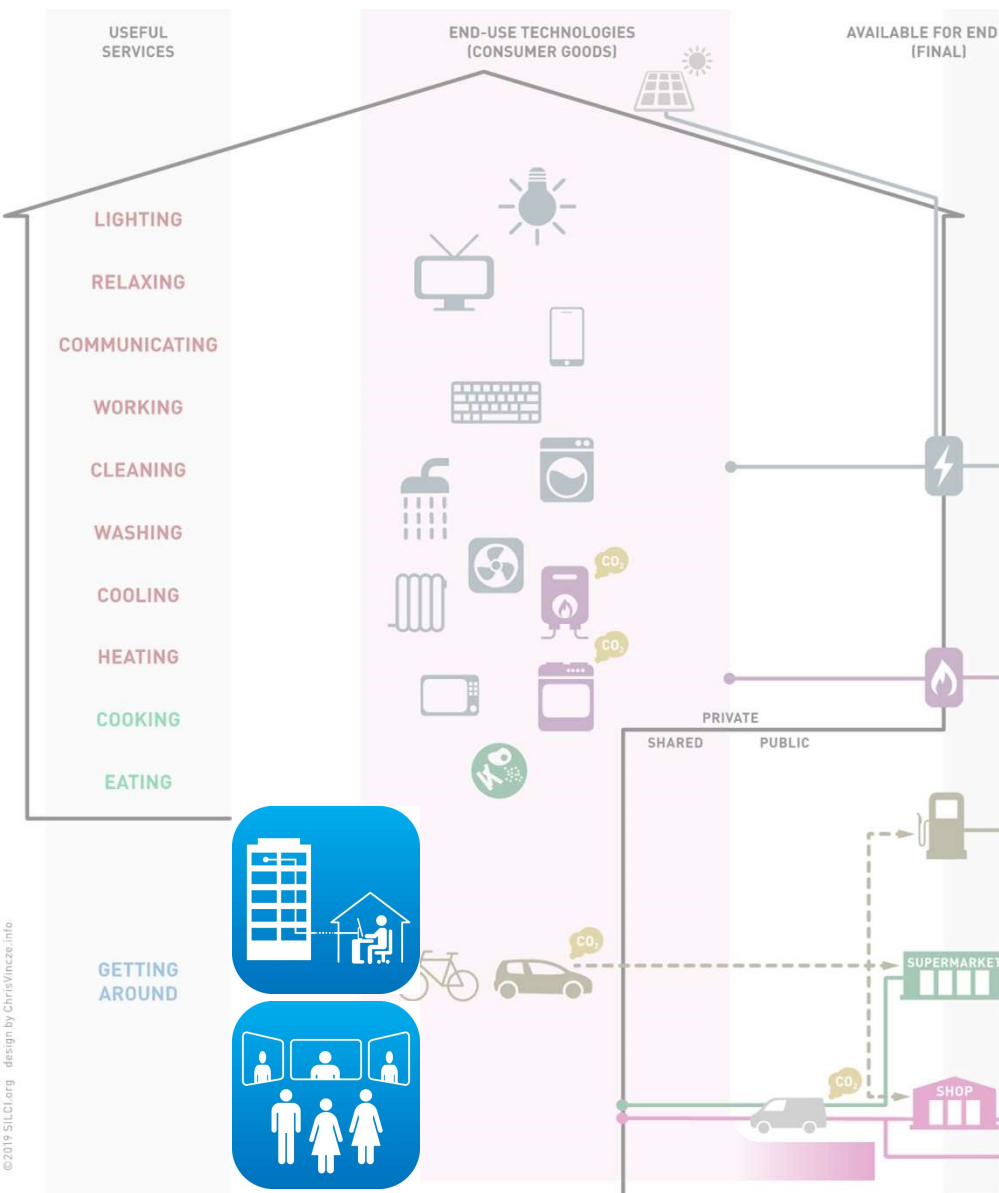
USEFUL SERVICES

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END (FINAL)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

GETTING AROUND

PRIVATE

SHARED   PUBLIC

SUPERMARKET

SHOP

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substitute

physical activity for digital activity

Share of employees working remotely full time during COVID-19 in 2020[2]

■ Pre-COVID-19   ■ During COVID-19

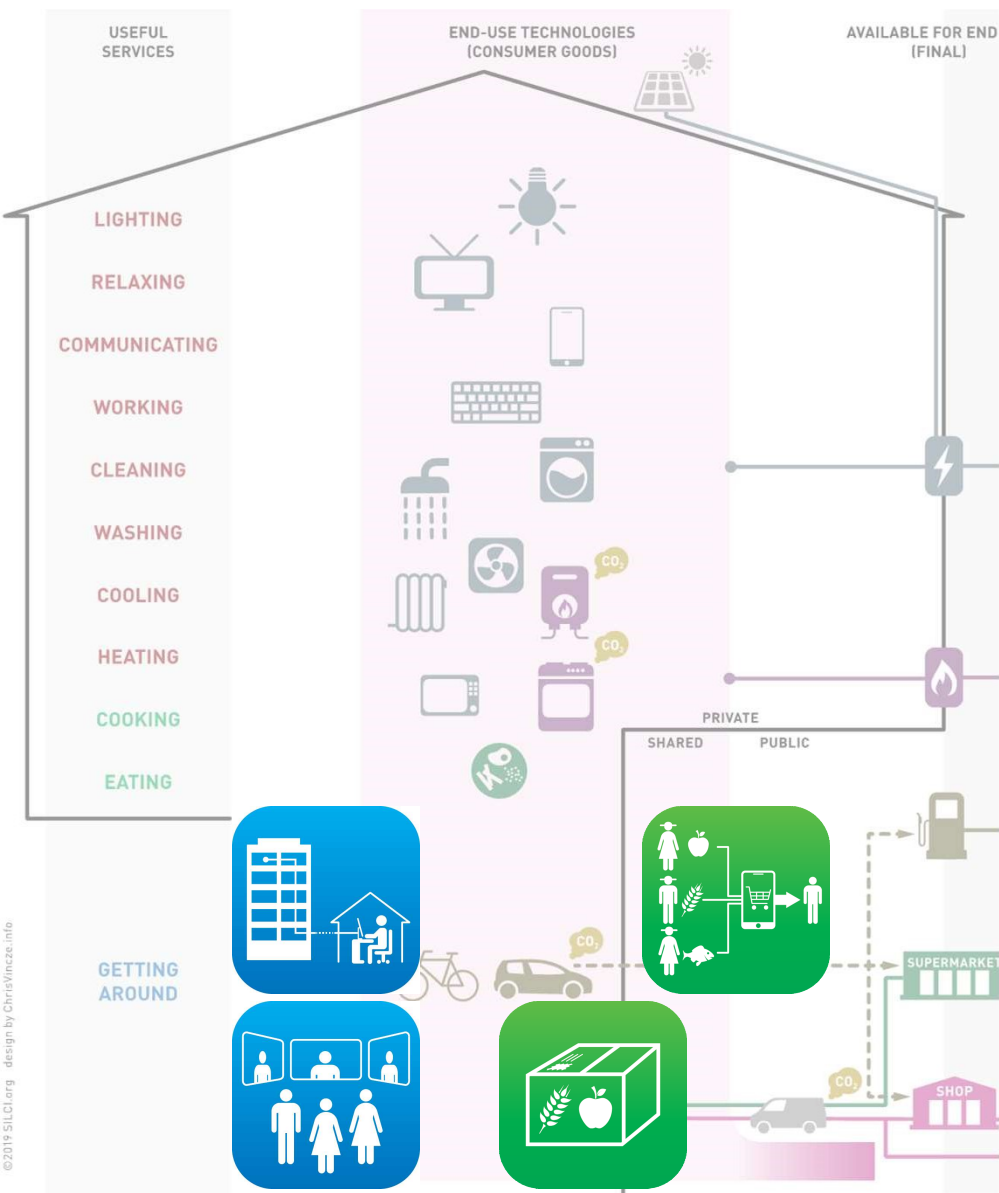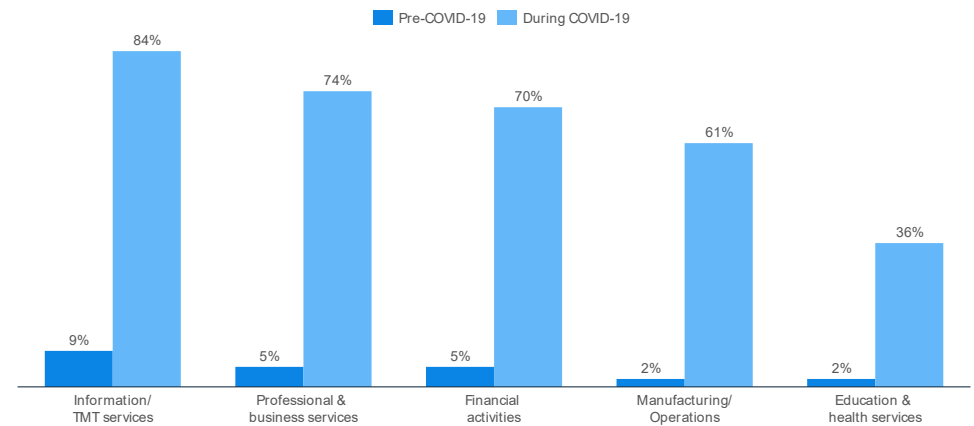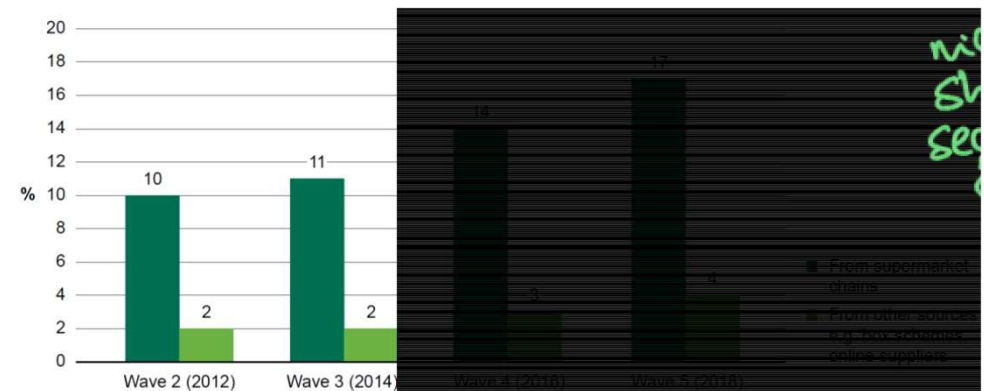|	Information/ TMT services	Professional & business services	Financial activities	Manufacturing/ Operations	Education & health services
During COVID-19	84%	74%	70%	61%	36%
Pre-COVID-19	9%	5%	5%	2%	2%
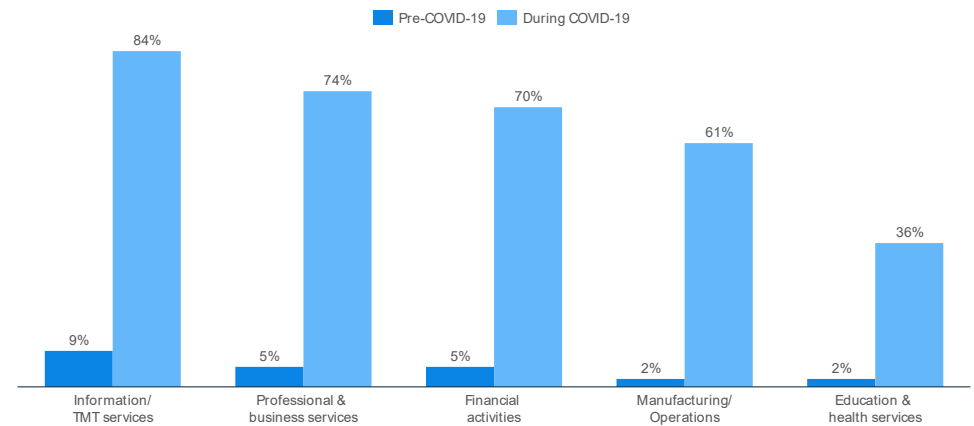
Source: p80, Statista (2020). Digital Economy Compass 2020.

substitute

physical activity for digital activity

Share of employees working remotely full time during COVID-19 in 2020[2]

■ Pre-COVID-19 ■ During COVID-19

Category	Pre-COVID-19	During COVID-19
Information/TMT services	9%	84%
Professional & business services	5%	74%
Financial activities	5%	70%
Manufacturing/Operations	2%	61%
Education & health services	2%	36%

Source: p80, Statista (2020). Digital Economy Compass 2020.
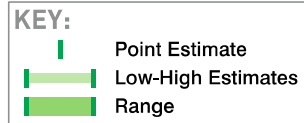
Source: Food Standards Agency (2019). Trends in the use of home delivery services by survey wave.

substitute
physical activity for digital activity

USEFUL SERVICES | END-USE TECHNOLOGIES (CONSUMER GOODS) | AVAILABLE FOR END (FINAL)

LIGHTING
RELAXING
COMMUNICATING
WORKING
CLEANING
WASHING
COOLING
HEATING
COOKING
EATING
GETTING AROUND

FOOD INNOVATIONS: % CHANGE IN OUTCOME MEASURE RELATED DIRECTLY OR INDIRECTLY TO EMISSIONS

KEY:
- Point Estimate
- Low-High Estimates
- Range

%Δ in activity, energy or carbon emissions

-100% -80% -60% -40% -20% 0% +20%
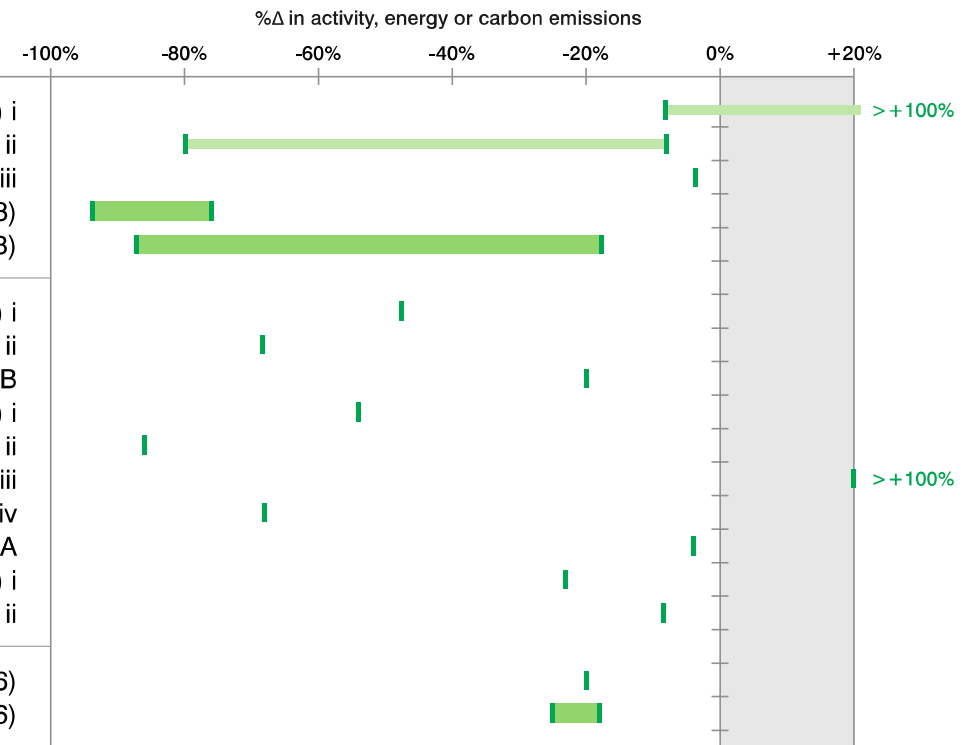
F1 DIGITAL HUBS FOR LOCAL FOOD
- F1: %Δ carbon (Peano 2018) i — >+100%
- F1: %Δ carbon (Peano 2018) ii
- F1: %Δ carbon (Peano 2018) iii
- F1: %Δ carbon (Pérez-Neira 2018)
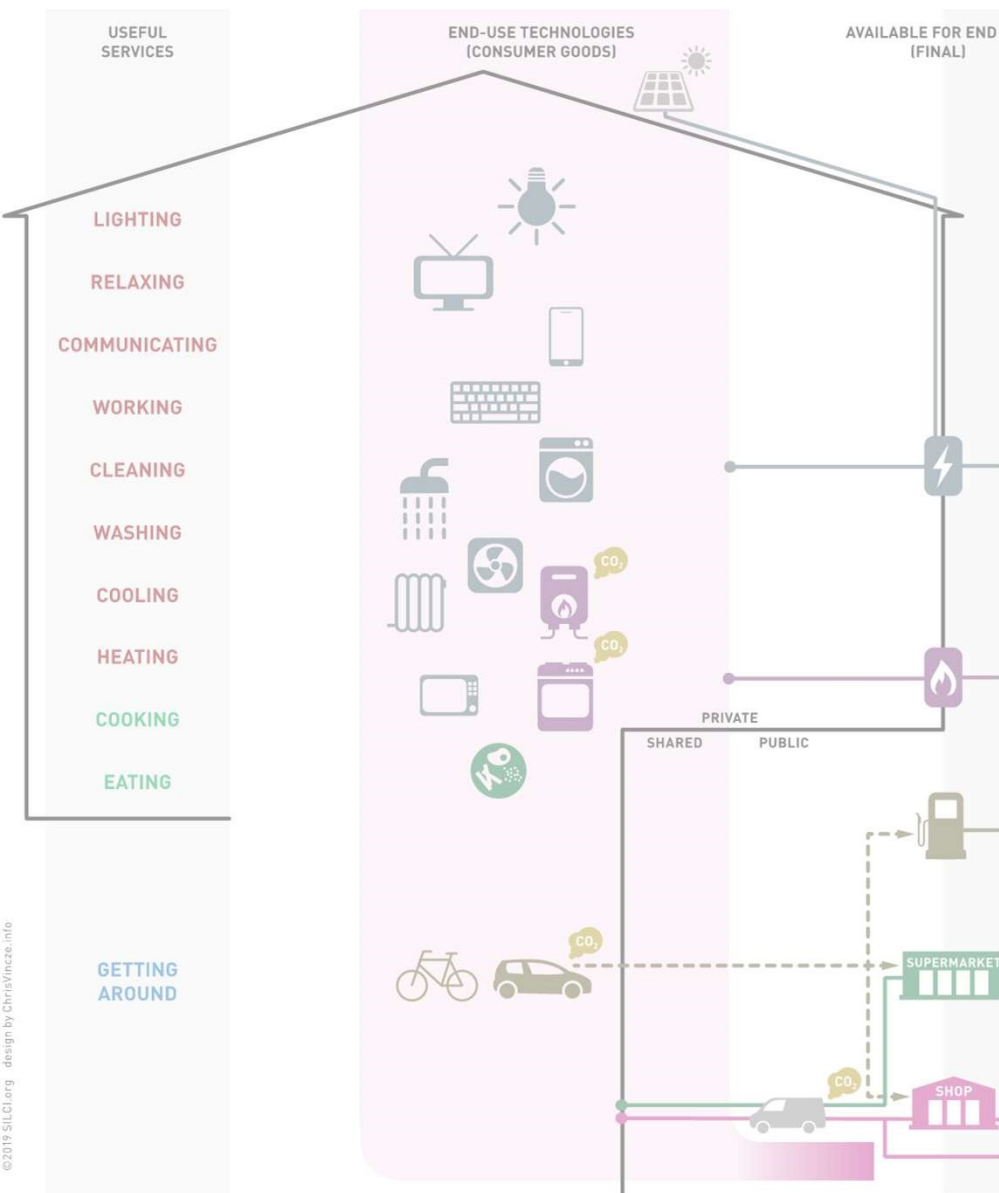- F1: %Δ carbon (Siikavirta 2003)

F2 MEAL KITS
- F2: %Δ activity (Peters 2016) i
- F2: %Δ activity (Peters 2016) ii
- F2: %Δ energy (Fenton 2017) B
- F2: %Δ energy (Gee 2019) i
- F2: %Δ energy (Gee 2019) ii
- F2: %Δ energy (Gee 2019) iii — >+100%
- F2: %Δ energy (Gee 2019) iv
- F2: %Δ carbon (Fenton 2017) A
- F2: %Δ carbon (Heard 2019) i
- F2: %Δ carbon (Heard 2019) ii

F3 11TH HOUR APPS
- F3: %Δ activity (Koh 2016)
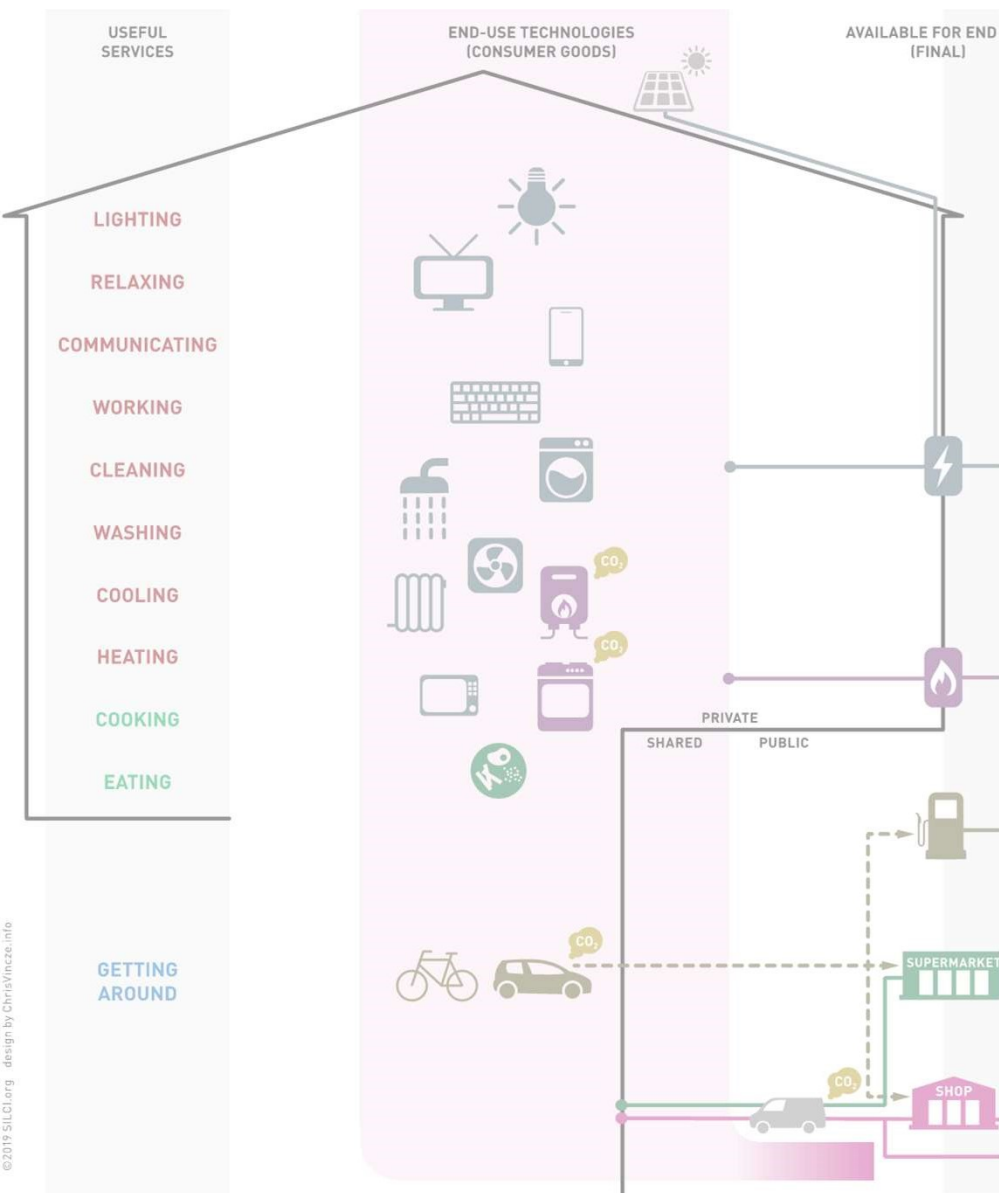- F3: %Δ activity (Wong 2016)

Source: Wilson et al. (2020). "Potential climate benefits of digital consumer innovations." *Annual Review of Environment and Resources* 45:113-144. doi.org/10.1146/annurev-environ-012320-082424
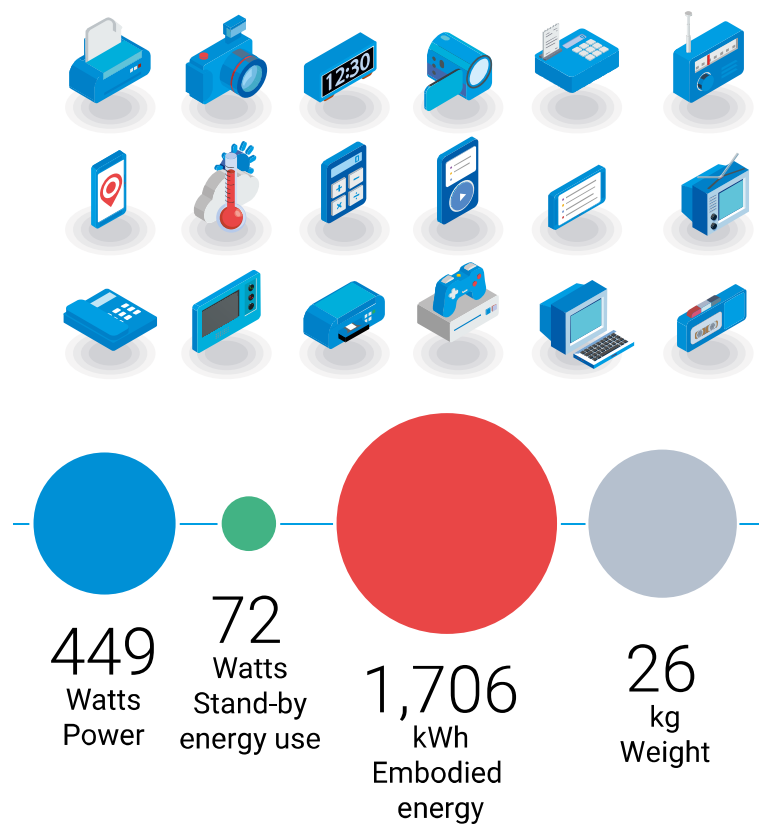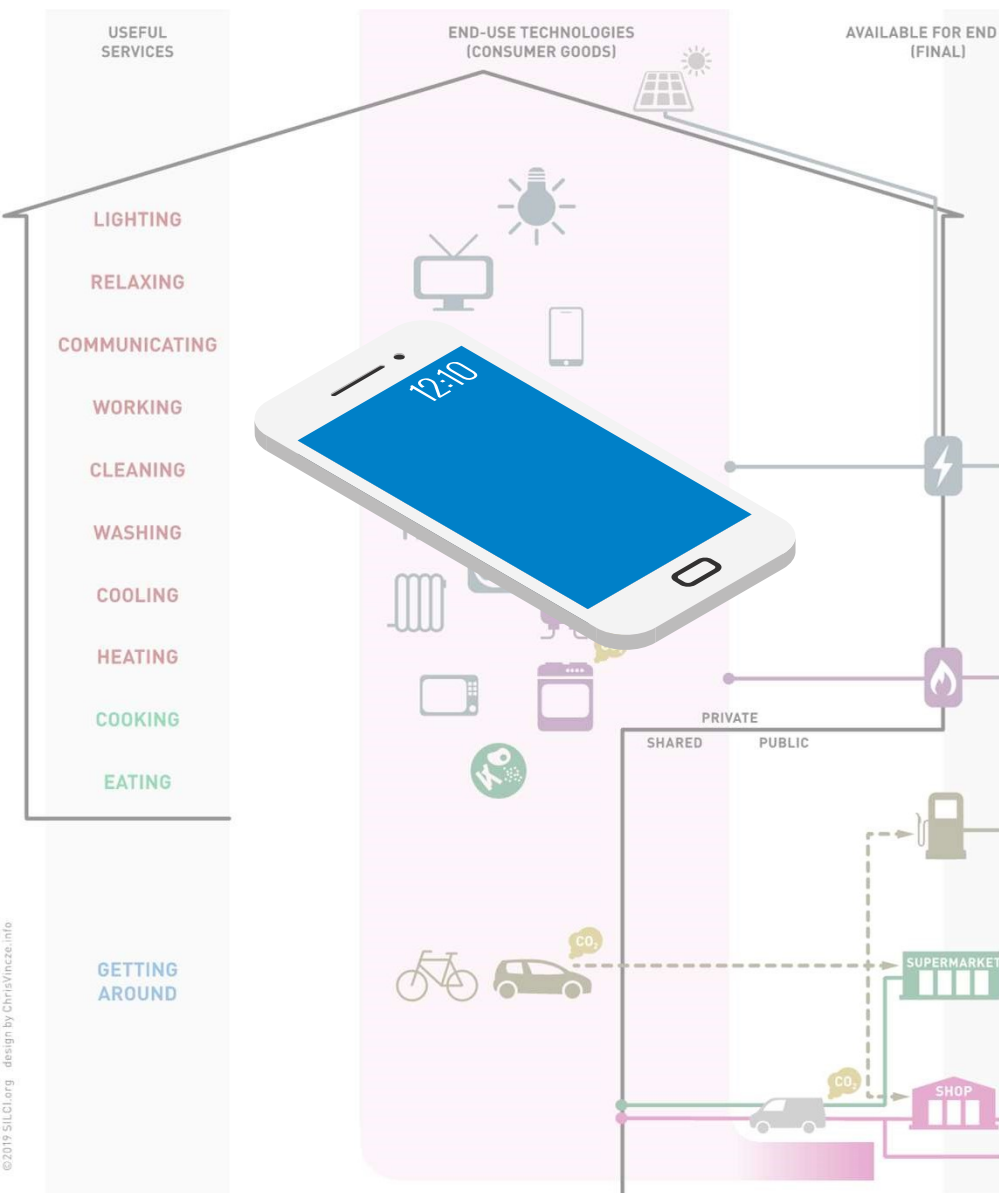
©2019 SILCI.org   design by ChrisVince.info

access

services instead of owning goods

USEFUL SERVICES | END-USE TECHNOLOGIES (CONSUMER GOODS) | AVAILABLE FOR END (FINAL)

LIGHTING
RELAXING
COMMUNICATING
WORKING
CLEANING
WASHING
COOLING
HEATING
COOKING
EATING

GETTING AROUND

PRIVATE
SHARED   PUBLIC

SUPERMARKET

SHOP

©2019 SILCI.org   design by ChrisVincze.info

access

services instead of owning goods

449
Watts
Power

72
Watts
Stand-by
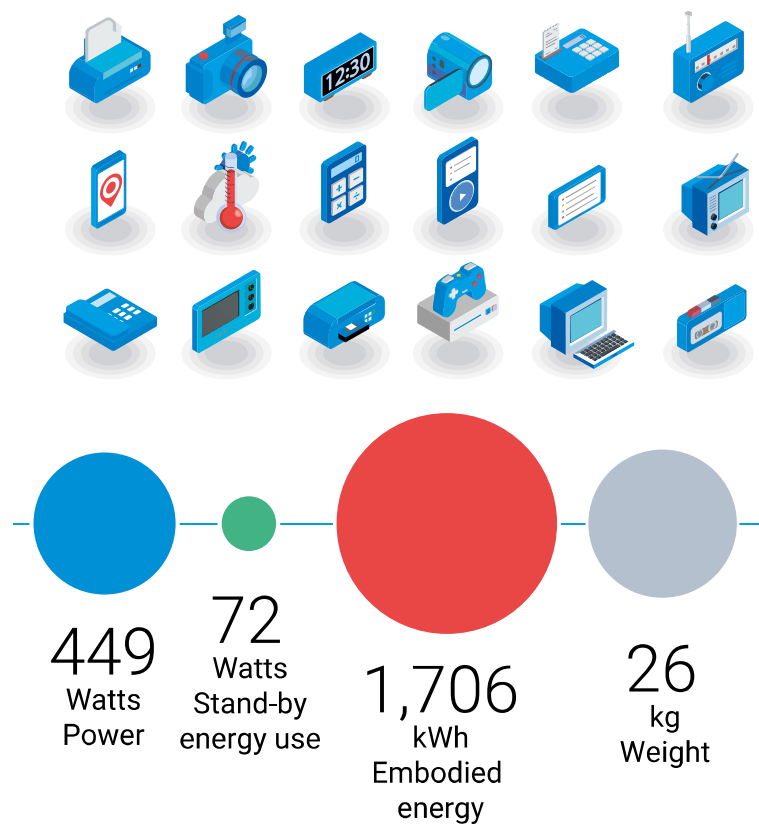energy use

1,706
kWh
Embodied
energy

26
kg
Weight

Source: Fig5.2, UNEP (2019) *Emissions Gap Report*, based on Grubler, Wilson et al. (2018) *Nature Energy*.

access

services instead of owning goods

| 449 Watts Power | 72 Watts Stand-by energy use | 1,706 kWh Embodied energy | 26 kg Weight |

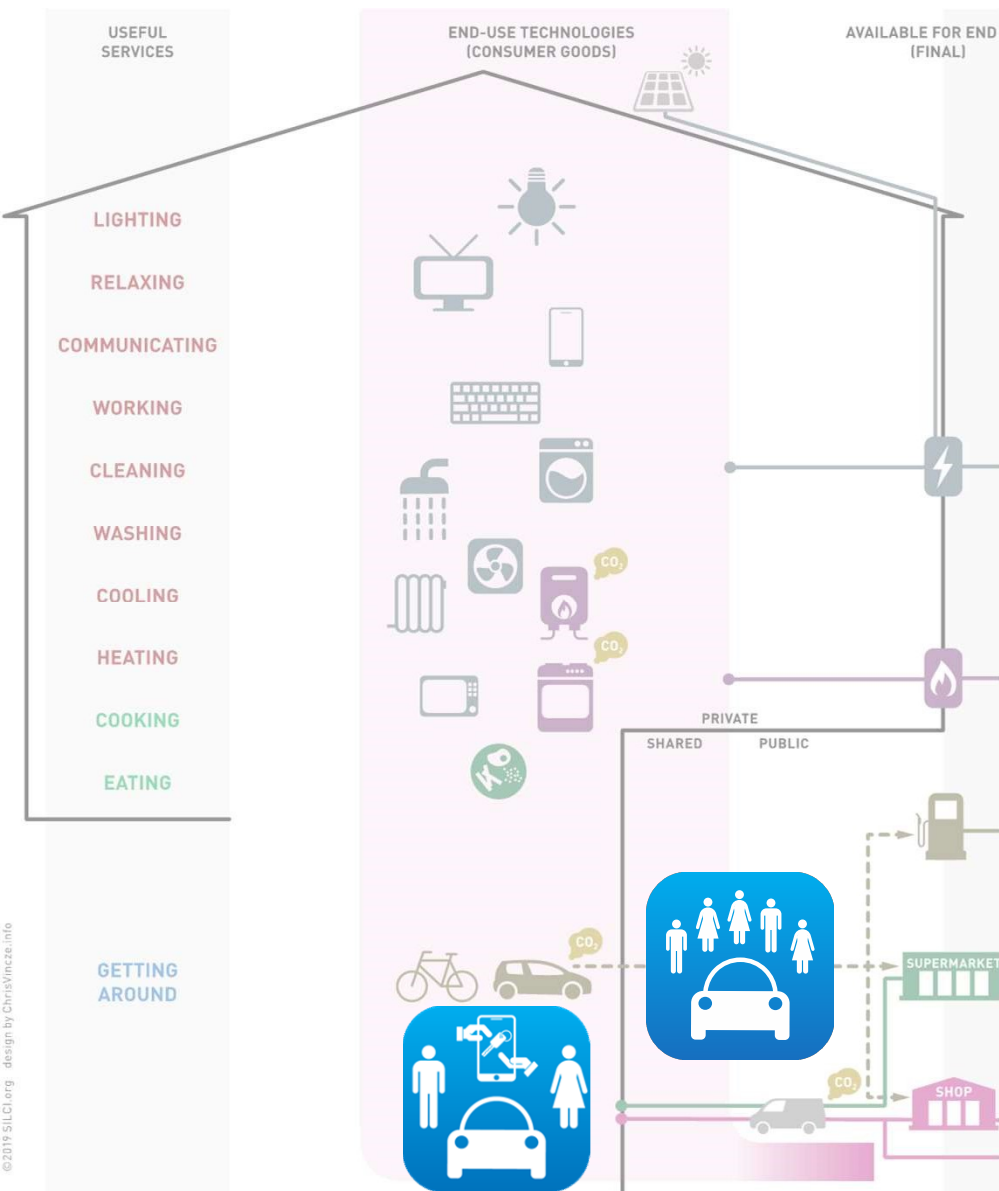Source: Fig5.2, UNEP (2019) *Emissions Gap Report*, based on Grubler, Wilson et al. (2018) *Nature Energy*.

USEFUL SERVICES

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END (FINAL)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

GETTING AROUND

PRIVATE

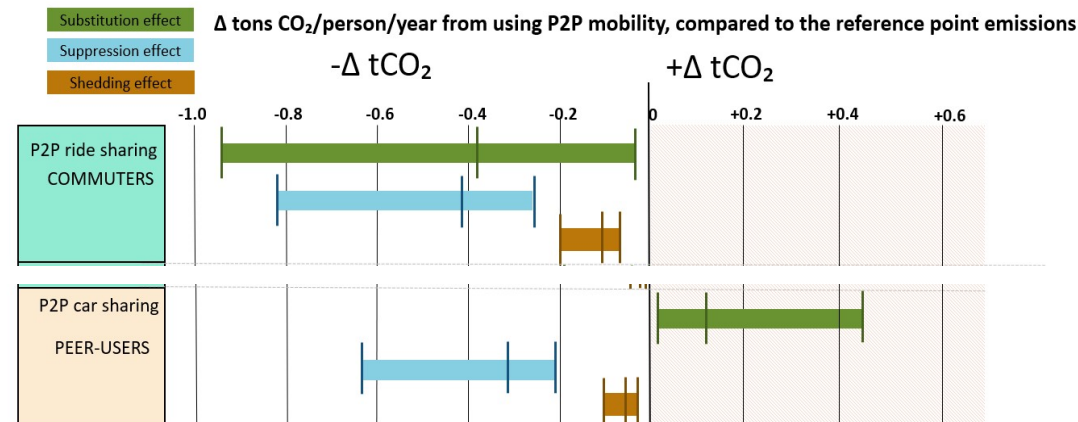SHARED   PUBLIC

SUPERMARKET

SHOP

CO_2

access

services instead of owning goods
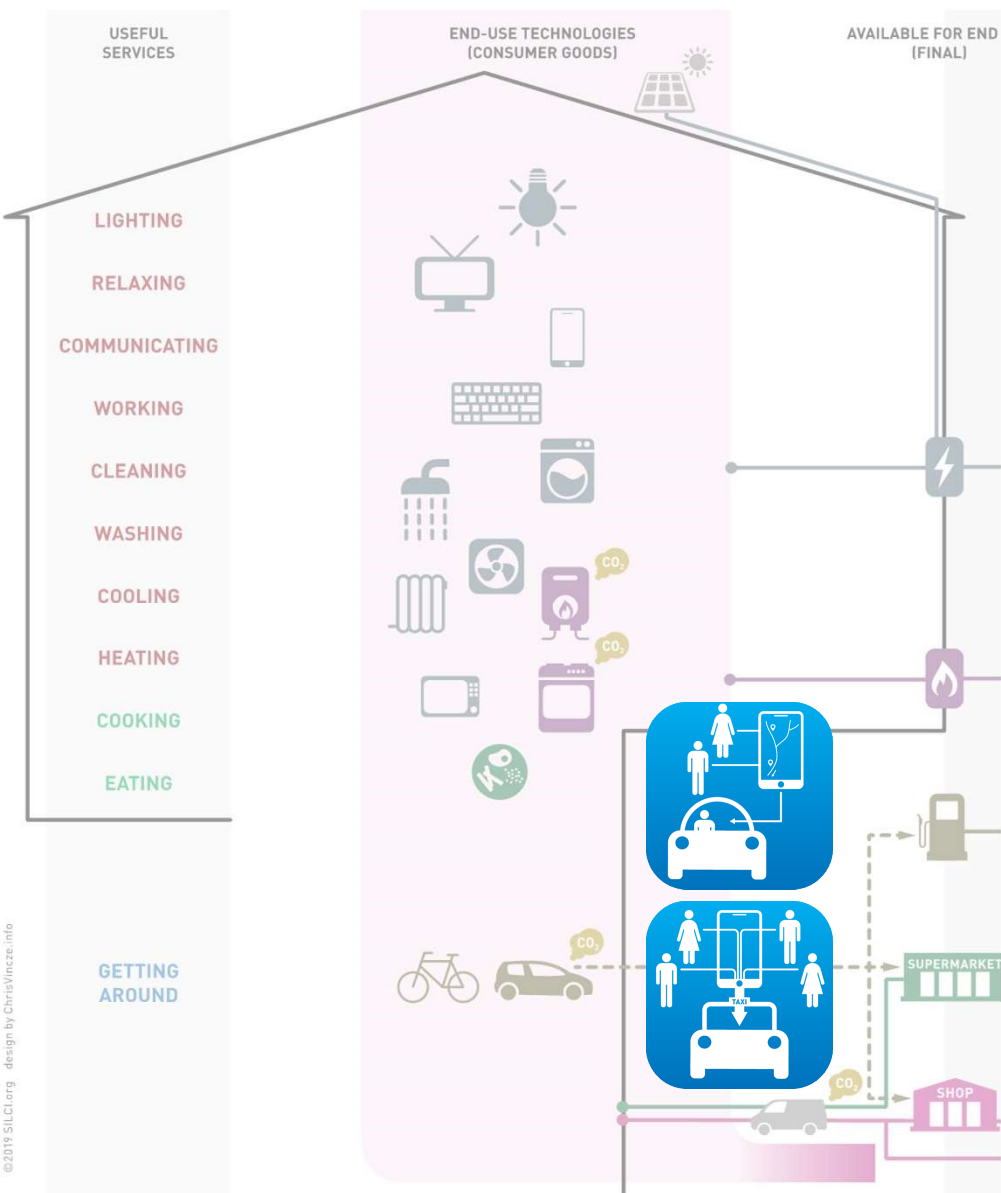
access

services instead of owning goods

Source: Laurie Kerr PhD thesis (forthcoming) on P2P carsharing and P2P ridesharing.

coordinate

how services are provided

Photo Credit: ShareNow @Unsplash.

International Transport Forum | **CPB**
Corporate Partnership Board

Shared Mobility
Innovation for Liveable Cities

Corporate Partnership Board Report

OECD

coordinate

how services are provided

USEFUL
SERVICES

END-USE TECHNOLOGIES
(CONSUMER GOODS)

AVAILABLE FOR END
(FINAL)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

GETTING
AROUND

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MOBILITY INNOVATIONS: % CHANGE IN OUTCOME MEASURE
RELATED DIRECTLY OR INDIRECTLY TO EMISSIONS

KEY:
Point Estimate
Low-High Estimates
Range

%Δ in activity, energy or carbon emissions

-100%   -80%   -60%   -40%   -20%   0%   +20%

T1 CARSHARING
T1: %Δ activity (Clewlow 2016)
T1: %Δ activity (Martin 2016)
T1: %Δ energy (Baptista 2014) A
T1: %Δ energy (Baptista 2014) B
T1: %Δ carbon (Baptista 2014) C
T1: %Δ carbon (Firnkorn 2011)
T1: %Δ carbon (Namazu 2015) A
T1: %Δ carbon (Namazu 2015) B
T1: %Δ carbon (Namazu 2015) C
T1: %Δ carbon (Nijland 2017)
T1: %Δ carbon (Rabbitt 2013)

T2 P2P CARSHARING
T2:

T3 RIDESHARING
T3: %Δ activity (Coulombel 2019)
T3: %Δ energy (Jacobson 2009)
T3: %Δ energy (Minett 2011)
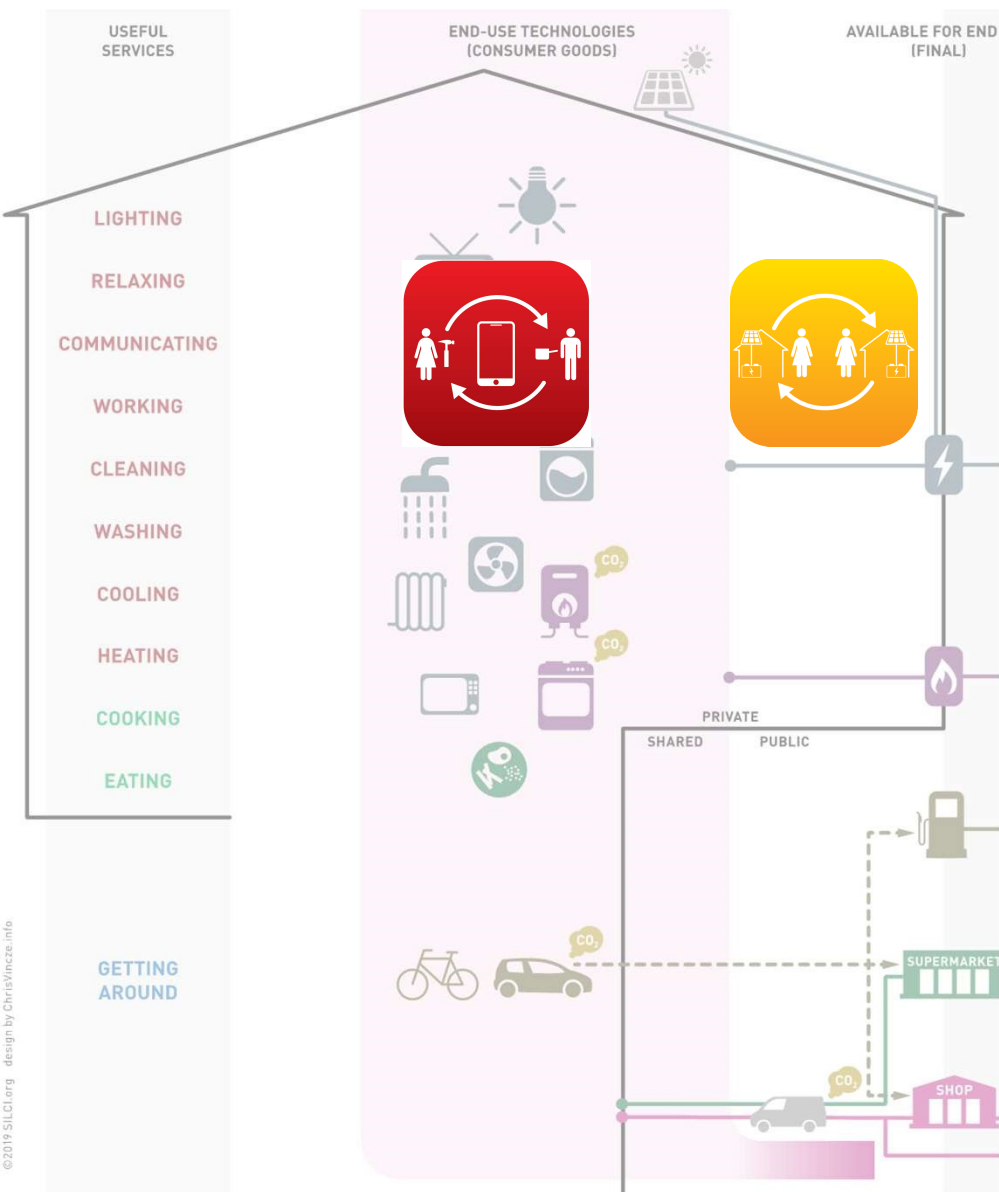T3: %Δ carbon (Bruck 2017)
T3: %Δ carbon (Yu 2017)

T4 SHARED RIDEHAILING
T4: %Δ activity (Cai 2019)
T4: %Δ activity (Lokhandwala 2018)
T4: %Δ activity (Ota 2016)
T4: %Δ carbon (Cheng 2018)
T4: %Δ carbon (ITF 2017a)
T4: %Δ carbon (ITF 2017b)
T4: %Δ carbon (Liu 2018)
T4: %Δ carbon (Merlin 2017)

Source: Wilson et al. (2020).
"Potential climate benefits of
digital consumer
innovations." *Annual Review
of Environment and
Resources* 45:113-144.
doi.org/10.1146/annurev-
environ-012320-082424

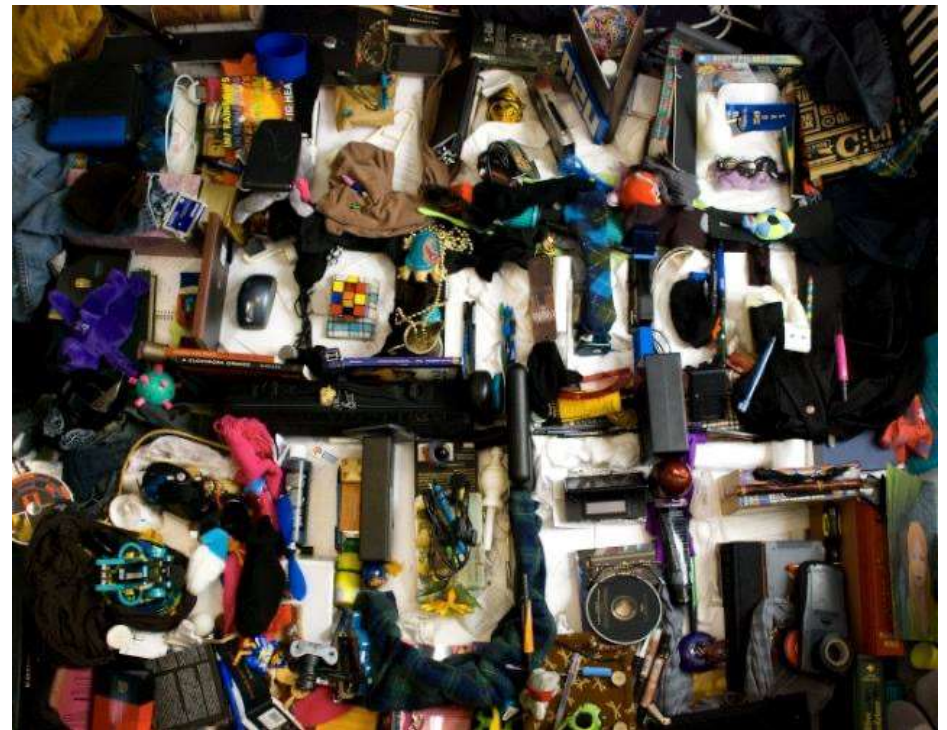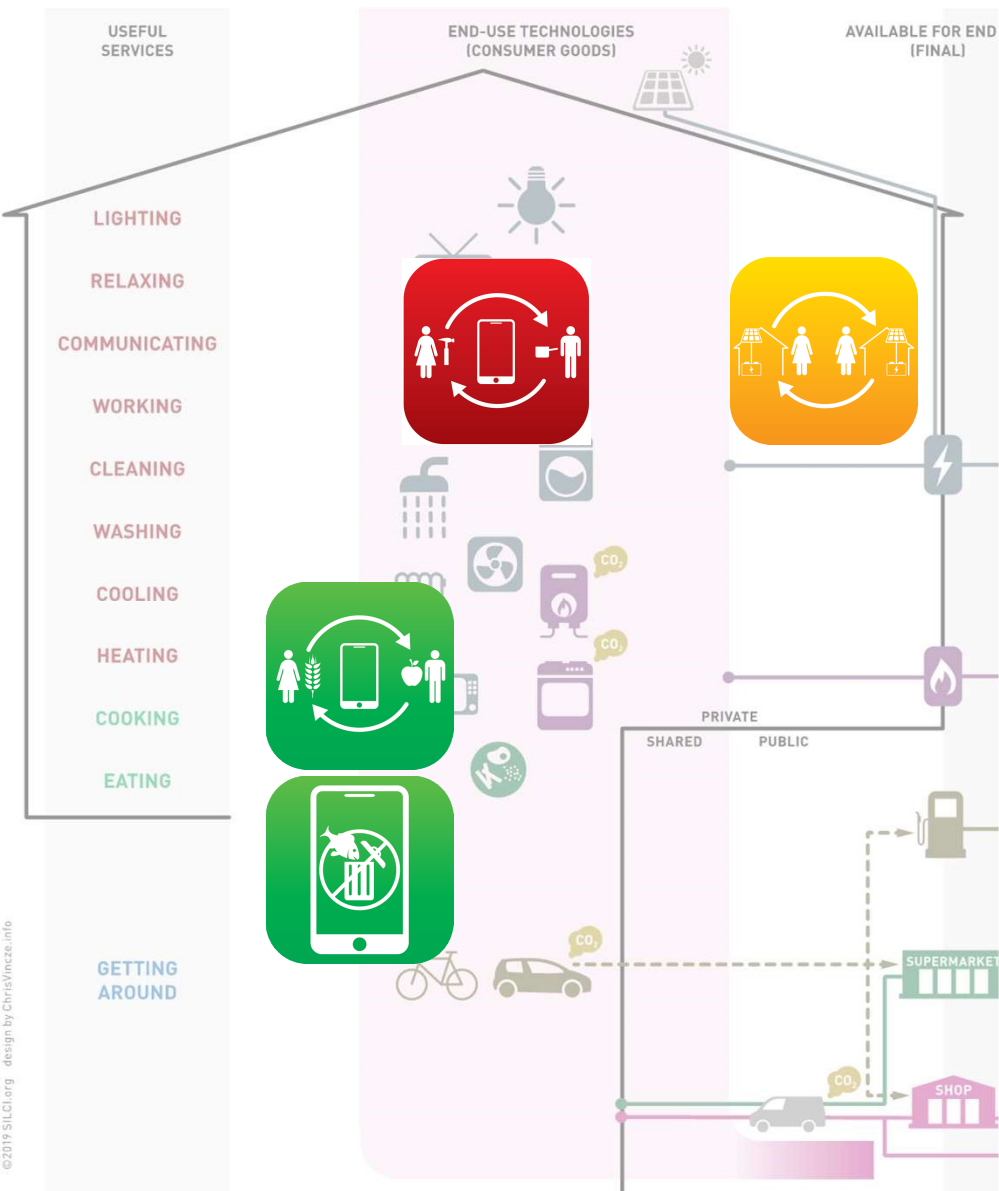# exchange
physical goods and avoid waste

Photo Credit: https://gravesmillstorage.com/too-much-stuff/

exchange
physical goods and avoid waste

Photo Credit: https://gravesmillstorage.com/too-much-stuff/

USEFUL SERVICES

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END (FINAL)

LIGHTING
RELAXING
COMMUNICATING
WORKING
CLEANING
WASHING
COOLING
HEATING
COOKING
EATING

GETTING AROUND

PRIVATE
SHARED   PUBLIC

SUPERMARKET
SHOP
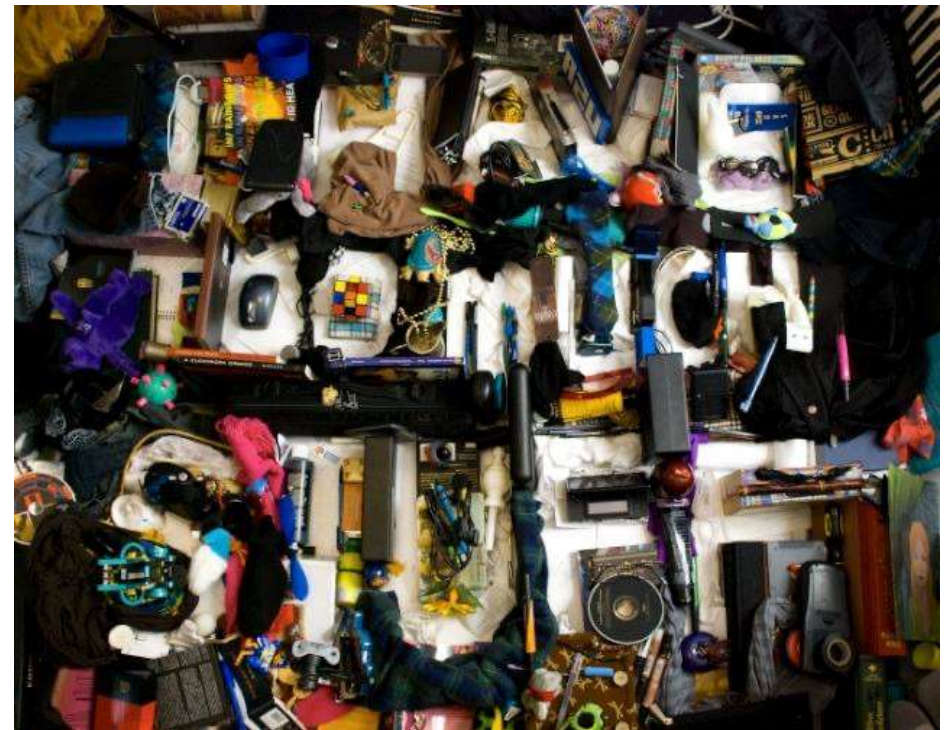
control

and manage resource use

control
and manage resource use

Photo Credit: Green Energy Futures @Flickr. CC BY-NC-SA 2.0.
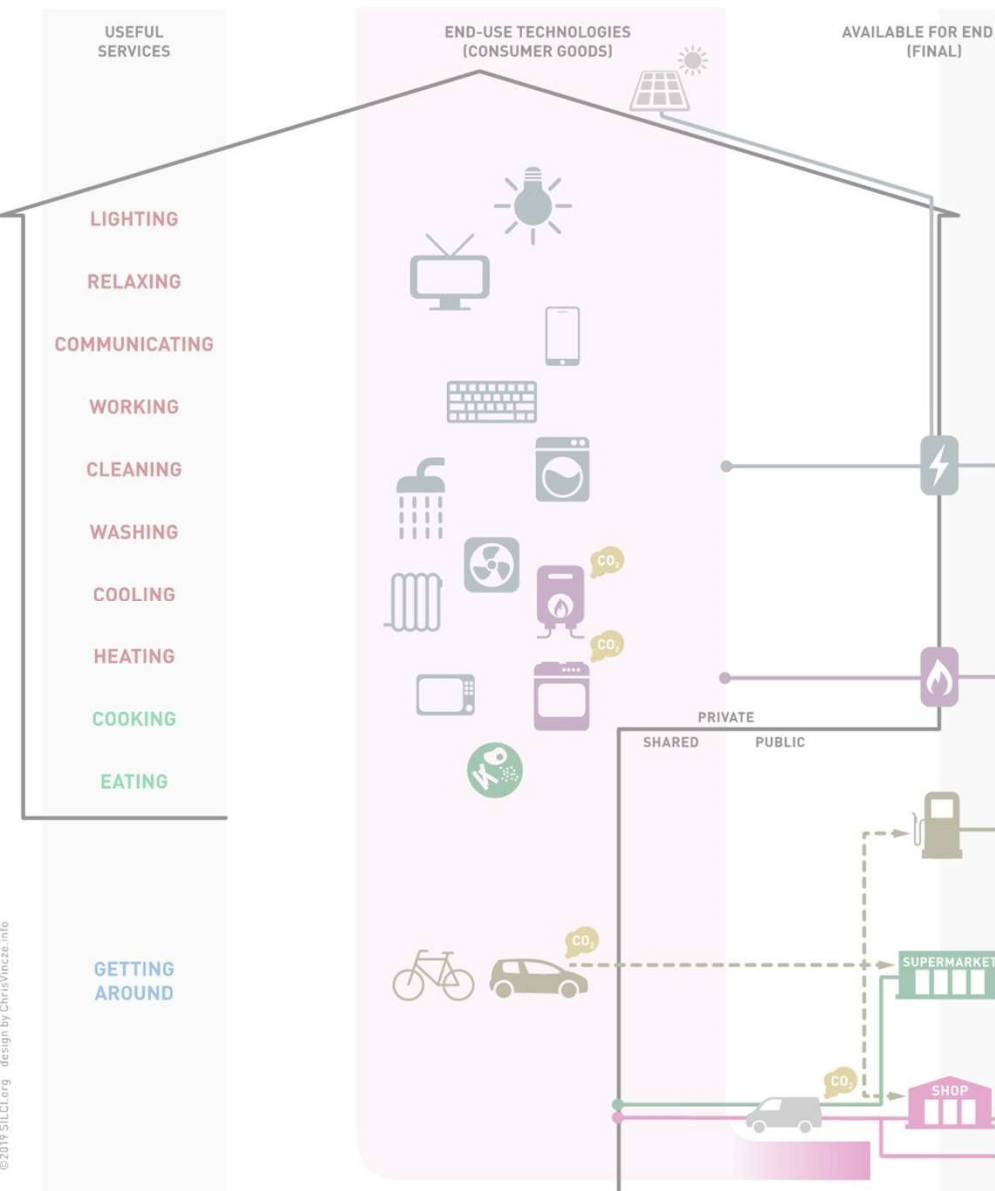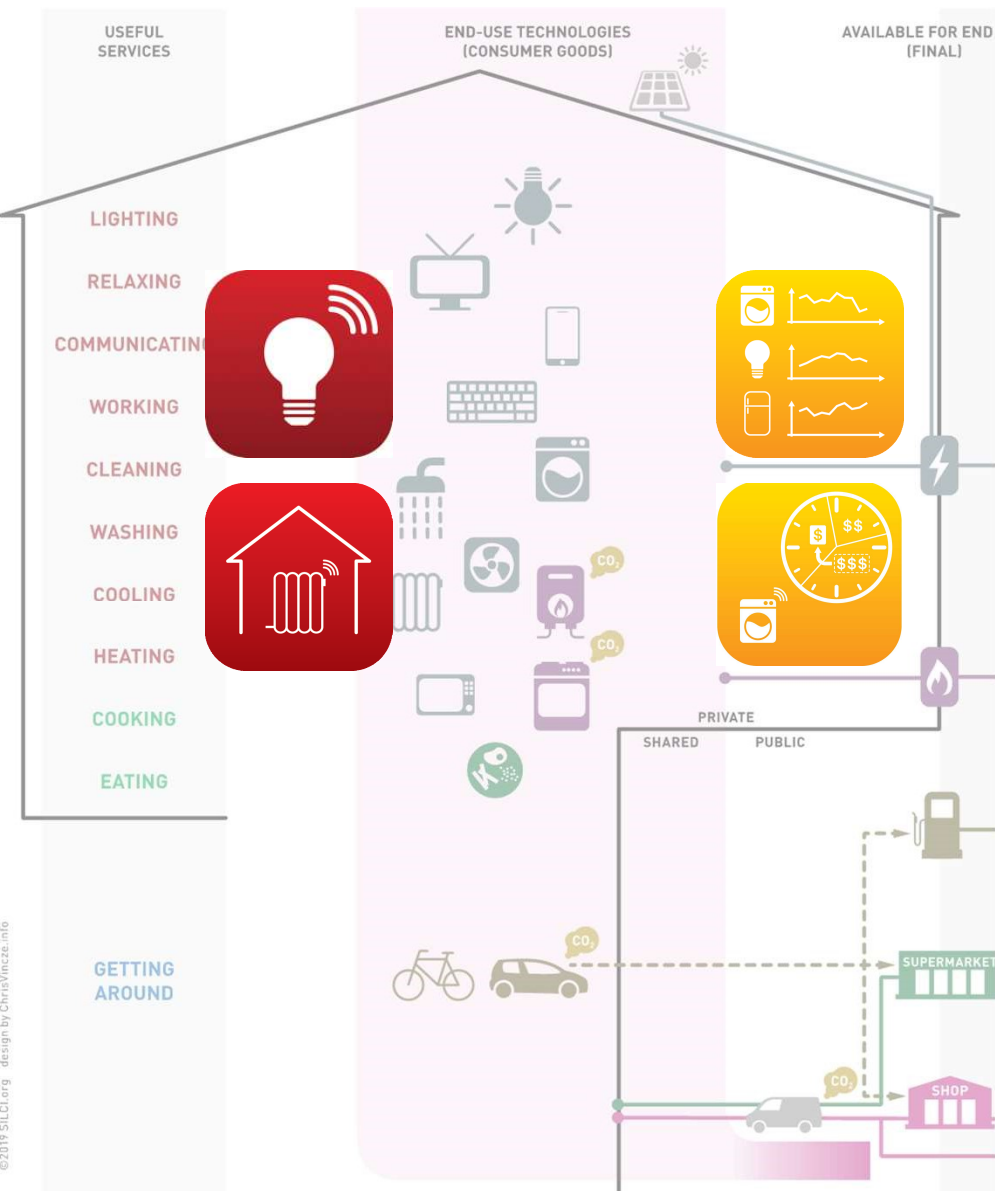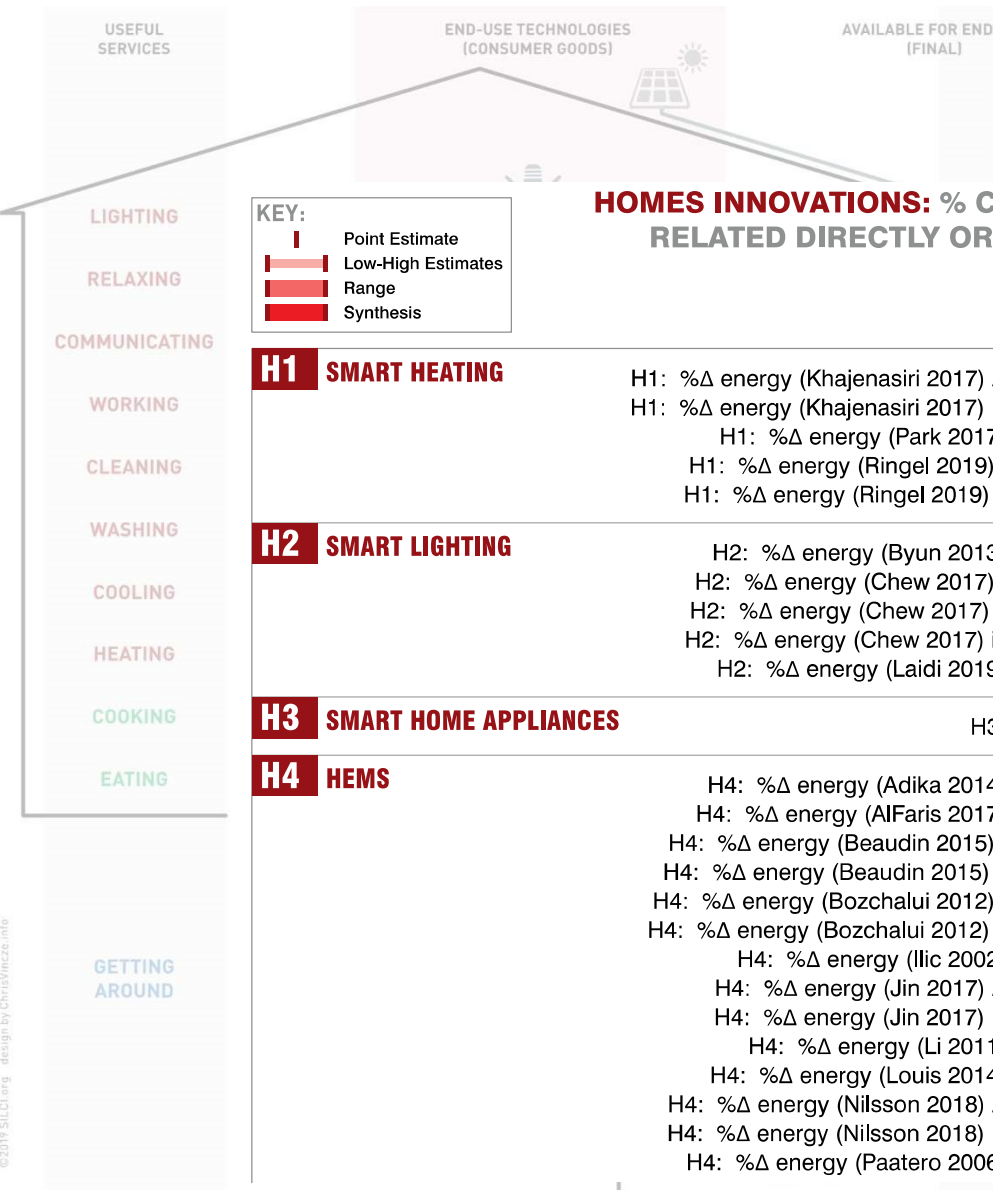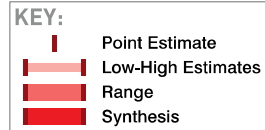
control

and manage resource use

HOMES INNOVATIONS: % CHANGE IN OUTCOME MEASURE
RELATED DIRECTLY OR INDIRECTLY TO EMISSIONS

USEFUL SERVICES

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END [FINAL]

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

GETTING AROUND

KEY:
| Point Estimate
├─┤ Low-High Estimates
▬ Range
▬ Synthesis

%Δ in activity, energy or carbon emissions

-100%   -80%   -60%   -40%   -20%   0%   +20%

H1 SMART HEATING

H1: %Δ energy (Khajenasiri 2017) A
H1: %Δ energy (Khajenasiri 2017) B
H1: %Δ energy (Park 2017)
H1: %Δ energy (Ringel 2019) i
H1: %Δ energy (Ringel 2019) ii

H2 SMART LIGHTING

H2: %Δ energy (Byun 2013)
H2: %Δ energy (Chew 2017) i
H2: %Δ energy (Chew 2017) ii
H2: %Δ energy (Chew 2017) iii
H2: %Δ energy (Laidi 2019)
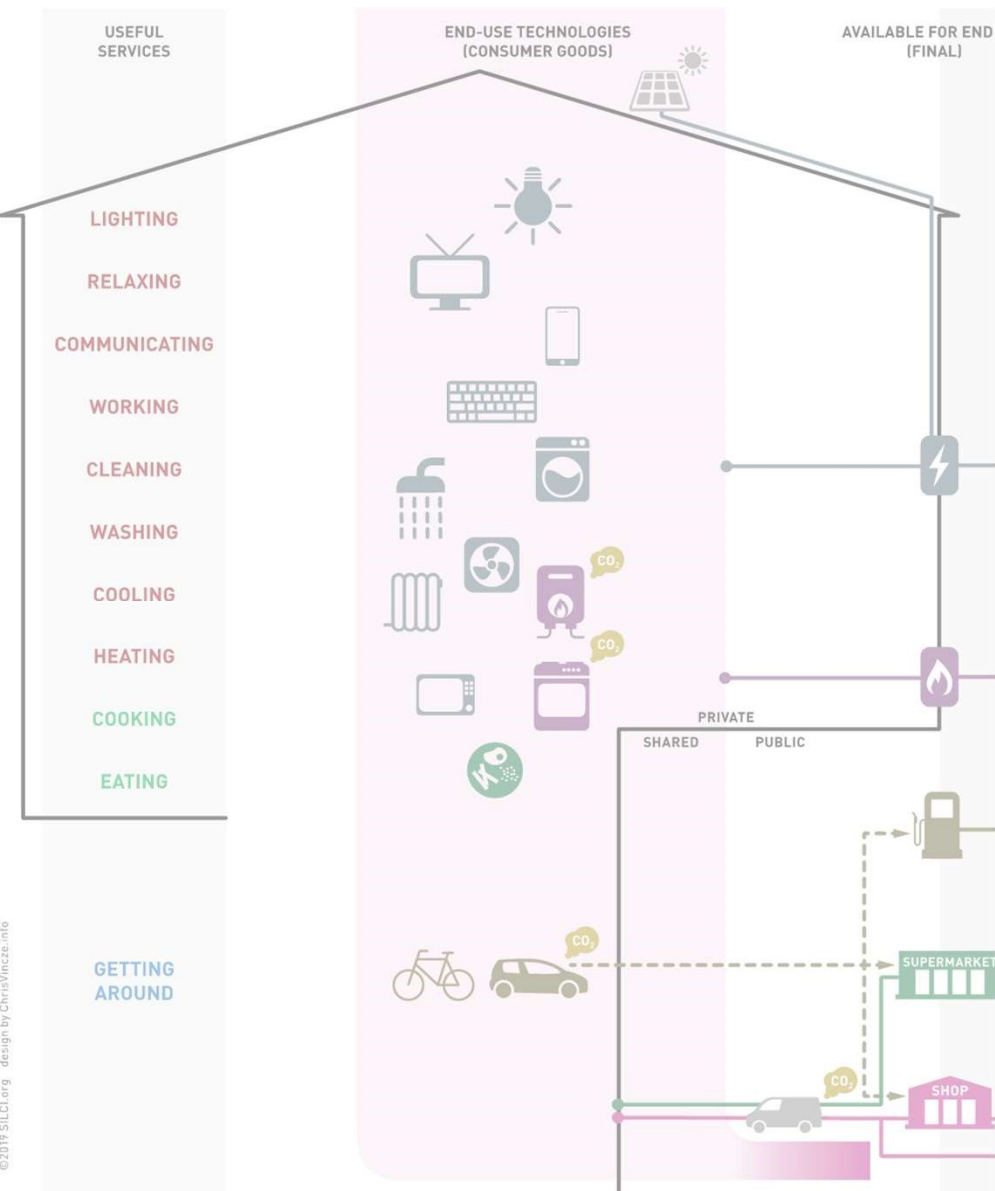
H3 SMART HOME APPLIANCES

H3:

H4 HEMS

H4: %Δ energy (Adika 2014)
H4: %Δ energy (AlFaris 2017)
H4: %Δ energy (Beaudin 2015) i
H4: %Δ energy (Beaudin 2015) ii
H4: %Δ energy (Bozchalui 2012) i
H4: %Δ energy (Bozchalui 2012) ii
H4: %Δ energy (Ilic 2002)
H4: %Δ energy (Jin 2017) A
H4: %Δ energy (Jin 2017) B
H4: %Δ energy (Li 2011)
H4: %Δ energy (Louis 2014)
H4: %Δ energy (Nilsson 2018) A
H4: %Δ energy (Nilsson 2018) B
H4: %Δ energy (Paatero 2006)
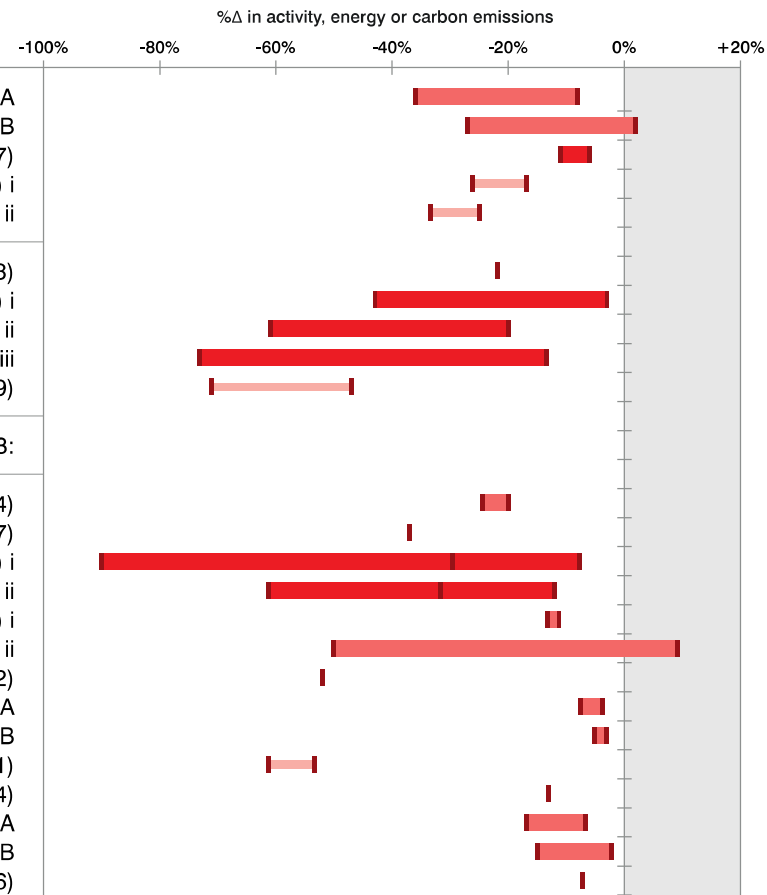
Source: Wilson et al. (2020). "Potential climate benefits of digital consumer innovations." *Annual Review of Environment and Resources* 45:113-144. doi.org/10.1146/annurev-environ-012320-082424

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USEFUL
SERVICES

END-USE TECHNOLOGIES
(CONSUMER GOODS)

AVAILABLE FOR END
(FINAL)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

PRIVATE

SHARED   PUBLIC

GETTING
AROUND

SUPERMARKET

SHOP

integrate
systems so they emit less carbon
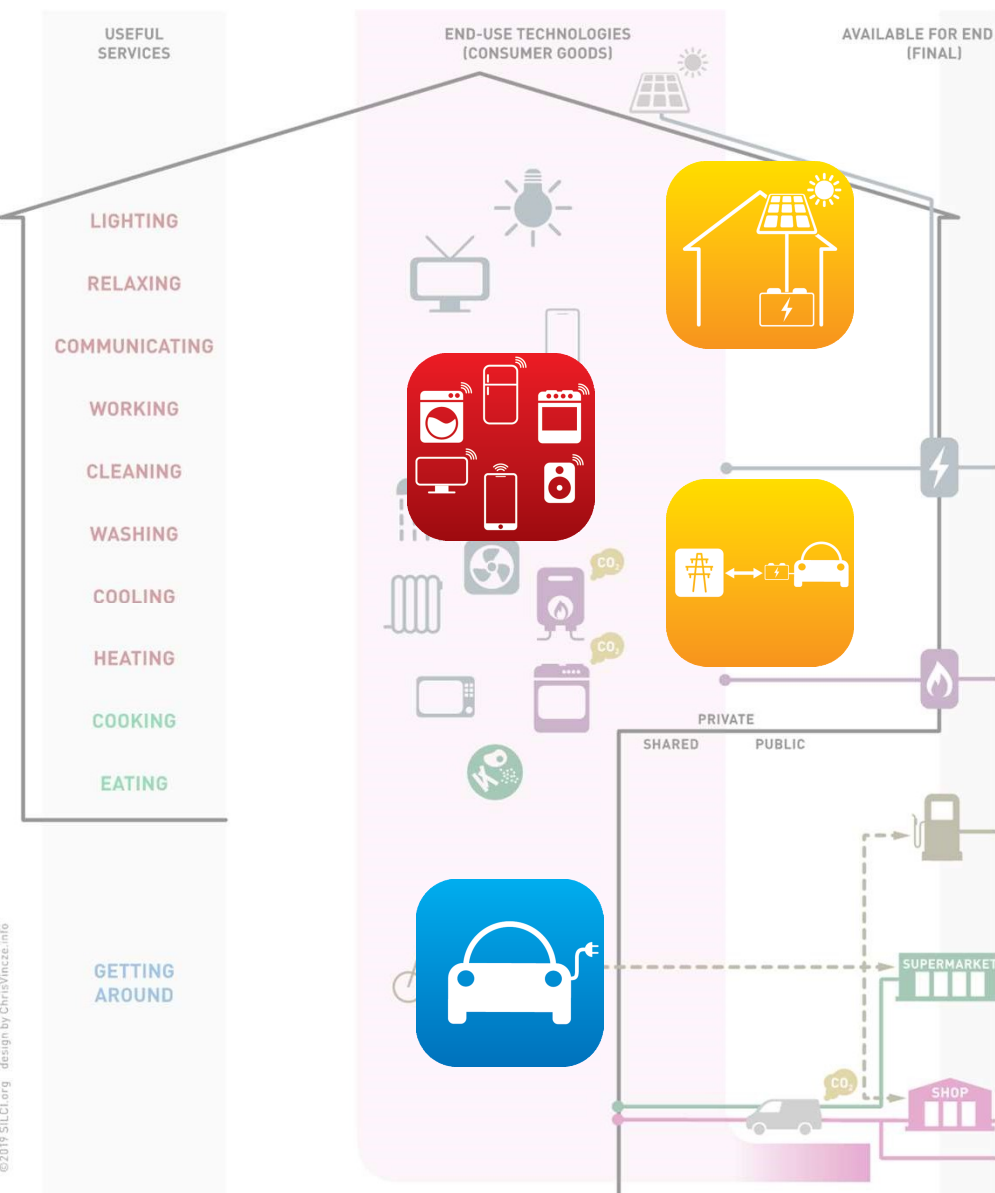
integrate

systems so they emit less carbon

ELECTRICITY SYSTEM OF THE PAST

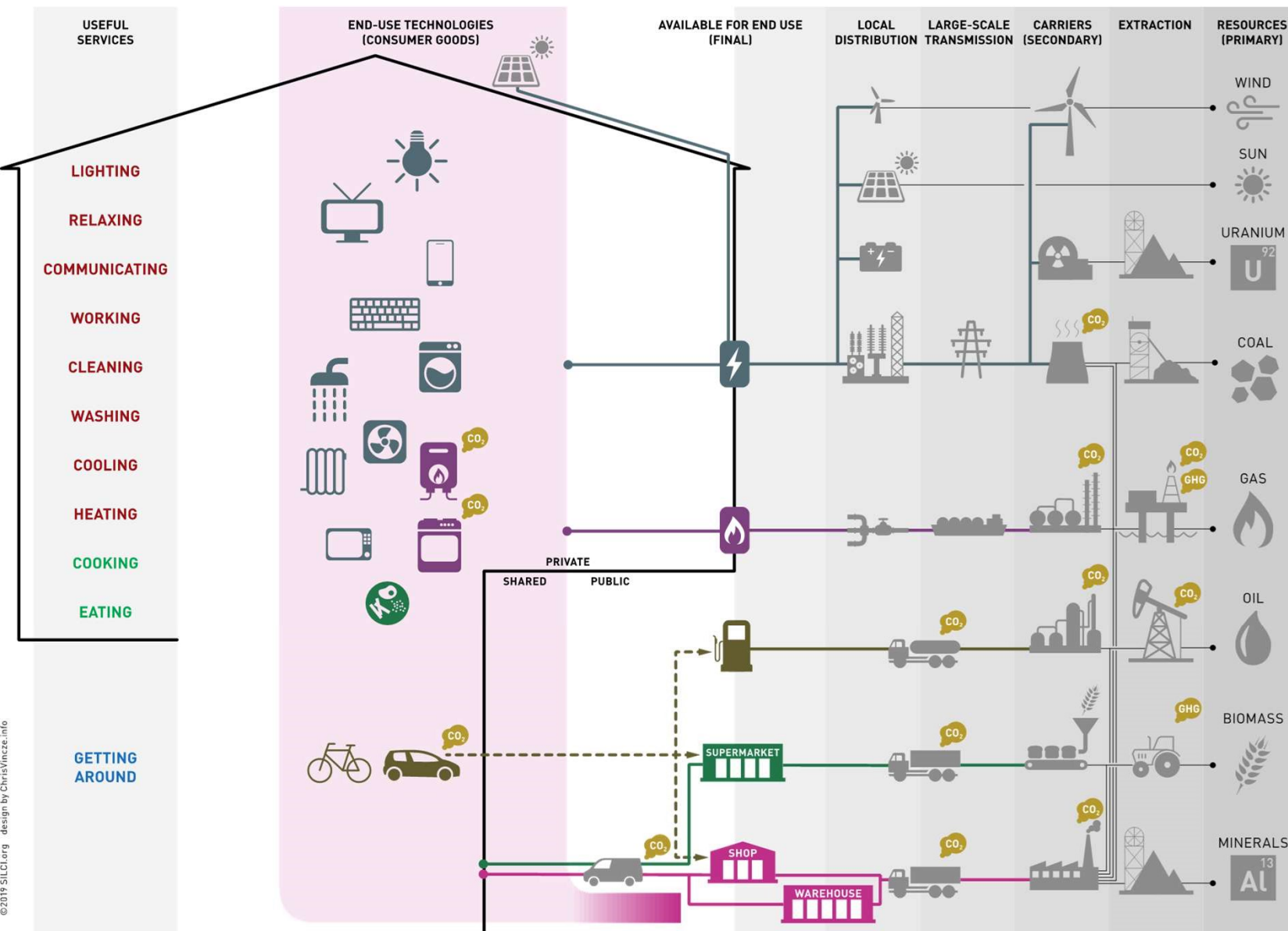| Few large and predictable power plants	Based on large power lines	Top to bottom	Centralised, mostly national	Passive, only paying
Generation	**Network infrastructure**	**Energy flows**	**Markets**	**Customers**
Many smaller sources but less predictable	Power lines and storage aided by smart digital tech	Both directions	Decentralised and interconnected	Empowered, participating

ELECTRICITY SYSTEM OF THE FUTURE

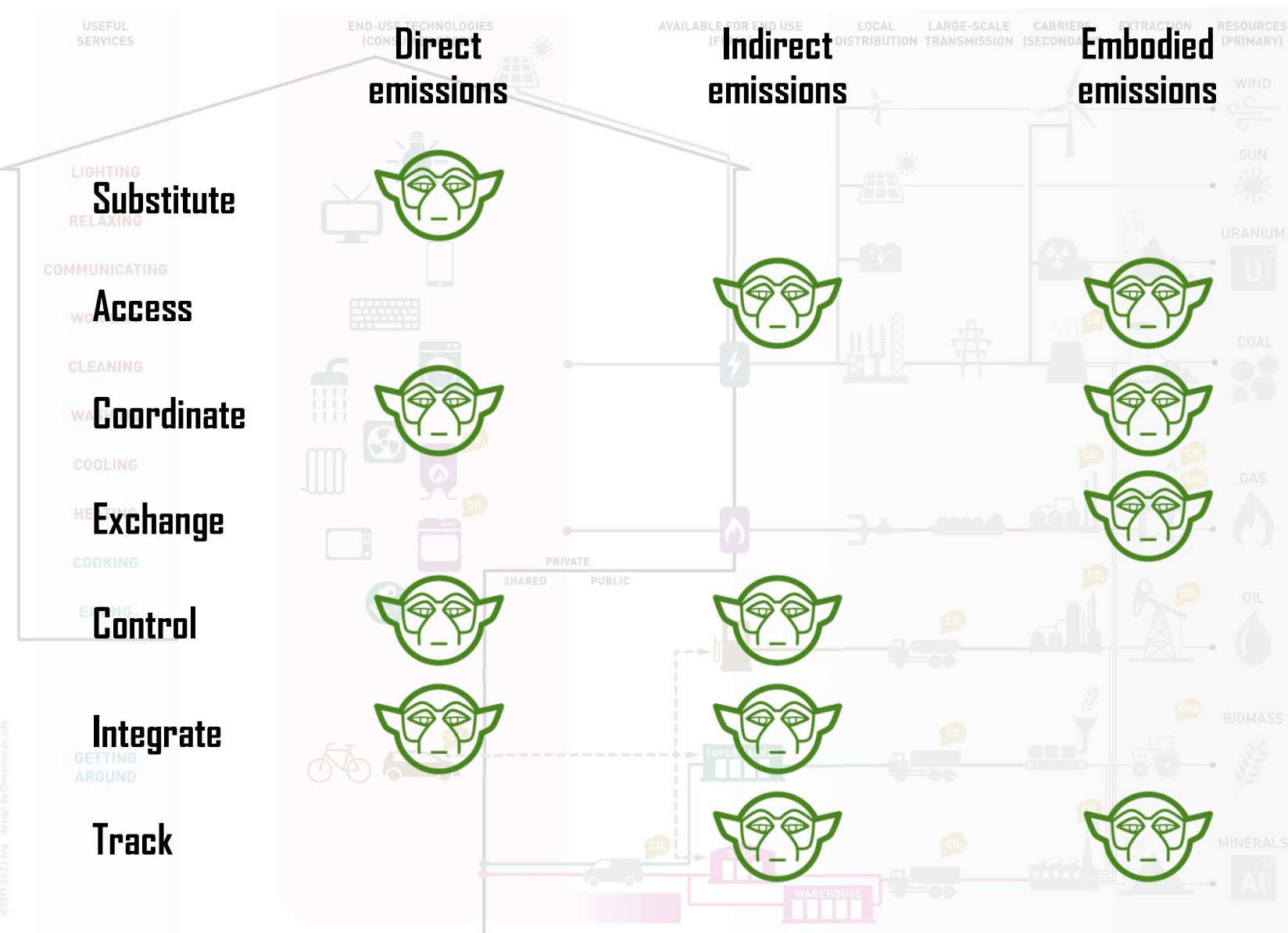Source: p70, BEIS (2020) Energy White Paper: Powering our net zero future.

track

CO$_2$ emissions of goods and services through supply chains

https://timbeter.com/solutions/log-counter/

USEFUL SERVICES

LIGHTING
RELAXING
COMMUNICATING
WORKING
CLEANING
WASHING
COOLING
HEATING
COOKING
EATING

GETTING AROUND

END-USE TECHNOLOGIES (CONSUMER GOODS)

PRIVATE
SHARED   PUBLIC

AVAILABLE FOR END USE (FINAL)

SUPERMARKET

SHOP

WAREHOUSE

LOCAL DISTRIBUTION

LARGE-SCALE TRANSMISSION

CARRIERS (SECONDARY)

EXTRACTION

RESOURCES (PRIMARY)

WIND
SUN
URANIUM
U 92
COAL
GAS
OIL
BIOMASS
MINERALS
Al 13

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Direct emissions

Indirect emissions

Embodied emissions

Substitute

Access

Coordinate

Exchange

Control

Integrate

Track

Rebound

Intensify

Distrust

Manipulate

Divide

Contaminate

Displace

USEFUL SERVICES

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

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GETTING AROUND

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END (FINAL)

PRIVATE

SHARED   PUBLIC

SUPERMARKET

SHOP

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rebound

increases activity as it becomes easier or cheaper

USEFUL SERVICES — END-USE TECHNOLOGIES (CONSUMER GOODS) — AVAILABLE FOR END (FINAL)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

GETTING AROUND

PRIVATE
SHARED   PUBLIC

SUPERMARKET

SHOP

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rebound
increases activity as it becomes easier or cheaper

Photo Credit: Steve Jurveston @Flickr. CC BY 2.0.

USEFUL SERVICES
- LIGHTING
- RELAXING
- COMMUNICATING
- WORKING
- CLEANING
- WASHING
- COOLING
- HEATING
- COOKING
- EATING
- GETTING AROUND

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END (FINAL)

PRIVATE
SHARED   PUBLIC

SUPERMARKET

SHOP

intensify

new forms of energy-hungry activity

Photo: johnlewis.com. (Note that alternative products and retailers are also available!)

USEFUL SERVICES

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

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SHARED   PUBLIC

SUPERMARKET

SHOP

intensify

new forms of energy-hungry activity

REUTERS

BIG STORY 10   FEBRUARY 18, 2020 / 11:05 AM
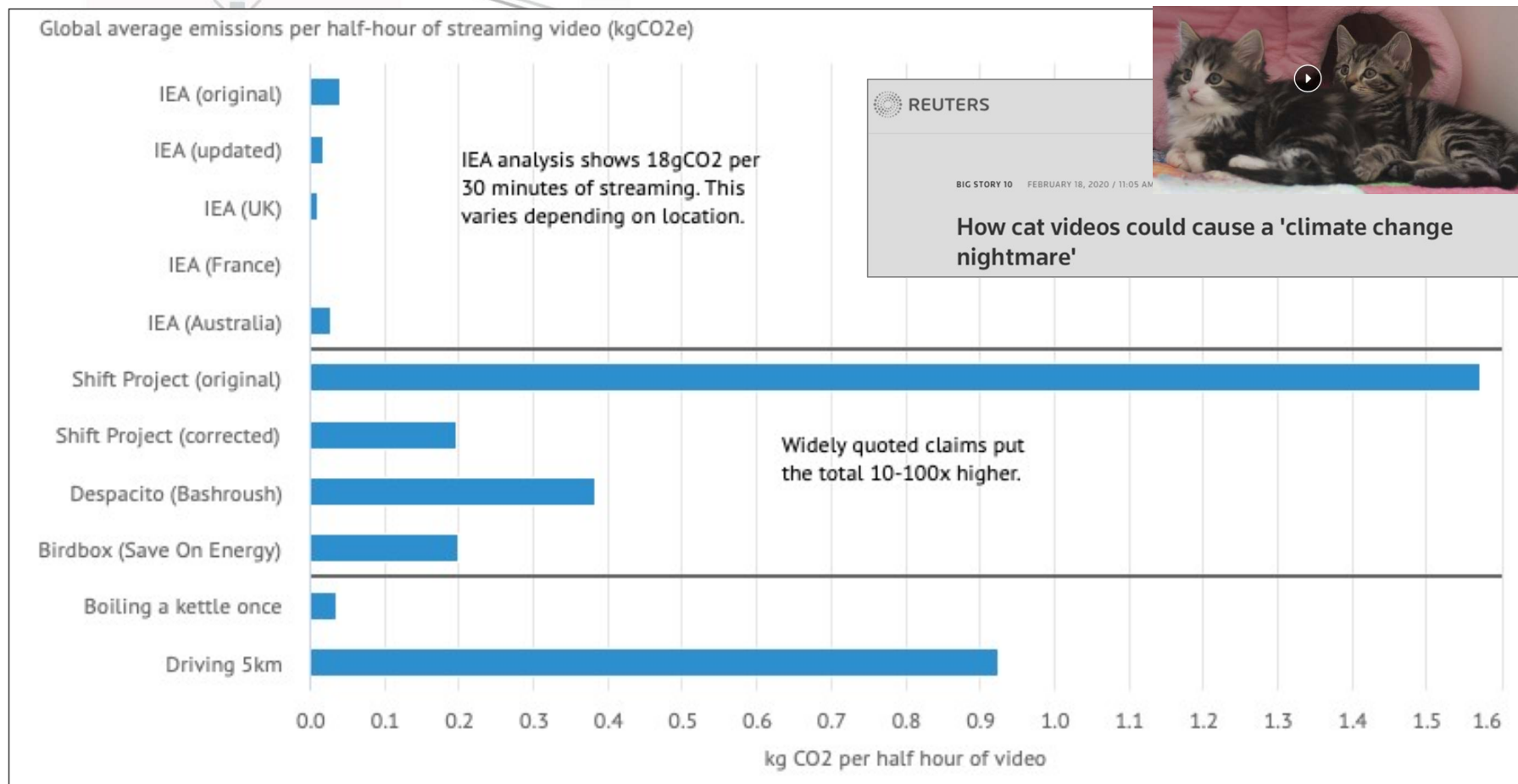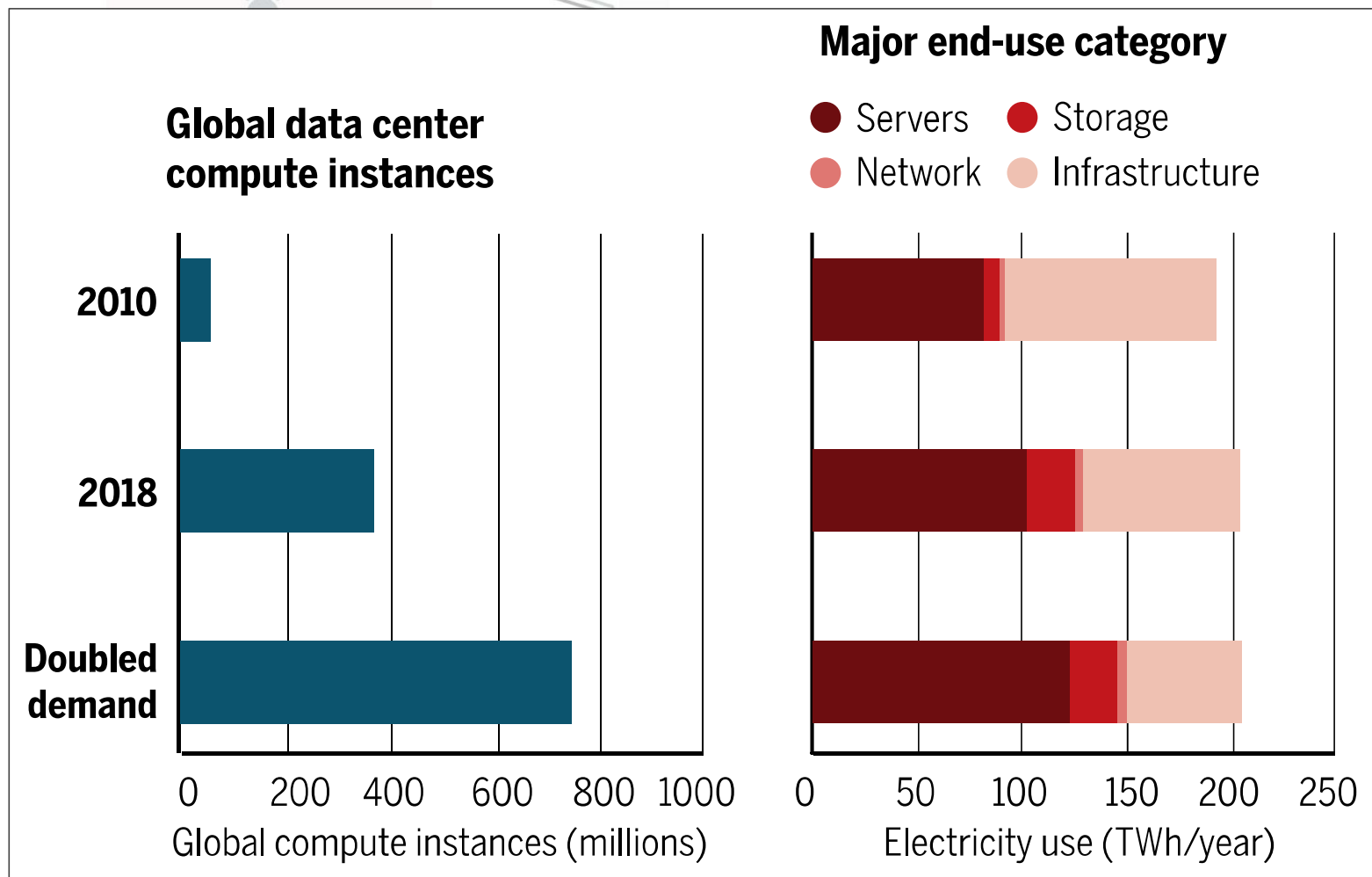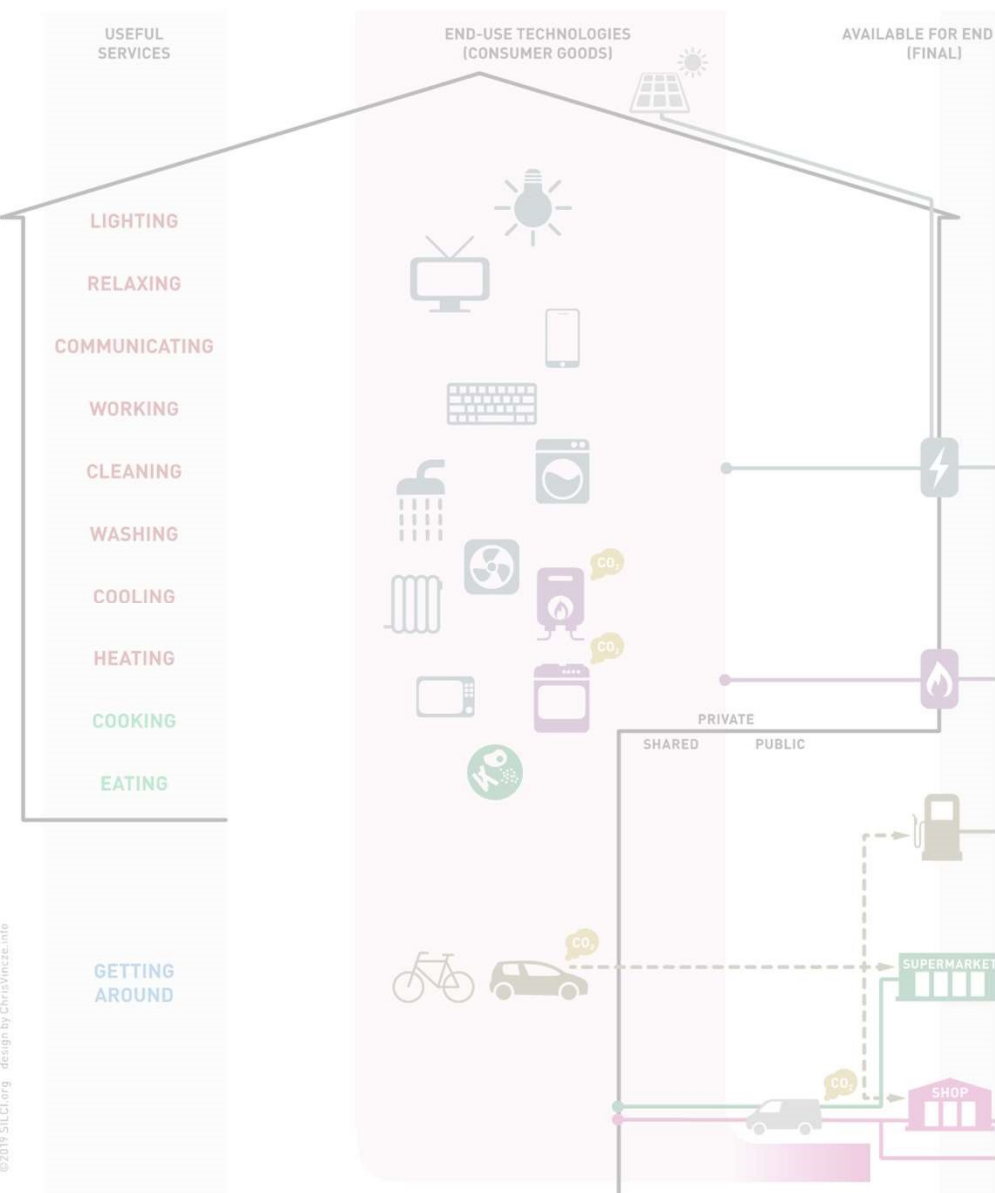
How cat videos could cause a 'climate change nightmare'

Figure: George Kamiya (IEA) in Carbon Brief. [https://www.carbonbrief.org/factcheck-what-is-the-carbon-footprint-of-streaming-video-on-netflix]. News Headline: [https://www.reuters.com/article/us-georgia-tech-climatechange-feature-tr-idUSKBN20C1A7]. Cat Video: Hehaden @Flickr. CC BY-NC 2.0.

intensify

new forms of energy-hungry activity

USEFUL SERVICES

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END (FINAL)

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RELAXING
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EATING

GETTING AROUND

Global average emissions per half-hour of streaming video (kgCO2e)

IEA (original)
IEA (updated)
IEA (UK)
IEA (France)
IEA (Australia)
Shift Project (original)
Shift Project (corrected)
Despacito (Bashroush)
Birdbox (Save On Energy)
Boiling a kettle once
Driving 5km

IEA analysis shows 18gCO2 per 30 minutes of streaming. This varies depending on location.

Widely quoted claims put the total 10-100x higher.

kg CO2 per half hour of video

REUTERS

BIG STORY 10   FEBRUARY 18, 2020 / 11:05 AM

How cat videos could cause a 'climate change nightmare'

Figure: George Kamiya (IEA) in Carbon Brief. [https://www.carbonbrief.org/factcheck-what-is-the-carbon-footprint-of-streaming-video-on-netflix]. News Headline: [https://www.reuters.com/article/us-georgia-tech-climatechange-feature-tr-idUSKBN20C1A7]. Cat Video: Hehaden @Flickr. CC BY-NC 2.0.

USEFUL SERVICES

END-USE TECHNOLOGIES (CONSUMER GOODS)

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Global data center compute instances

Major end-use category

- ● Servers
- ● Storage
- ● Network
- ● Infrastructure

2010

2018

Doubled demand

0   200   400   600   800   1000
Global compute instances (millions)

0   50   100   150   200   250
Electricity use (TWh/year)

Source: Figure 2, Masanet et al. (2020). *Science* 367: 984-986.

distrust

service providers and data flows

"Recent inventions and business methods call attention to the next step which must be taken for the protection of the person, and for securing 'the right to be let alone'."

Source: Warren & Brandeis, *Harvard Law Review*.

distrust
service providers and data flows

Photo Credit: Paolo Trabattoni @Flickr. CC BY 2.0

"Recent inventions and business methods call attention to the next step which must be taken for the protection of the person, and for securing 'the right to be let alone'."

Source: Warren & Brandeis, *Harvard Law Review*.
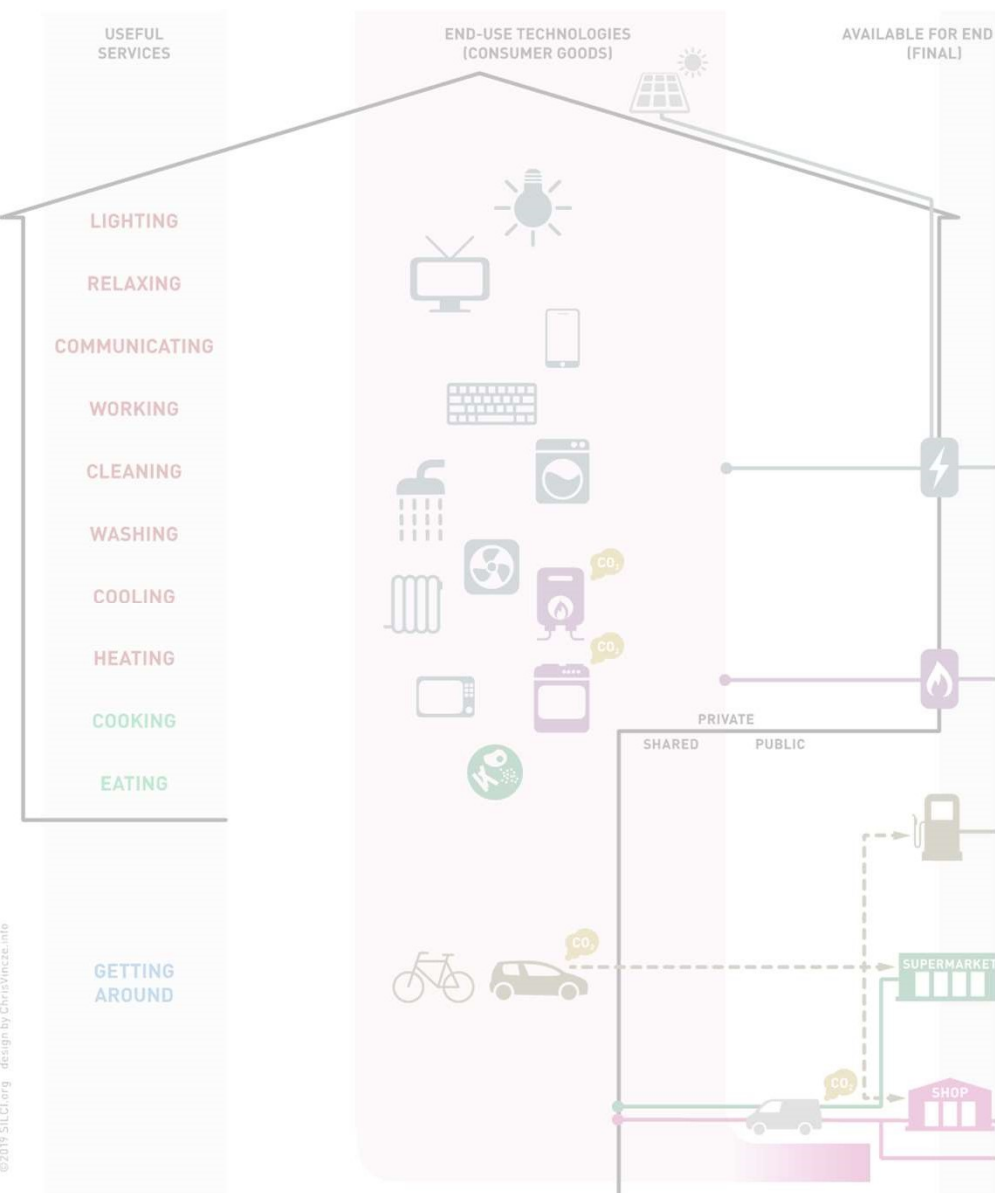
distrust
service providers and data flows

Annual revenue of Google from 2002 to 2020
(in billion U.S. dollars)

Year	Revenue
2002	0.4
2003	1.5
2004	3.2
2005	6.1
2006	10.6
2007	16.6
2008	21.8
2009	23.7
2010	29.3
2011	37.9
2012	50.18
2013*	55.51
2014	65.67
2015	74.54
2016	89.98
2017	110.55
2018	136.36
2019	160.74
2020	181.69

© Statista 2021

Source: https://www.statista.com/statistics/266206/googles-annual-global-revenue/

distrust

service providers and data flows

Number of monthly active Facebook users worldwide

3,000m
2,797m

Facebook users
2.8 billion

World population
7.8 billion

Internet users
4.9 billion

2,000m

1,000m

1m

0m
2004   '10   '15   '20

Facebook users as of the end of the respective year;
world population and internet usage estimates as of Dec. 31, 2020
Sources: Facebook, Internet World Stats

statista

USEFUL SERVICES

- LIGHTING
- RELAXING
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- GETTING AROUND

END-USE TECHNOLOGIES (CONSUMER GOODS)

AVAILABLE FOR END (FINAL)

PRIVATE
SHARED   PUBLIC
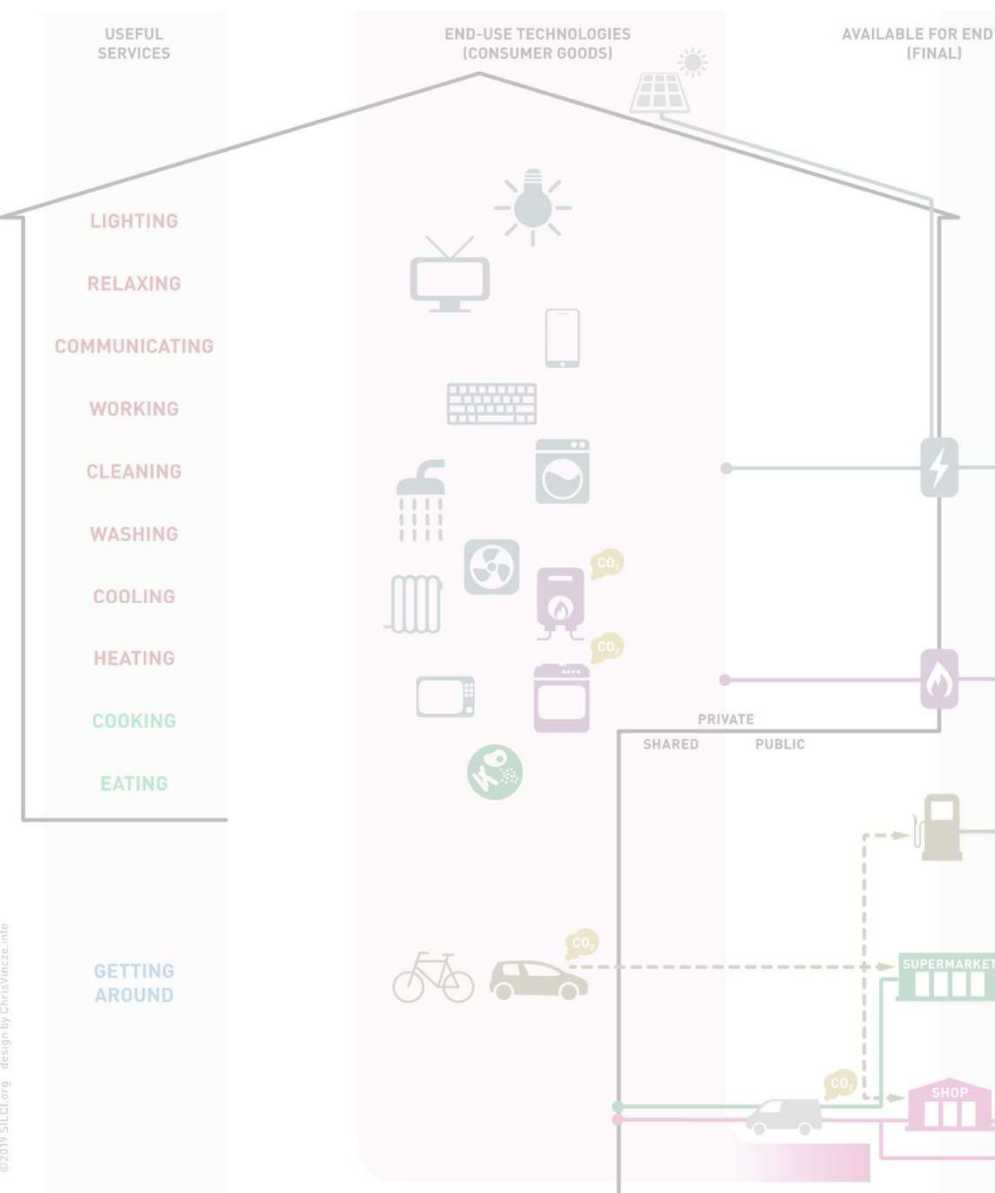
manipulate
'predict' and control behaviour

THE AGE OF SURVEILLANCE CAPITALISM

THE FIGHT FOR A HUMAN FUTURE AT THE NEW FRONTIER OF POWER

SHOSHANA ZUBOFF

TOO SMART

HOW DIGITAL CAPITALISM IS EXTRACTING DATA, CONTROLLING OUR LIVES, AND TAKING OVER THE WORLD
JATHAN SADOWSKI
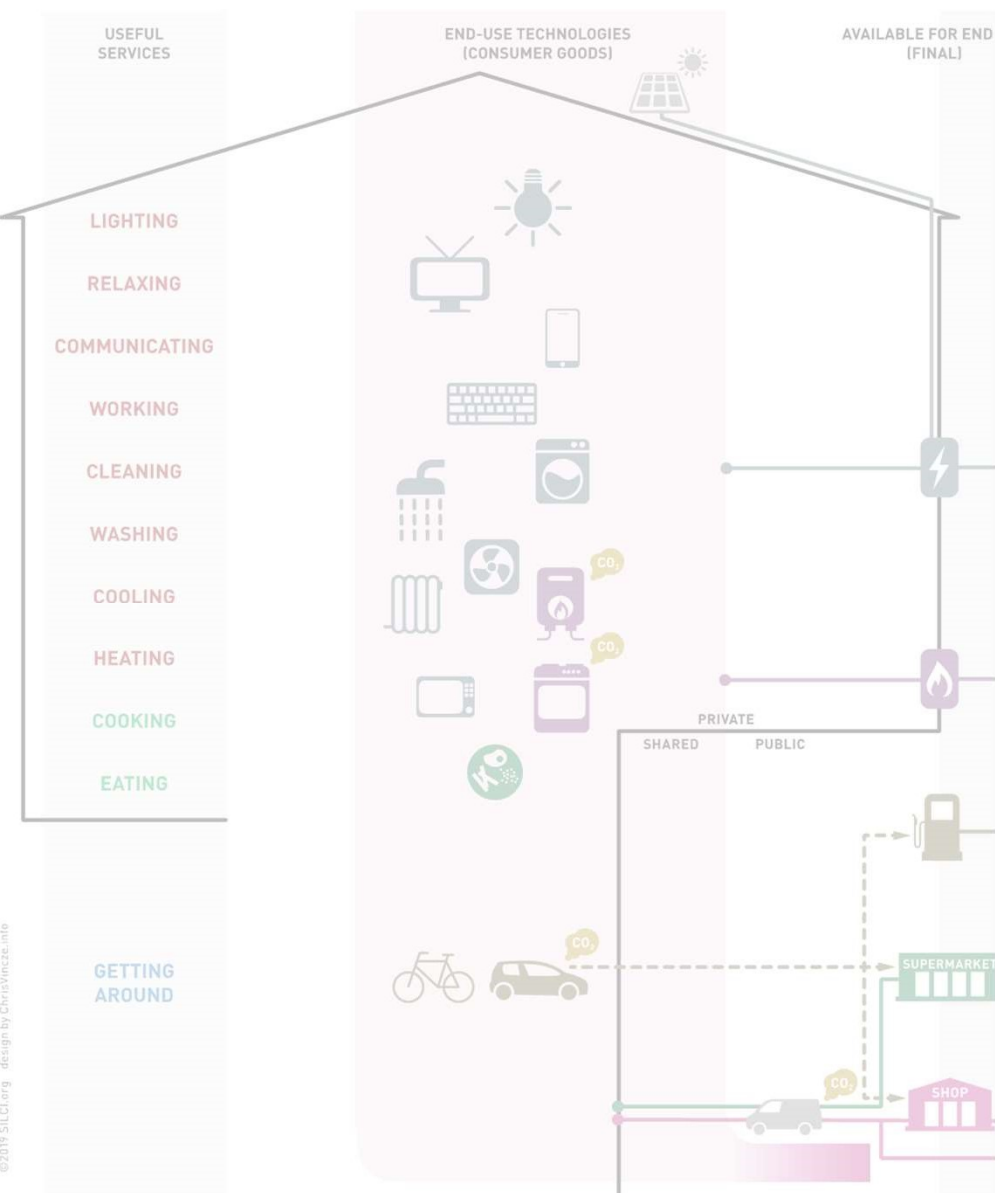
divide
society into digital haves
and have nots

Figure 13: Proportion of regional population with zero Basic Digital Skills. Source 2a

Scotland 7%
North East 12%
Yorkshire & Humberside 6%
North West 10%
East Midlands 9%
West Midlands 9%
East England 8%
Wales 19%
South East 5%
South West 9%
London 6%

Base too small
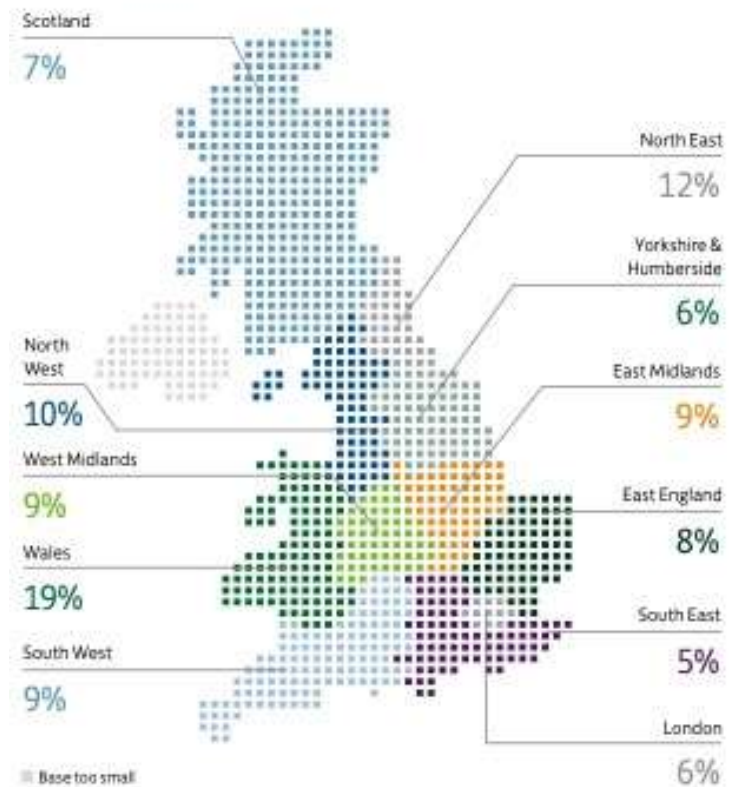
Source: p20, Lloyds (2018) UK Consumer Digital Index.

divide

society into digital haves
and have nots

IDI 2017 Value

| 0 – 3 | 4 – 5 | 6 – 7 | 8 – 10 | No Data |
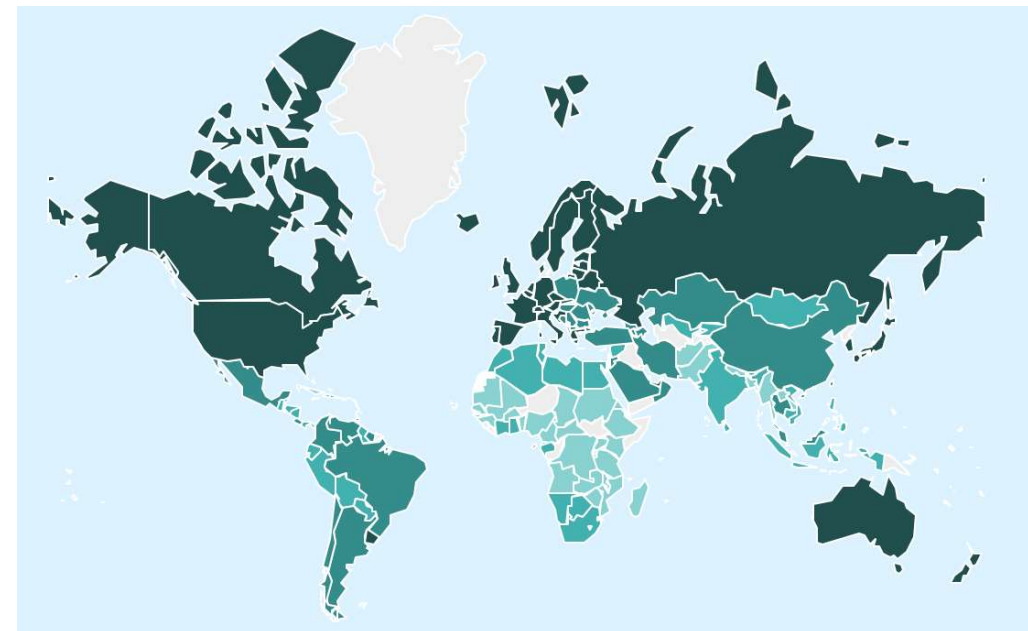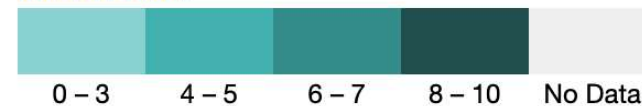
Source: ITU (2017) ICT Development Index.
https://www.itu.int/net4/ITU-D/idi/2017/index.html#idi2017map-tab
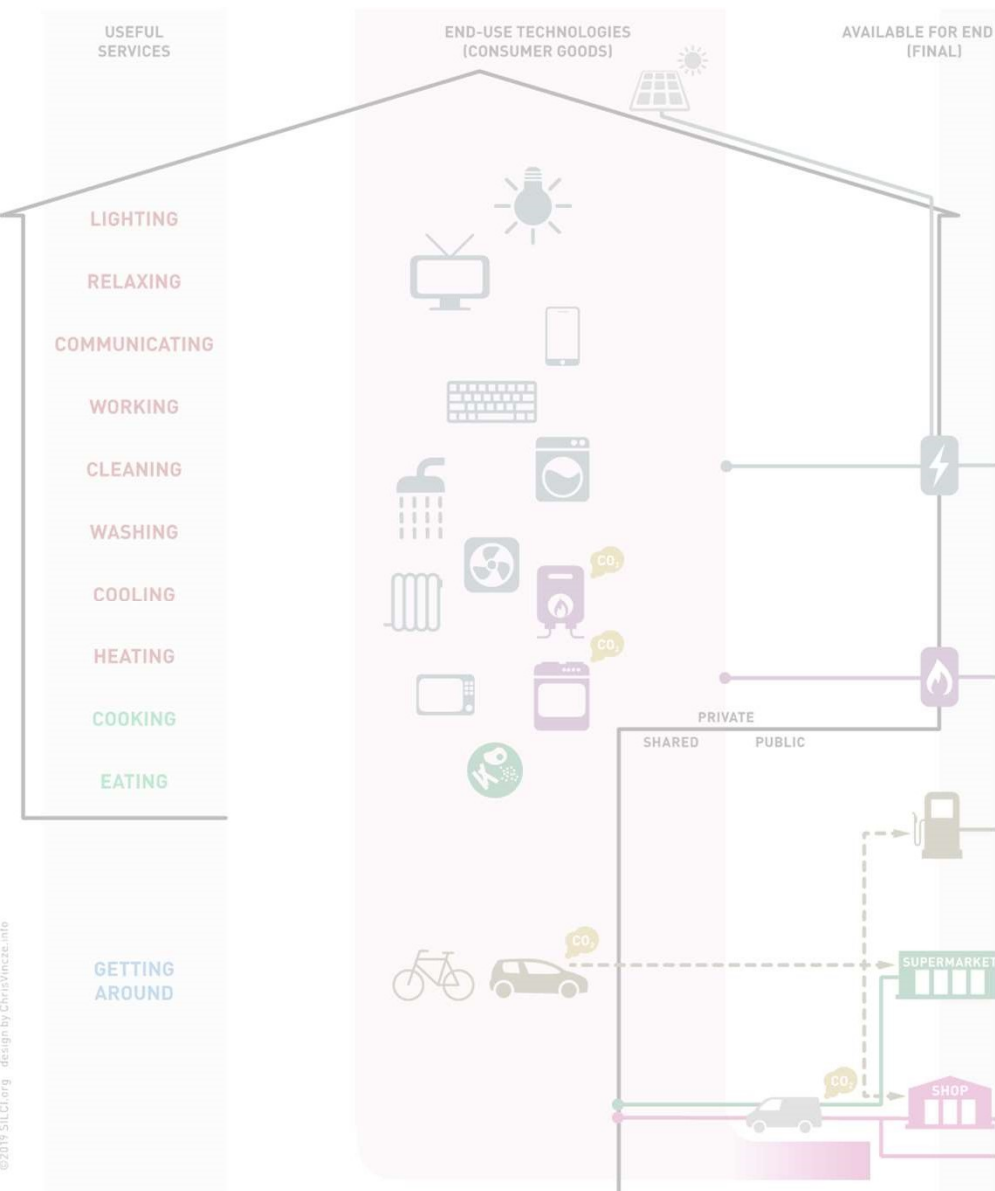
contaminate
local environments and peoples through mining and waste

USEFUL
SERVICES

END-USE TECHNOLOGIES
(CONSUMER GOODS)

AVAILABLE FOR END
(FINAL)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

PRIVATE

SHARED   PUBLIC

GETTING
AROUND

SUPERMARKET

SHOP

CO₂

CO₂

CO₂

CO₂

CO₂

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displace
jobs and livelihoods through automation

Technical feasibility, % of time spent on activities that can be automated by adapting currently demonstrated technology

9	18	20	25	64	69	78

Least susceptible   *Less susceptible*   *Highly susceptible*

Time spent in all US occupations, %

7	14	16	12	17	16	18

Managing others   Applying expertise[1]   Stakeholder interactions   Unpredictable physical work[2]   Data collection   Data processing   Predictable physical work[2]

Substitute

Access

Coordinate

Exchange

Control

Integrate

Track
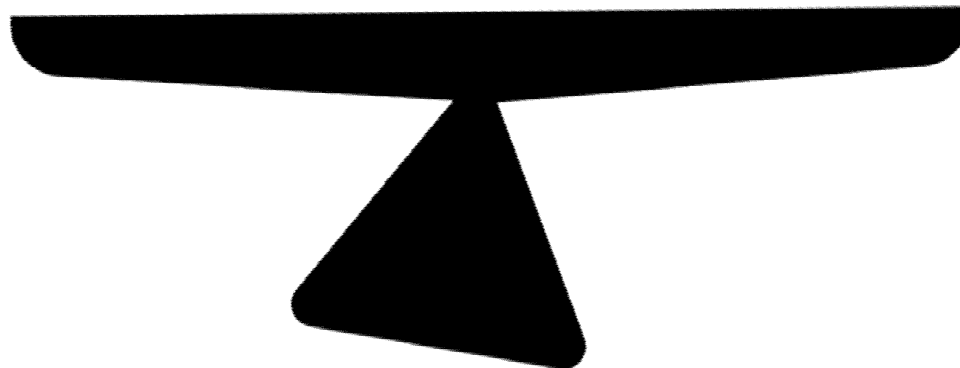
Rebound

Intensify

Distrust

Manipulate

Divide

Contaminate

Displace

So ... what does the future hold? Illustrative pathways for digitalisation in the Anthropocene.
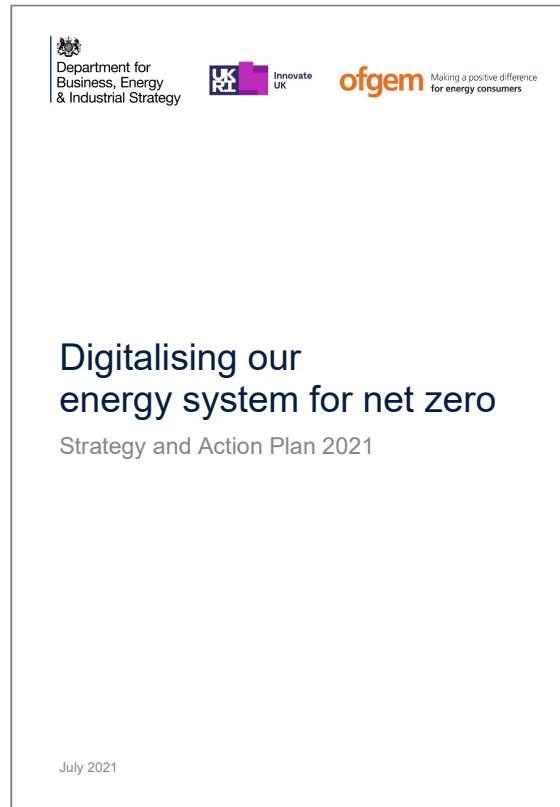
(unpublished figure from Felix Creutzig).

So ... what does the future hold? Illustrative pathways for digitalisation in the Anthropocene.
(unpublished figure from Felix Creutzig).
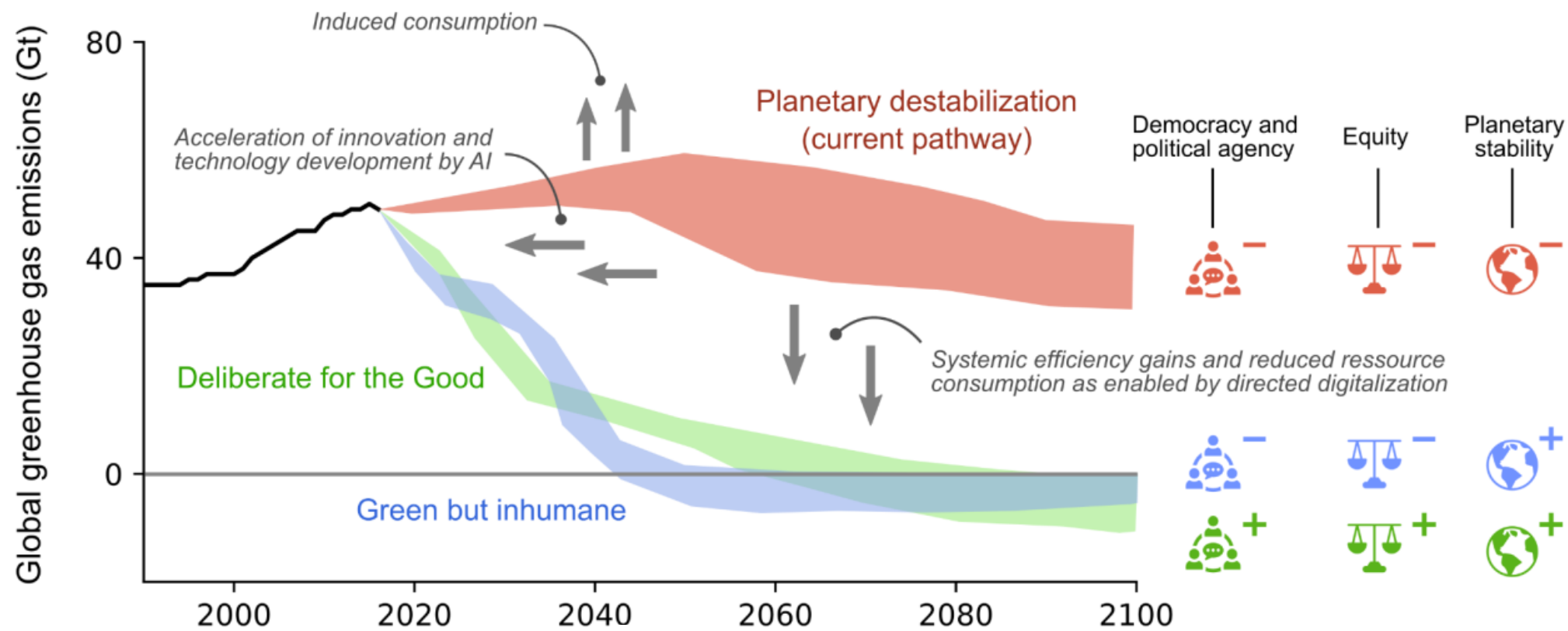
'Directed digitalisation' for public purpose:
(1) *policy & regulation*

Digital technology and the planet
Harnessing computing to achieve net zero
THE ROYAL SOCIETY

Department for Business, Energy & Industrial Strategy
UKRI Innovate UK
ofgem Making a positive difference for energy consumers

Digitalising our energy system for net zero
Strategy and Action Plan 2021

July 2021

WBGU
German Advisory Council on Global Change

Flagship Report

Towards Our Common Digital Future

'Directed digitalisation' for public purpose:
(2) *social contract for the digital age*

THE MONTREAL STATEMENT ON SUSTAINABILITY IN THE DIGITAL AGE

PREAMBLE	WE RECOGNIZE	WE ASK

*"Two major forces shaping the future of human civilisation: anthropogenic **climate change** and the **digital revolution** …*

*recognizing the severity of the **risks** and the magnitude of the **opportunity**,*

*we call for a **global collaboration** among business, civil society, researchers, and innovators to focus on leveraging the digital age to help build a sustainable and equitable world."*

WE ASK
1. A New Social Contract for the Digital Age
2. Open and Transparent Access to Data and Knowledge
3. Public-Private Collaborations
4. Research and Innovation
5. Targeted Communication, Engagement, and Education

'Directed digitalisation' for public purpose:
(3) *us as users and innovators* - experiment, resist, adapt

Global greenhouse gas emissions from human activity

- Growing things 19%
- Plugging things in 27%
- Heating and cooling things 7%
- Moving things around 16%
- Making things 31%
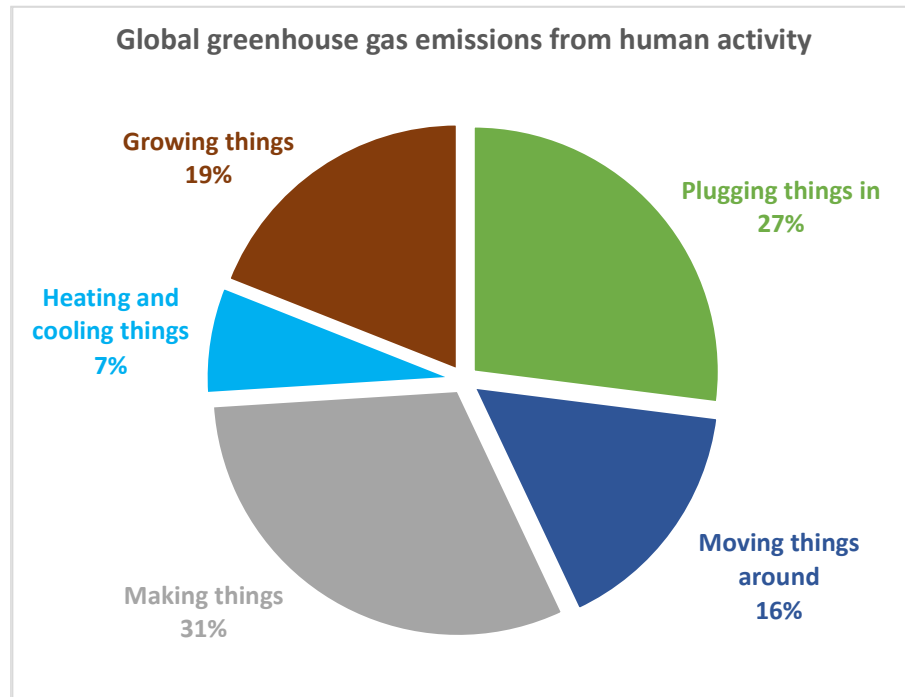
Source: Based o n Breakthrough data.
[https://www.breakthroughenergy.org/our-challenge/the-grand-challenges]

The digitalisation of daily life and its impacts on climate change

Charlie Wilson
Oxford Martin School & Oxford Energy Network
8 March, 2022

iDODDLE

idoddle.org

eci UNIVERSITY OF OXFORD

Environmental *Change* Institute
SCHOOL OF GEOGRAPHY AND THE ENVIRONMENT

Extra slides

- RISKS

intensify

new forms of energy-hungry activity

intensify

new forms of energy-hungry activity

Historical Bitcoin network power demand

Select an area by dragging across the lower chart

Zoom 1m 3m 6m YTD 1y All   01-2017 → 03-2022

Cambridge Bitcoin Electricity Consumption Index

divide

society into digital haves and have nots

Daily internet users during the three months preceding the survey, 2019 (% of people aged 16-74 years, by NUTS 2 regions)
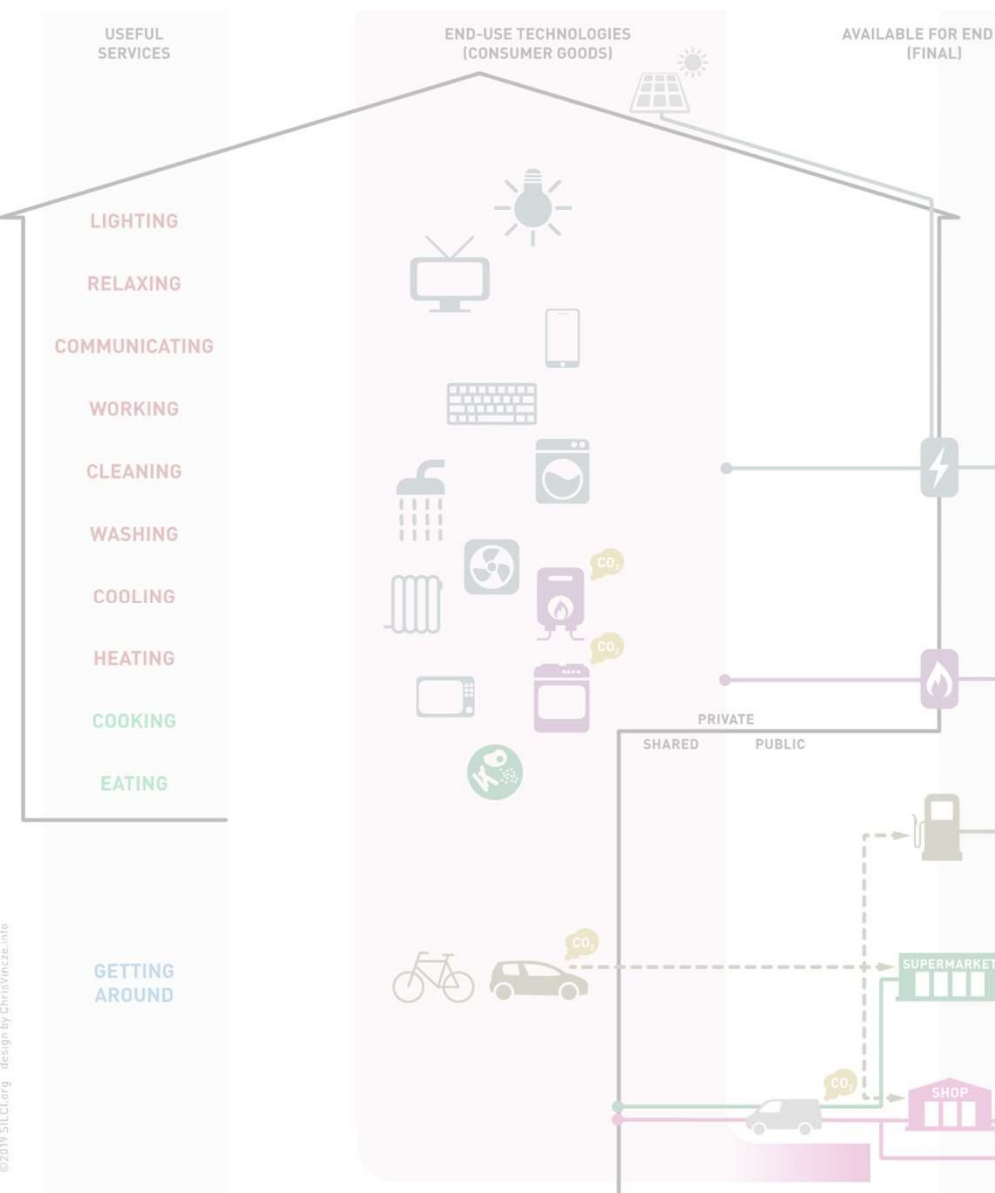EU-27 = 77

- < 60
- 60 - < 70
- 70 - < 80
- 80 - < 90
- ≥ 90
- Data not available
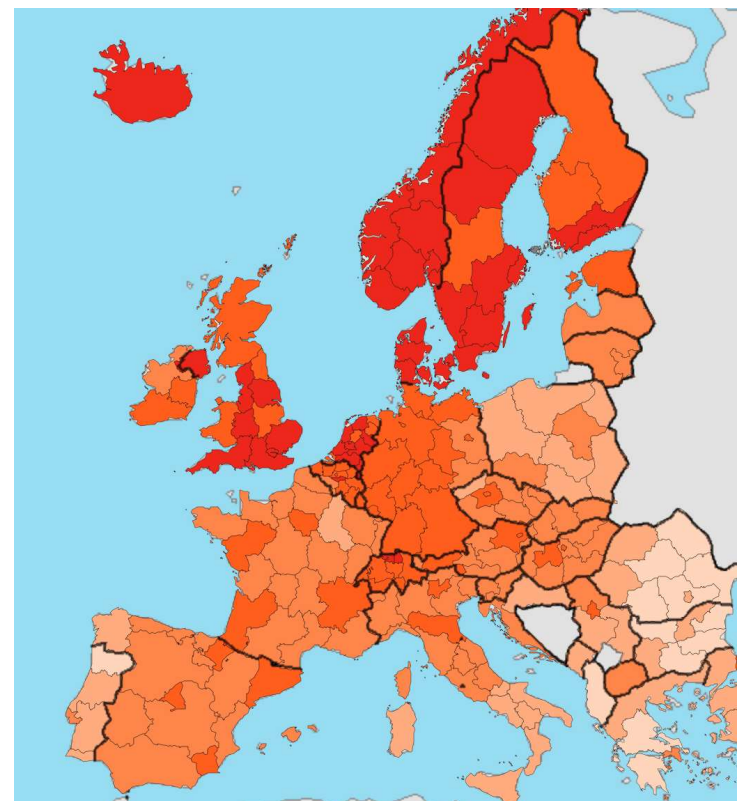
Source: Eurostat Statistical Atlas (2020). Regional yearbook 2020.

Extra slides

- UPSTREAM EFFECTS

USEFUL
SERVICES

END-USE TECHNOLOGIES
(CONSUMER GOODS)

AVAILABLE FOR END
(FINAL)

LIGHTING

RELAXING

COMMUNICATING

WORKING

CLEANING

WASHING

COOLING

HEATING

COOKING

EATING

GETTING
AROUND

PRIVATE

SHARED   PUBLIC

SUPERMARKET

SHOP

Beyond our more direct
experiences of digitalisation
in 'daily life',

there are many other
transformative impacts ...

Socio-economic trends

Legend: OECD, BRICS, Others

Population — Billion (y-axis), Year (x-axis)

Real GDP — Trillion US dollars (y-axis), Year (x-axis)

Foreign direct investment — Trillion US dollars (y-axis), Year (x-axis)

Urban population — Billion (y-axis), Year (x-axis)

Fertilizer consumption — Million tonnes (y-axis), Year (x-axis)

Transportation — Million motor vehicles (y-axis), Year (x-axis)

Telecommunications — Billion phone subscriptions (y-axis), Year (x-axis)
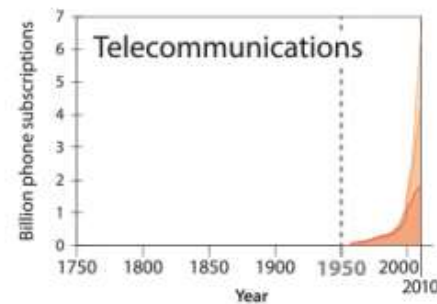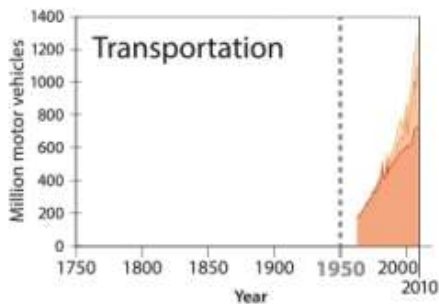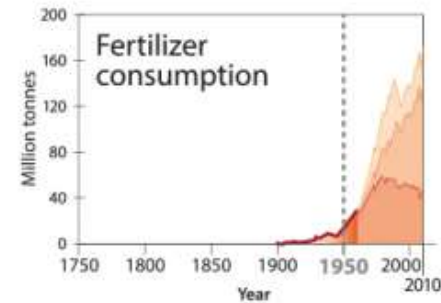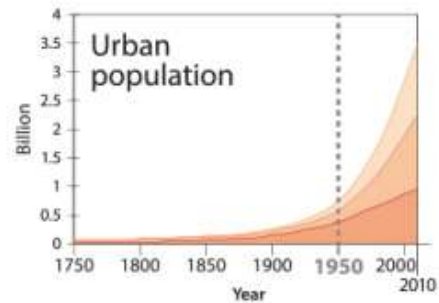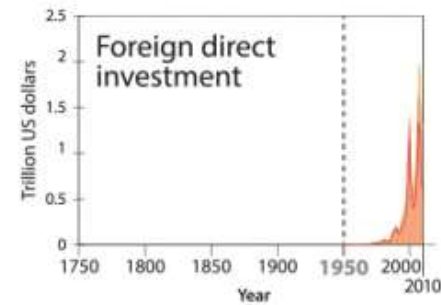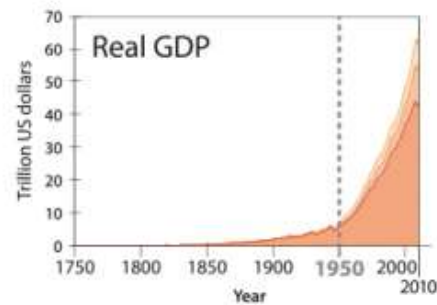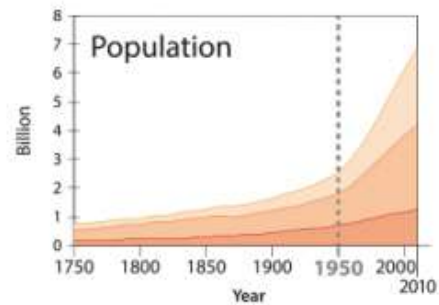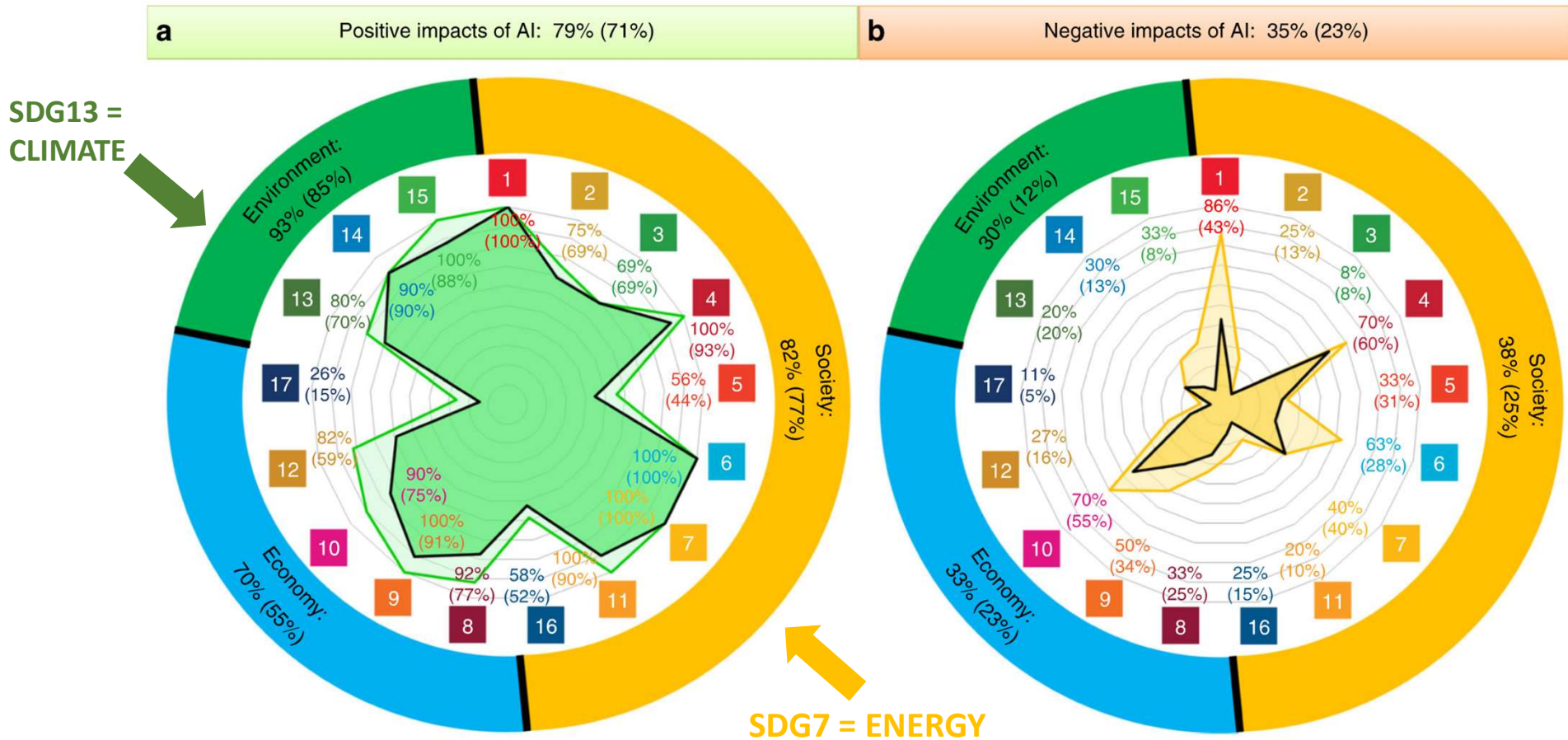
Steffen et al. (2015). "The trajectory of the Anthropocene: The Great Acceleration."
The Anthropocene Review 2 (1):81-98. doi.org/10.1177/2053019614564785.
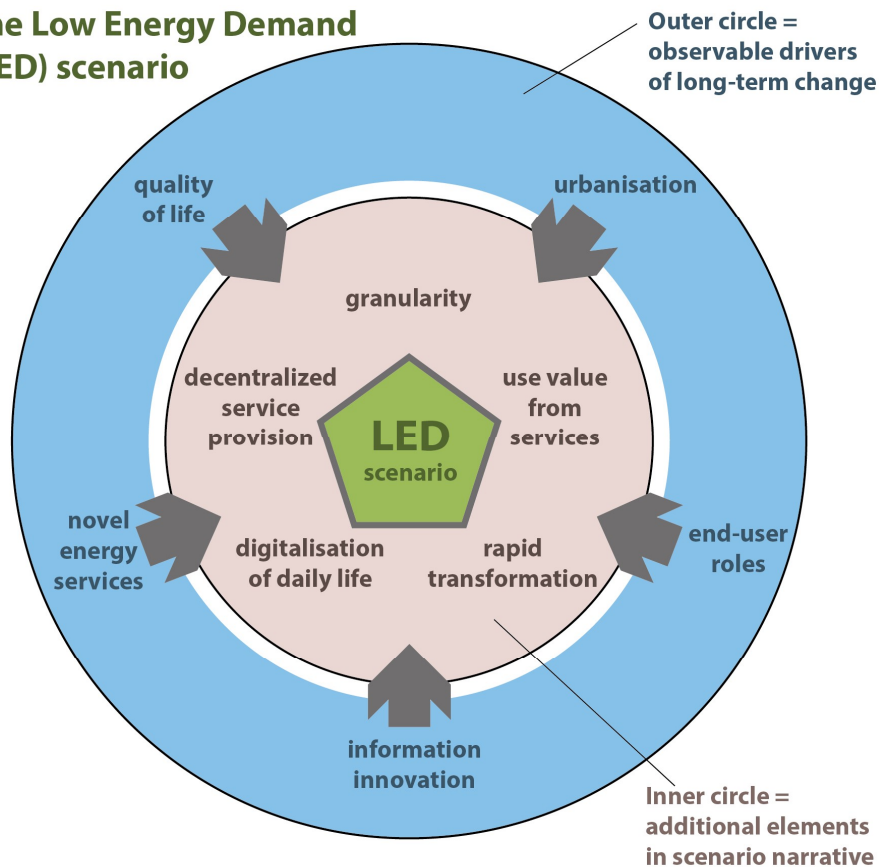
Extra slides

- FUTURE PATHWAYS

AI is expected to have clear net positive impacts on 17 UN SDGs and 169 targets

SDG13 = CLIMATE

SDG7 = ENERGY

Vinuesa et al. (2020). "The role of artificial intelligence in achieving the Sustainable Development Goals." *Nature Communications* 11(1): 233.
doi.org/10.1038/s41467-019-14108-y

Digitalisation is a transformative force 'harnessed' in an imagined low energy demand and 1.5°C future world ...

The Low Energy Demand (LED) scenario

Outer circle = observable drivers of long-term change

quality of life

urbanisation

granularity

decentralized service provision

use value from services

LED scenario

novel energy services

digitalisation of daily life

rapid transformation

end-user roles

information innovation

Inner circle = additional elements in scenario narrative

Source: Grubler, Wilson et al. (2018) *Nature Energy*.

END-USE SECTORS - *EXAMPLES*

- urban-scale shared vehicle fleets

- smart controls of building energy flows

- physical-to-digital substitution

- managed rebound in activity levels

UPSTREAM SECTORS - *EXAMPLES*

- rapid integration of intermittent renewables (60% of primary energy by 2050)

- electrification of transport & vehicle-to-grid

Scenario studies are starting to explicitly factor in digitalisation as a transformative force.
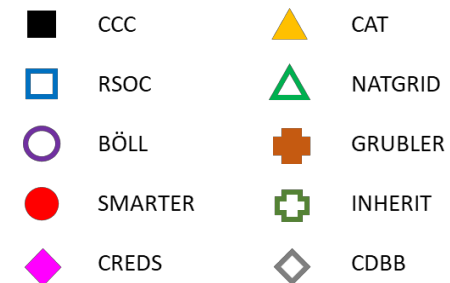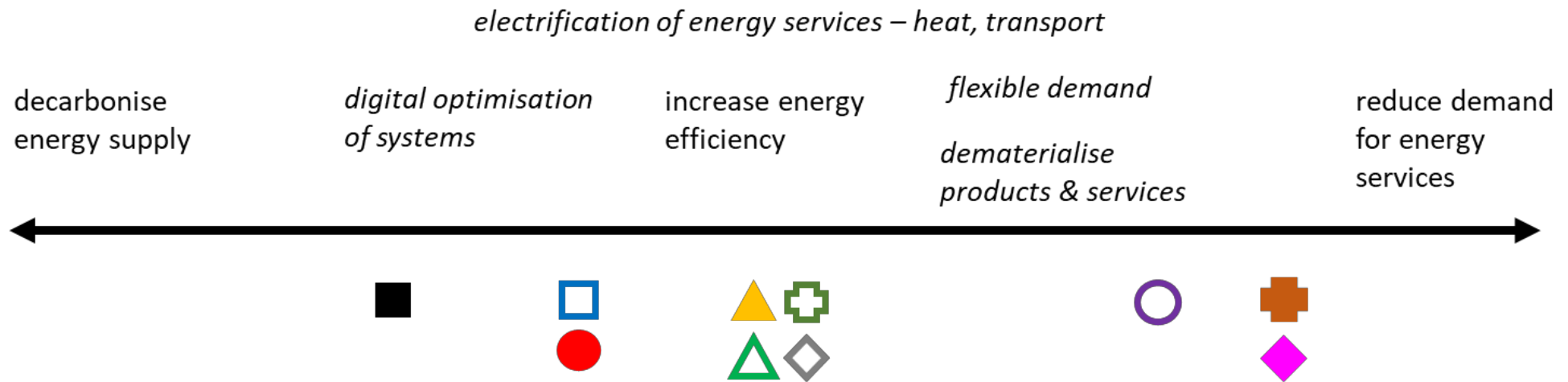
Bergman & Foxon (2021). "Drivers and effects of digitalisation on energy demand in low carbon scenarios."
SPRU Working Paper Series. Brighton, UK: Science Policy Research Unit (SPRU), University of Sussex.

A new generation of technology, like Einride's driverless T-pod truck, could revolutionize the transport sector   Image: Einride

15 Jan 2019

Börje Ekholm
President and Chief Executive Officer, Ericsson

Johan Rockström
Director, Potsdam Institute for Climate Impact
Research (PIK)

This article is part of the **World Economic Forum Annual Meeting**

The time for action is now.

The Earth is facing an imminent risk of crossing tipping points in Earth's life support systems. When that happens, self-reinforcing cycles will kick in that could potentially lead to a 'hothouse Earth' state.

https://www.weforum.org/agenda/2019/01/why-c

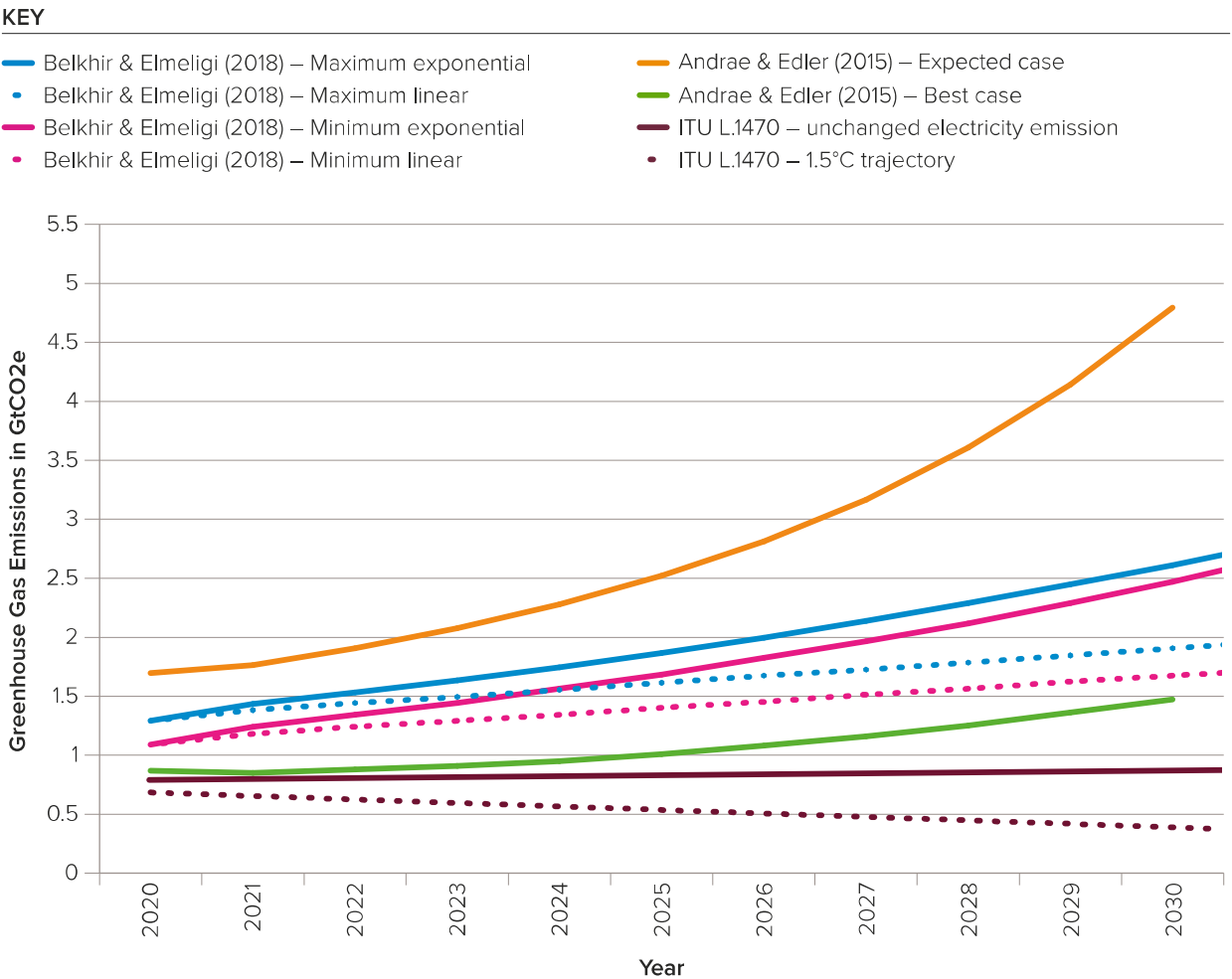# Projections of GHG emissions from digitalisation.

Figure 5, p84 in Royal Society (2020). Digital technology and the planet: Harnessing computing to achieve net zero. London, UK, The Royal Society,

Extra slides

Figure 23: Statements about the benefits of using the internet. Split by digital capability segments. Sources 1 and 3

		Digital capability →			Advanced vs. Established (% difference)
	UK average	3. Established	4. High	5. Advanced	
Helps me me to better connect with friends and family	82%	72%	78%	85%	18%
Helps me to better organise my life	76%	59%	74%	79%	34%
Helps me save time, so I can enjoy myself more	72%	59%	67%	75%	27%
Helps me save money	69%	57%	66%	72%	26%
Helped me find a job	53%	38%	44%	58%	53%
Feel more like part of a community	48%	43%	40%	51%	19%
Manage and improve health	47%	39%	41%	49%	26%
Helps me feel less alone	42%	40%	38%	43%	8%

p27 Source: Lloyds (2018) UK Digital Consumer Index.
digitalisation has many benefits