Digital economy and Industry 4.0 technologies in the development of Arctic under climate change

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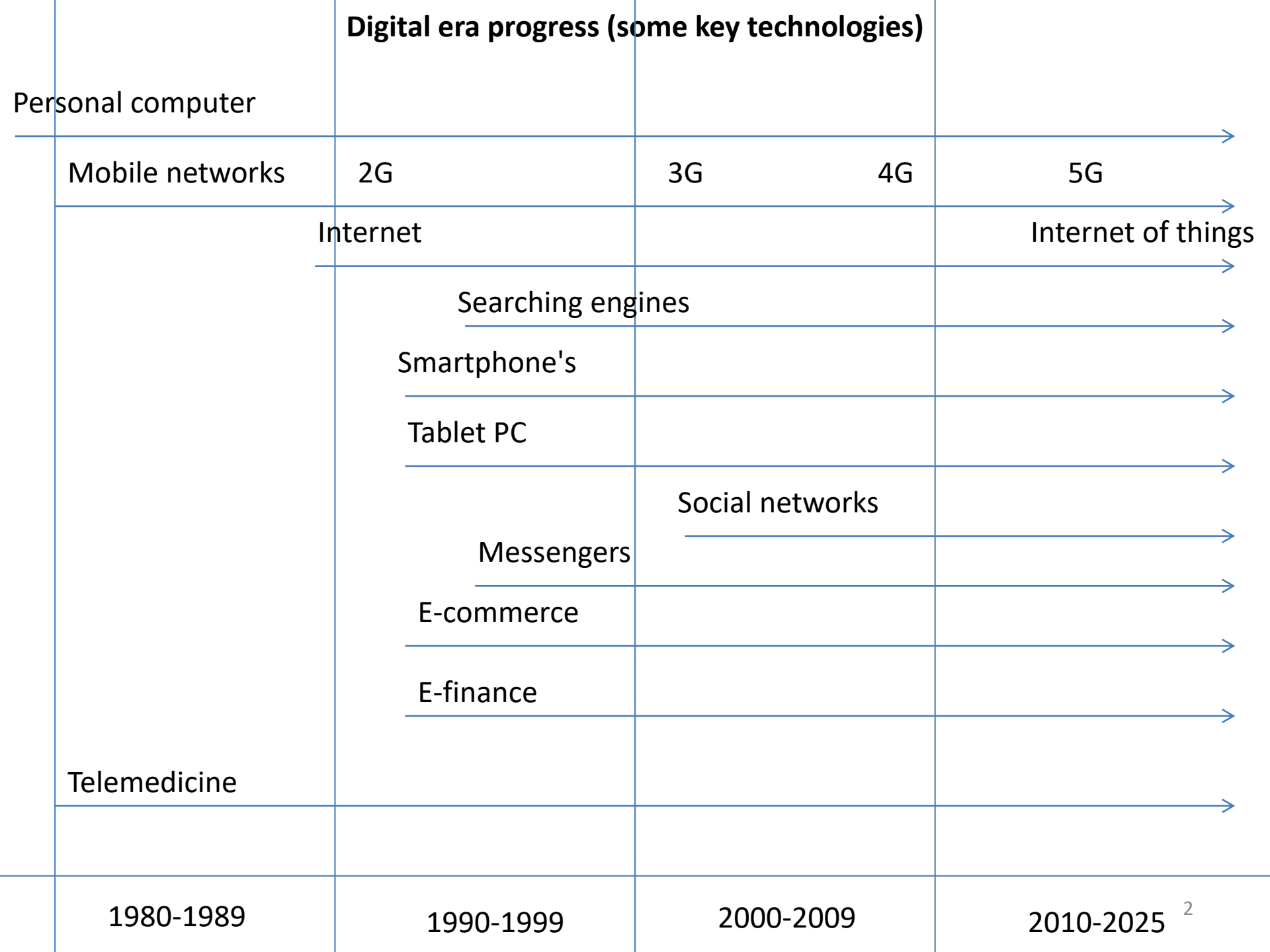
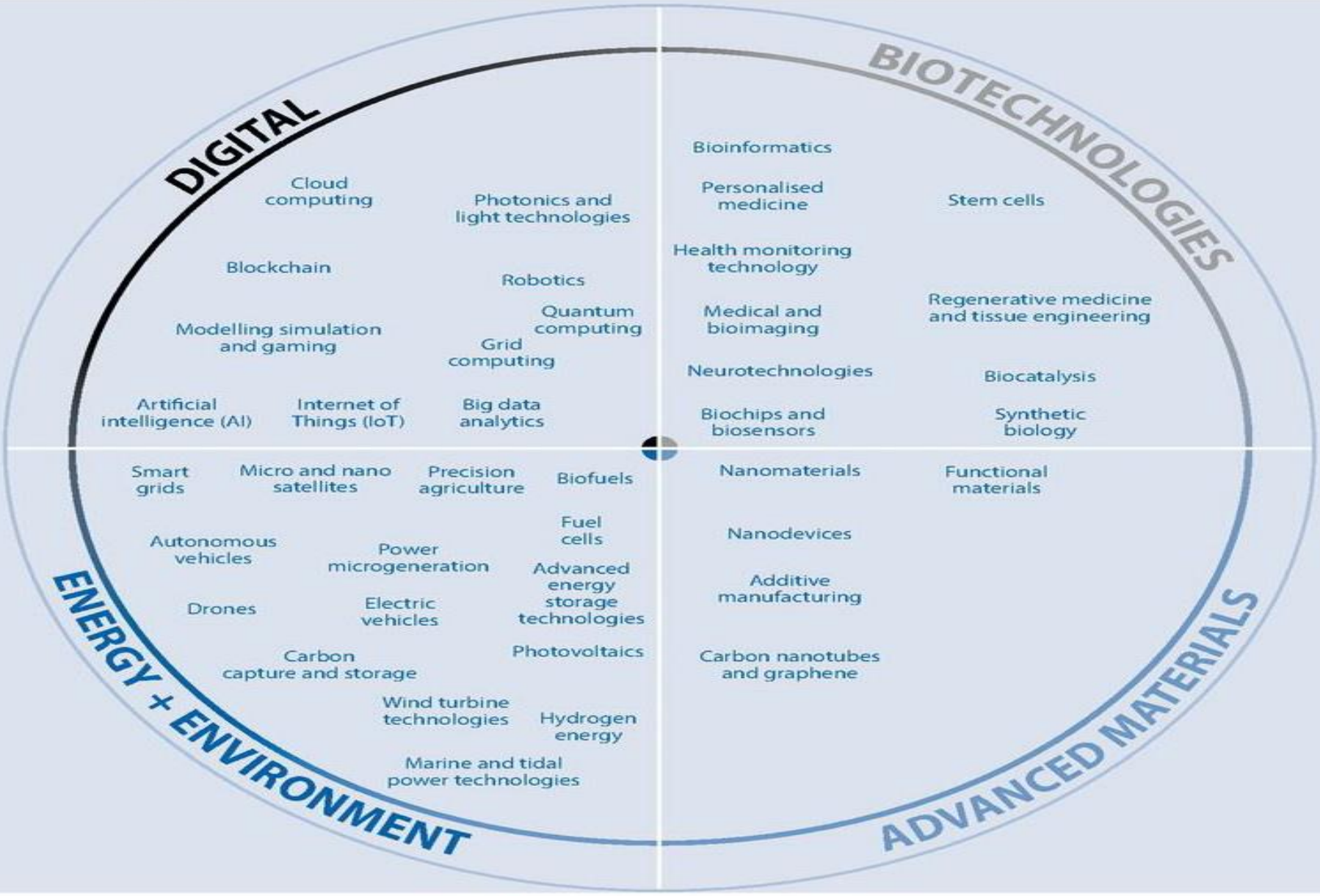
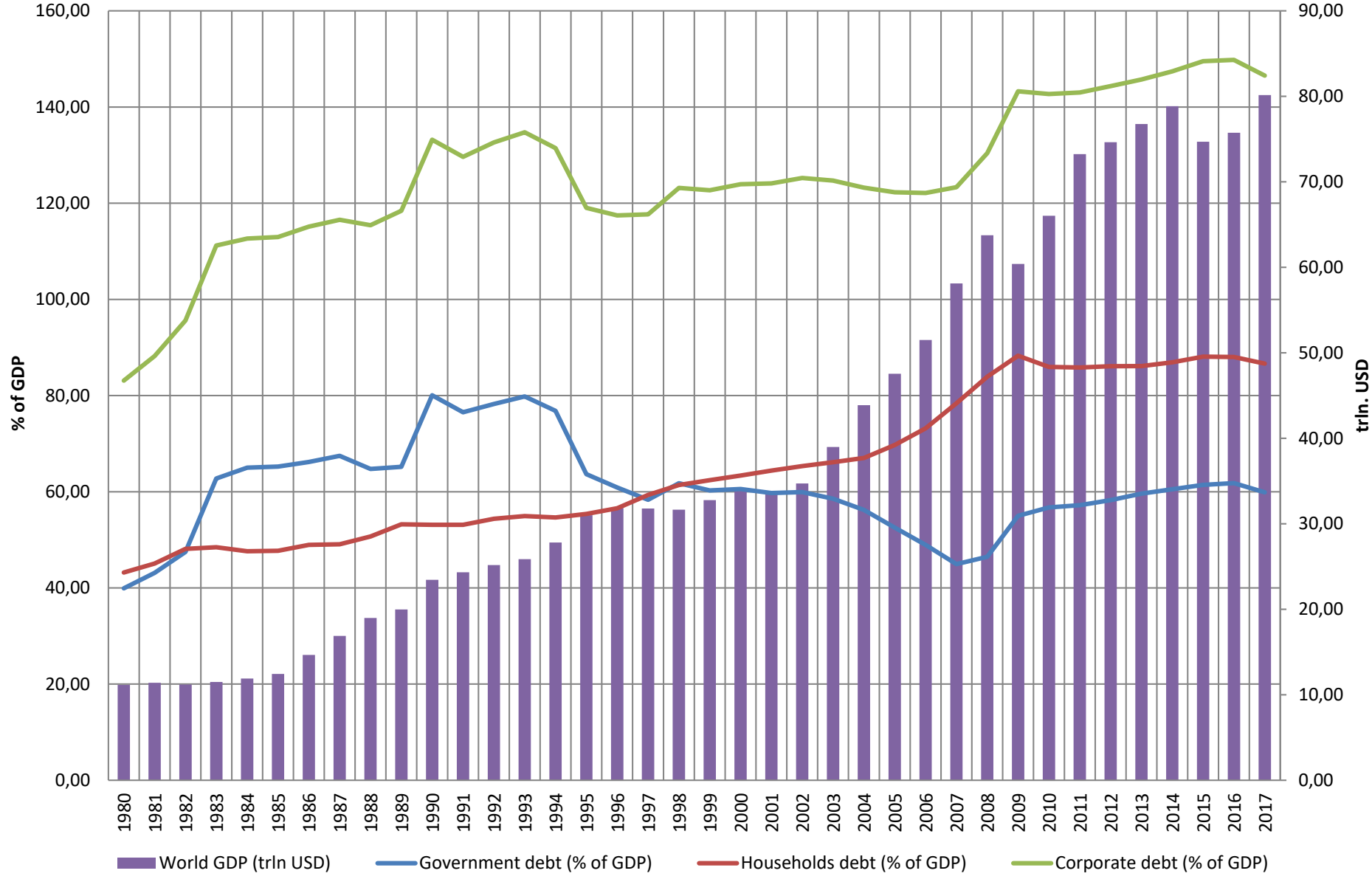

Digital era progress (some key technologies)
Personal computer
Mobile networks
2G
3G
4G
5G
Internet
Internet of things
Searching engines
Smartphone's
Tablet PC
Social networks
Messengers
E-commerce
E-finance
Telemedicine
1980-1989
1990-1999
2000-2009
2010-2025

Key technologies of the digital future by OECD

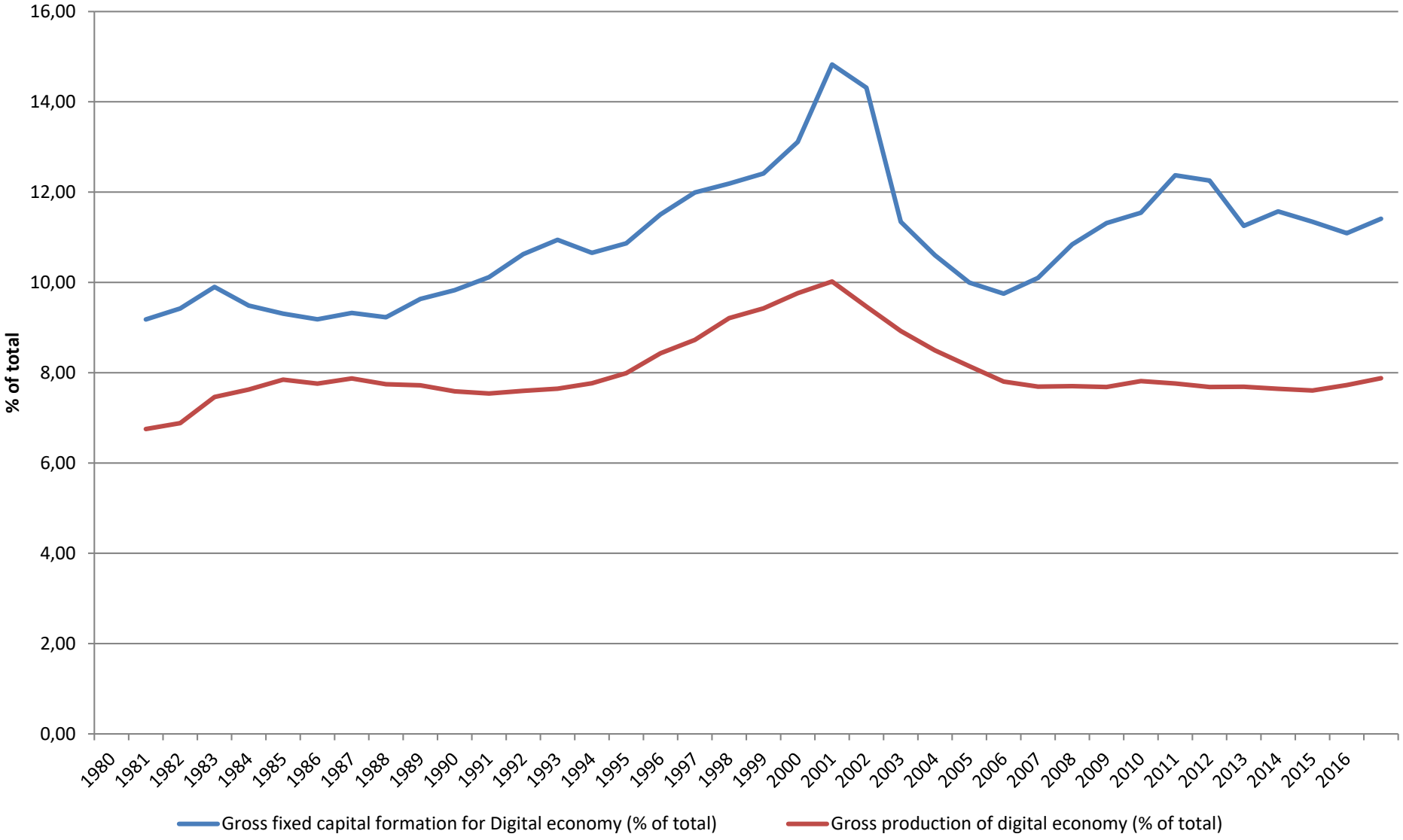


Growth of world GDP and Debt



Source: adopted from IMF, WB, OECD

Investments and production of Digital industry in USA (% of total)

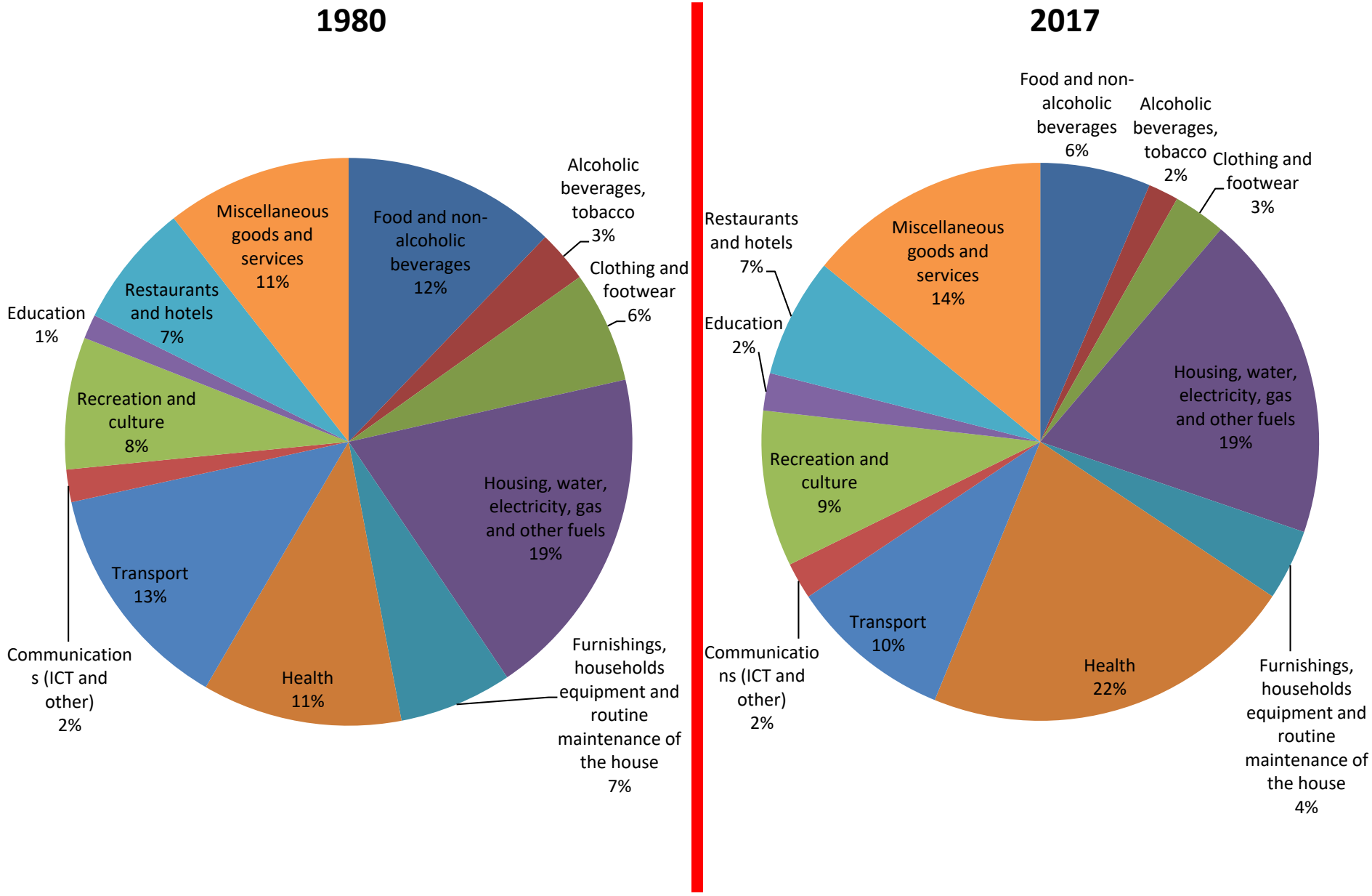


Investments in Digital in OECD (% of gross capital investments 2006-2014)

Country	2006	2008	2010	2012	2013	2014
Australia	11,37	9,93	8,43	7,74	7,45	7,63
Austria	12,53	12,27	13,36	13,28	13,56	13,2
Belgium	11,18	10,64	12,59	12,3	12,08	12,09
Canada	11,84	11,29	10,28	9,28	8,9	8,15
Czech	12,26	12,21	12,81	14,4	14,56	14,31
Denmark	12,56	11,36	14,65	14,2	13,97	12,98
France	12,5	12,53	12,88	13,39	13,55	14,03
Greece	6,87	7,11	10,14	11,13	9,82	10,51
Italy	9,29	9,11	9,68	10,66	11,51	12,04
Netherlands	13,61	13,35	15,56	16,61	17,56	18,16
Portugal	9,79	10,08	10,09	12,35	12,88	13,27
Spain	5,5	6,33	8,06	9,98	10,59	11,13
Sweden	16,46	16,18	15,12	14,76	14,99	14,31
Great Britain	11,8	12,12	12,71	13,58	13,39	12,9
USA	14,3	15,74	17,48	16,39	16,09	15,66

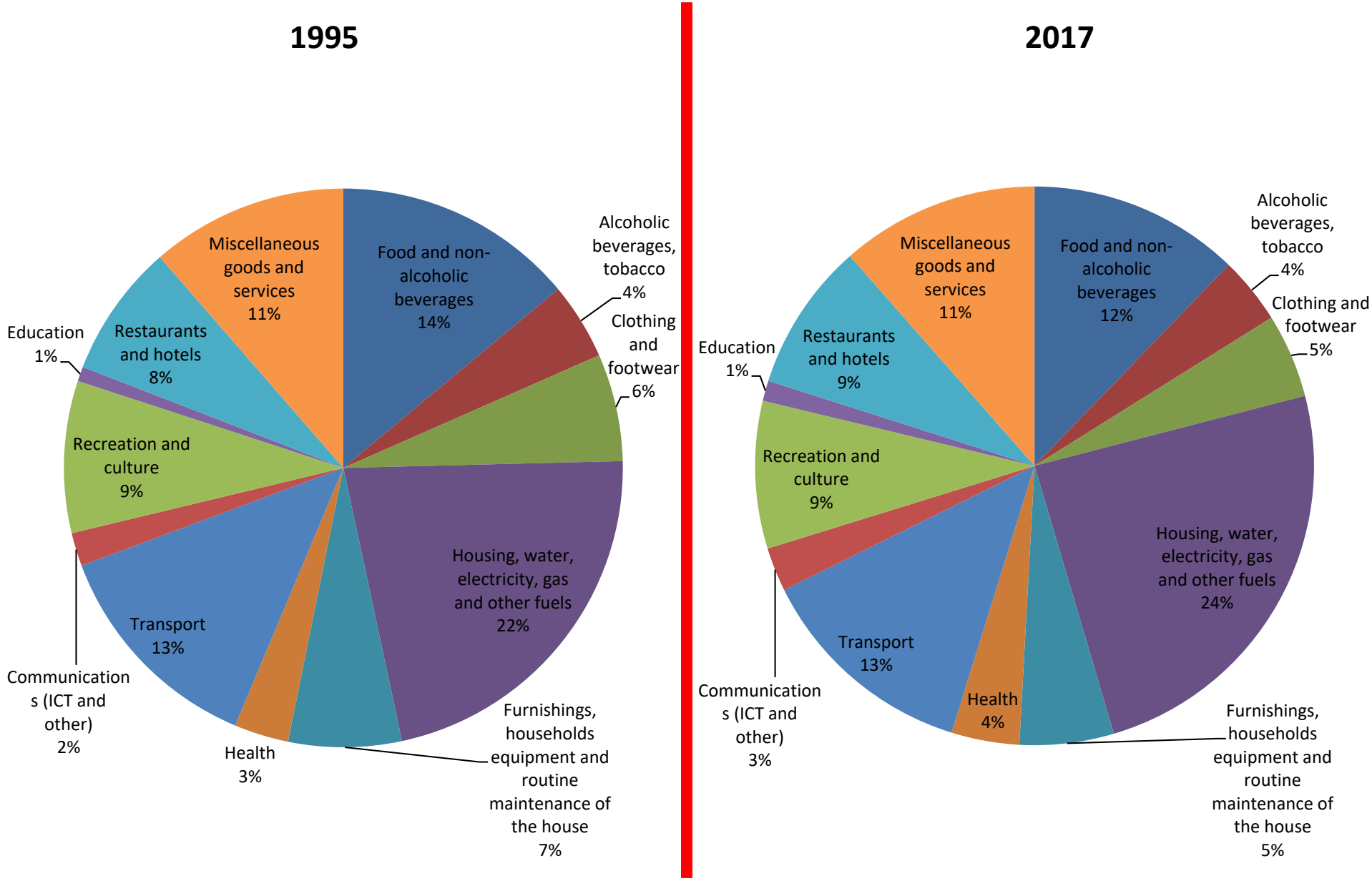
Source: OECD science, technology and innovation outlook 2016

Final consumption expenditure of households in USA



Source: OECD database

Final consumption expenditure of households in European Union



Source: OECD database

Potential problems of digital economy

1) 19 trln. USD of corporate debt on zombie companies most of those are digital leaders like UBER, Tesla, Wework

2) World annual investments in IT and digital is about 1 trln. US dollars
3) 5G investments worldwide will be around 4-5 trln. US dollars – questions of return for those investments

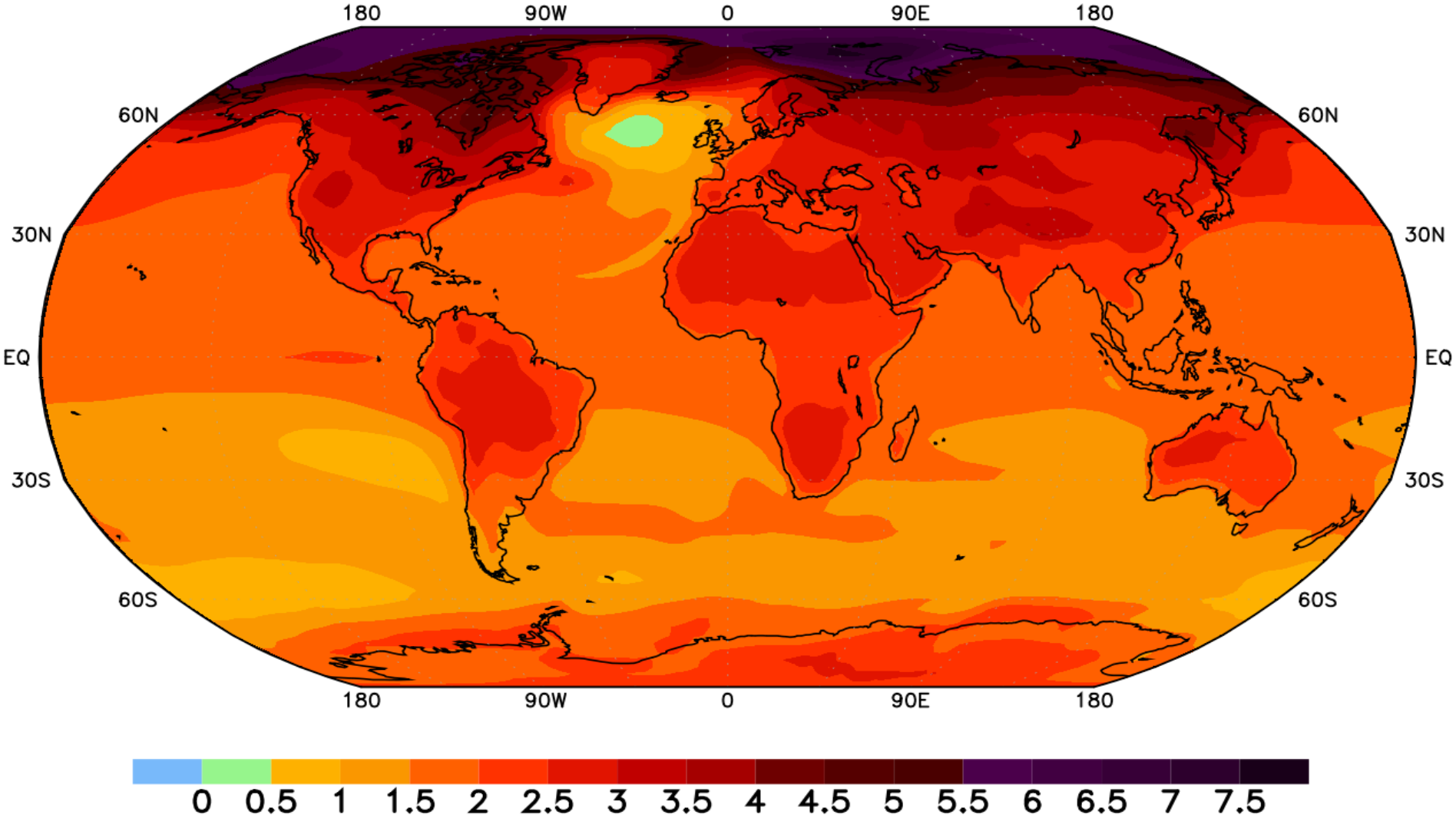
4) Global employment change due to digital economy expand – around 47% of all professions will disappear transport, banking, trade, industry

5) Robotics and IOT manufacturing is still expensive compare to workers. Adidas closed automated factories

What is Russian Arctic

40% crude oil 75% gas, 90% nickel, 60% copper, 90% platinum, 100% diamonds
10 % of Russian GDP
30% exports.
2 million of people living

Temperature changes due to climate change by the end of XXI century



Source: IPCC 2013

Dark color means intensive plus

Effects of global climate change to Russian Arctic and digital future

1) increase in freight traffic on the North sea route up to 130 mln. tons per year
Digital needs: autonomous drones, satellite monitoring, data systems, rapid communications

2) Infrastructure instability due to permafrost degradation
Digital needs: 3D-modelling for construction, new technologies for roads, buildings, pipelines
Autonomous drones, centralized systems of monitoring land surface

3) Increase of different infectious diseases:
Digital needs: 5G network and rapid speed Internet for telemedicine

4) Economic growth due to better climate conditions
Digital needs: 3D modelling for oil/gas fields and other mineral resources
5G and rapid speed Internet for communications
3D printing for new materials

5) Changes housing and communal services due to temperature increase:
Digital needs: smart grids, “green” energy production

North sea route traffic perspectives

Volume of cargo

2018 – 20 mln. tons; 2024 – 50 mln. tons; 2030 – 70 mln. tons; 2035 – 130 mln. tons

Needs:

Satellite and on sea/ground communications infrastructure for ice monitoring

Drones for weather control

IT infrastructure for high speed communications

Cost of impacts of permafrost degradation to infrastructure

Administrative region	Buildings affected (%)	Structures affected (%)	Infrastructure affected (%)	Cost of buildings affected (bln USD)	Cost of structures affected (bln USD)	Cost of infrastructure affected (bln USD)	Mean total cost of impacts (bln USD; +/− variability)	Cost of impacts relative to GRP (2016) (%; +/− variability)
Komi Republic	100.0 (100.0/100.0)	94.7 (89.6/99.8)	89.1 (89.1/89.1)	2.17 (2.17/2.17)	0.83 (0.79/0.88)	5.51 (5.51/5.51)	8.51 (8.46/8.55)	2.2 (2.2/2/2)
Nenets AO	99.0 (0.3/99.1)	40.0 (35.9/44.2)	40.0 (36.2/43.8)	1.75 (0.01/1.75)	0.86 (0.77/0.95)	6.04 (5.46/6.61)	8.65 (6.24/9.31)	5.0 (3.6/5.4)
Khanty-Mansi AO	4.1 (0.0/60.9)	0 (0.0/28.2)	27.2 (27.2/27.2)	0.05 (0.0/0.82)	0.00 (0.15/0.00)	1.41 (1.41/1.41)	1.46 (1.41/2.37)	0.1 (0.1/0.1)
Yamalo-Nenets AO	99.8 (79.1/99.8)	30.5 (24.6/36.5)	27.6 (22.5/32.6)	9.11 (7.22/9.11)	5.26 (4.23/6.28)	37.96 (30.88/45.05)	52.33 (42.33/60.44)	4.0 (3.2/4.6)
Krasnoyarsk Krai	74.4 (0.1/99.4)	4.1 (0/27.8)	63.1 (62.6/63.6)	5.87 (0.01/7.83)	0.11 (0.0/0.72)	3.97 (3.94/4.00)	9.94 (3.94/12.55)	0.8 (0.3/1.1)
Republic of Sakha (Yakutia)	6.5 (0.0/97.7)	64.8 (41.1/88.5)	33.6 (29.6/37.6)	1.69 (0.0/25.3)	8.65 (5.48/11.82)	10.93 (9.63/12.23)	21.26 (15.11/49.34)	3.7 (2.6/8.5)
Kamchatka Krai	0.0 (0.0/0.0)	27.0 (9.1/44.9)	5.8 (3.00/8.6)	0.00 (0.0/0.0)	0.04 (0.01/0.07)	0.02 (0.01/0.03)	0.07 (0.03/0.10)	0.1 (0.0/0.1)
Magadan Oblast	2.6 (0.0/97.2)	5.1 (0.0/43.3)	25.8 (24.2/27.5)	0.08 (0.0/2.77)	0.07 (0.0/0.56)	0.82 (0.77/0.87)	0.96 (0.77/4.20)	1.0 (0.8/4.2)
Chukotka AO	0.6 (0.6/81.0)	74.6 (41.2/100)	35.7 (34.6/36.8)	0.01 (0.01/0.88)	0.87 (0.48/1.17)	1.02 (0.99/1.05)	1.90 (1.48/3.11)	4.2 (3.3/6.9)
TOTAL	53.8 (29.9/95.2)	19.7 (11.9/39.7)	18.8 (16.7/20.9)	20.71 (9.41/50.63)	16.69 (11.77/22.60)	67.67 (58.59/76.75)	105.07 (79.76/149.98)	1.8 (1.3/2.5)

*The values show the percent of building, structures and infrastructure affected by the average loss of bearing capacity using ensemble of six CMIP5 models and variability associated with (mean −5%, mean +5%), and average subsidence and variability associated with (mean −1 cm, mean +1 cm).

Source: Dmitry A Streletskiy et al 2019 Environ. Res. Lett. 14 025003

Medical statistics of Russian arctic 2017

Region	Population per 1 place in hospital	Visits to doctor per 10 000 population a day	Population per 1 doctor	Incidence per 1000 of population
Russian Federation	124,2	270,1	210,7	778,9
Komi republic	99,8	404,7	194,5	1158,5
Nenets AR	108,1	272,5	220,0	1361,0
Murmansk region	103,2	296,6	187,9	825,3
Yamal-nenets AR	128,2	246,0	182,2	1224,4
Krasnoyarsky krai	121,9	327,5	203,5	795,6
Saha republic	101,3	303,0	165,4	1021,1
Chukotka AR	75,1	507,6	133,7	1342,9

Some digital development indicators for Russian Arctic

Indicators	Regions	2016	2017	2018
Households with computer (% of total no. of households)	Arctic	84,8	74,8	83,8
	Russian Federation	74,3	74,4	72,4
Households with internet (% of total no. of households)	Arctic	73,9	72,8	80,1
	Russian Federation	70,7	72,6	73,2
No. of population using Internet (% of total no. of population)	Arctic	82,9	82,9	88,4
	Russian Federation	71,5	74,1	79,3
No. of population using internet for e-commerce (% of total no. of population)	Arctic	38,0	44,1	55,9
	Russian Federation	23,1	29,1	34,7
No. of househlods with highspeed internet (% of total no. of households)	Arctic	73,9	72,8	80,1
	Russian Federation	70,7	72,6	73,2
No. of personal computers with internet access per 100 jobs in enterprises	Arctic	27	27	29
	Russian Federation	32	33	35
No. of organizations with websites (% of total no.)	Arctic	46,3	47,0	49,9
	Russian Federation	45,9	47,4	50,9
Investments into ICT per population (roubles)	Arctic	14 950,0	13 600,0	11 750,0
	Russian Federation	8 556,0	10 189,0	11 480,0

Thank you for your attention