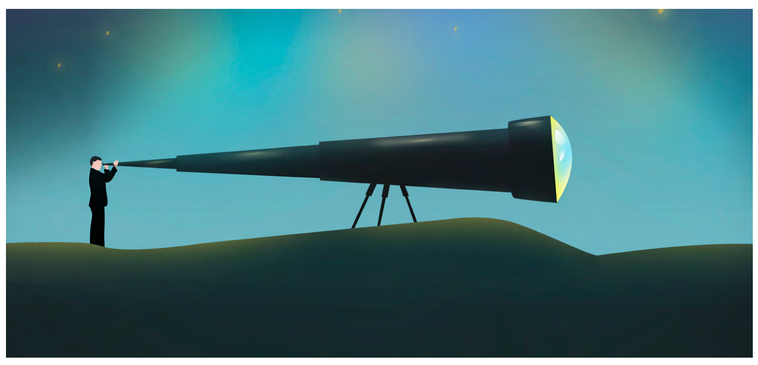
TABLE OF **RADICAL INNOVATIONS BREAKTHROUGHS**

A dashboard of 100 emerging developments offering strong impact on global value creation and potential solutions to societal needs

EUROPEAN POSITION — STRONG

	Underwater living **UL** 86 BR						Harvesting methane hydrate **HmH** 87 EC			
			Marine and tidal power **MtP** 81 EN		3D Printing of food **3DF** 82 PM		Bioplastic **BiPl** 83 BR	Chatbots **CB** 84 AI	Lab-On-A-Chip **LoC** 85 BH	
Artificial photosynthesis **AP** 74 EN		Geoengineering: landscapes **Geo** 75 BR		Microbiome **Mic** 76 BM	Splitting carbon dioxide **ScD** 77 BR	Quantum cryptography **QCr** 78 EC		Driverless **DrL** 79 AI	Neuromorphic chip **NmC** 80 HM	
Spintronics **SpT** 64 EC	Humanoids **Hu** 65 AI	High-precision clock **HpC** 66 EC	Holograms **Ho** 67 AI	Brain machine interface **BMI** 68 HM	Drug delivery **DD** 69 BM	Regenerative medicine **RM** 70 BM	Precision farming **PF** 71 AI	Blockchain **BC** 72 AI	Gene editing **GE** 73 BM	
Aluminium-based energy **Ae** 54 EM	3D Printing of glass **3DG** 55 PM	Microbial fuel cells **MfC** 56 EN	Smart tattoos **ST** 57 HM	Self-healing materials **ShM** 58 PM	Carbon capture & sequestration **CCS** 59 BR	Molecular recognition **MR** 60 BH	Touchless gesture recognition **TG** 61 AI	Hyperspectral imaging **Hypl** 62 AI	Speech recognition **SpR** 63 AI	
Airborne wind turbine **AW** 44 EN	Control of gene expression **CGE** 45 PM	Antibiotic Susceptibility **ASu** 46 BM	Desalination **Ds** 47 BR	Soft robots **SR** 48 AI	Quantum computers **QuC** 49 EC	3D Printing of Large Objects **3DL** 50 PM	Emotion recognition **ER** 51 HM	Biodegradable sensors **BiS** 52 BH	Swarm Intelligence **Sln** 53 AI	
Plant communication **PC** 34 BH	Bioelectronics **BiE** 35 BH	Neuroscience of creativity **NsC** 36 AI	Brain function mapping **BF** 37 HM	Metamaterials **Mm** 38 PM	Disaster preparednes **Dp** 39 BR	Artifical intelligence **AI** 40 AI	Computational creativity **Cc** 41 AI	Augmented reality **AR** 42 AI	Exoskeleton **Ex** 43 AI	
Asteroid mining **AM** 26 BR		Plastic eating **PE** 27 BR	Bionics (medicine) **BiN** 28 HM	Epigenetic change **Ec** 29 BM	Carbon Nanotubes **Cn** 30 EC	Smart windows **SW** 31 EN	Wastewater nutrient **Ww** 32 BR		Flexible electronics **FE** 33 EC	
	Artificial synapse/ brain **AsB** 17 HM	Targeting cell death pathways **TcD** 18 BM	2D Materials **2DM** 19 PM	Hyperloop **HyL** 20 BR	Hydrogels **Hy** 21 PM	Water splitting **WS** 22 EN	Nanowires **NW** 23 EC	Warfare drones **WD** 24 AI	Nano-LEDs **NL** 25 EC	
	Flying car **FC** 9 AI	Hydrogen fuel **HyF** 10 EN	Bioprinting **BiPr** 11 BM	Graphene transistors **GT** 12 EC	Optoelectronic **OE** 13 EC	4D Printing **4DP** 14 PM	Genomic vaccines **GV** 15 BM	Gene therapy **GeT** 16 BM		
	Bioinformatics **BiO** 2 BH	Molten salt reactors **MsR** 3 EC	Reprogrammed human cells **RhC** 4 BM	Thermoelectric paint **TP*** 5 EN	Energy harvesting **EH** 6 EN		Computing memory **CM** 7 EC		Automated indoor farming **AiF** 8 AI	
									Bio-luminescence **Bil** 1 EN	



HOW TO READ ENTRIES

Bioinformatics **BiO** 2 BH

- **Full name**
- **Abbreviation**
- **Thematic group code** (See just below)
- **Recent progress** (See bottom part panel)

THEMATIC GROUPS

- **AI** Artificial Intelligence and Robots
- **HM** Human-Machine Interaction & Biomimetics
- **EC** Electronics & Computing
- **BH** Biohybrids
- **BM** Biomedicine
- **PM** Printing & Materials
- **BR** Breaking Resource Boundaries
- **EN** Energy
- **SI** Social Innovations

LIKEHOOD OF SIGNIFICANT USE / EXPANSION BY 2038 → STRONG

Local food circles **Lf** 88 SI	Basic income **BI** 89 SI	Owning & sharing health data **Osh** 90 SI	New journalist networks **Nj** 91 SI	Alternative currency **AC** 92 SI	Life caching **LC** 93 SI	Car-free city **CF** 94 SI	R/W culture diversifying **RwC** 95 SI	Access/commons economy **AE** 96 SI	Reinventing education **Re** 97 SI	Collaborative R&I spaces **CS** 98 SI	Body 2.0 & the quantified self **B2** 99 SI	Gamification **Gm** 100 SI

1 Glowing plants, Visualization of gene expression
2 Biohybrid
3 Waste-burning with lithiumflouride/ thoriumfloride material, Collaborative efforts in Canada, Protoypes in China
4 Destruction of cancer cells, Macrophages to kill the Tuberculosis pathogen
5 (*No value for European position) - Thermoelectric paint, Harvest of electriciy from waste heat
6 Biological motion, Other sources (wind, heat, radio, chemical)
7 In-memory algorithms, Faster phase-shifting computer memory
8 Techno farming in extreme conditions
9 Personal autonomous drones and rockets, Coordinated flying taxi services
10 Production, Storage, Hydrogen-powered vehicles
11 Bones, tissue, skin, blood vessels and other human parts, 3D-printed models
12 Microprocessors, Neuromorphic chips, Next-generation electronics
13 Optical computing, 5D optical data storage, Photonic chips
14 Exposure to heat, Water contact
15 Clinical trials, DNA vaccines for animals, Better delivery pathways
16 Disease areas, Treatments
17 Atomristors, ENODe, Junction-based artificial synaptic device, epiRAM
18 Targeting new pathways to trigger cell death
19 2D Semiconductors, 2D Magnets, Black phosphorous ink
20 Section of Hyperloop Track finalised in NL, Further tests under way at several sites
21 Regenerative medicine, Soft robots, Biothreat detection devices, Optogenetics
22 New Catalysts, Fertilizers
23 Batteries, Nanosensors, Electrochromic devices, FET, Heat dissipators
24 Intelligence, Fuel autonomy, Microdrones, Defense against drones
25 Multitasking LED displays, Deep UVC, Optical Data Communication
26 Asteroid detection, Examination and mining technologies
27 Plastic-colonizing fungi, Micro-to-macro: plastic-munching worms
28 Exoskeleton, Upper limbs, Internal organs
29 Epigenetic technologies for diagnosis and other technologies
30 Nanotubes with fullerenes, On-chip light sources, Liquid biopsy chip
31 Electrochromic materials, Liquid crystal sandwich, Nanocrystals
32 Nutrient recovery from wastewater, Biological phosphate removal
33 Transistors, Displays, Energy storage, Sensors, Health monitoring, 3D printing
34 Senses of plants, Parasites involved in plant communication
35 Biochip, Biological computer, Biological computer parts, Bio interface
36 Testing and Influencing imagination and creativity
37 Brain electrical activity and biomarker mapping, Improving cognitive functions
38 Cloaking devices, Photovoltaic devices, Medical imaging
39 Submarine (smart-)cable network, Robots & AI emergency response
40 Duelling Networks, Capsule Networks, One Shot Image Recognition
41 Computational Creativity
42 Synchronization with the physical world, Live instructions, Therapy
43 Medical applications, Military applications, Industrial applications
44 Ground- and flying Generator Airborne Energy Systems
45 Epitranscriptomics, Embryo development
46 AST Micro-assay, Lab-on-a-Stick, Microfluidic devices, AST Gadget
47 Nanofiltration, New distillation solutions
48 Pneumatic, Living muscle tissue, Hydrogel, Mechanical
49 Quantum systems, Quasiparticle control
50 Energy: 3D-printed turbine prototype, 3D-printing robots for building
51 Interpreting facial expressions and text, voice, heartbeat, breathing
52 Medical uses, Food/medication tracking, Environmental sensing
53 The Swarm-Organ project, Unmanned Aerial Vehicles
54 Aluminium-ion batteries, Aluminium-air batteries
55 Fused filament fabrication, Stereolitography
56 New catalysts, Cheap material for electrodes, Wearable energy devices
57 Medical technologies, Environmental monitoring, Marketing
58 Civil engineering, Protective clothing, Energy storage, Soft robotics
59 Exploring new storage solutions, New uses for CO_2
60 Portable diagnostic devices, Electrodiagnosis, Screening (medicine)
61 Ultrasonic gesture sensing, Optical cameras and sensors, Gesture decoding equipment
62 Medical imaging, Food quality, Mining, Recycling, Security, Hardware & Software
63 Dedicated chipsets and algorithms, Systems and devices
64 Spin relaxation and spin transport, Combination with Claytronics
65 Mimicking humans, Application demonstrators, Control
66 Attophysics, Ultra-precise time measurement for GPS applications VoIP
67 Acoustic holograms, Touchable/printable holograms
68 Electroencephalography (EEG, ECoG, fNIRS, fMRI)
69 Breaking the Blood-Brain-Barrier, New- and nano-materials, Genetically-engineered devices
70 Cellular therapies, Tissue engineering and artificial tissues or organs
71 Agrobots, Internet of Things in precision farming, In-field devices
72 Trust, Notarization, Smart contracts, Corporate blockchain networks
73 CRISPR as revolution in health, CRISPR in agriculture
74 Drug production, Fuel processing, Renewable energy, Air purification
75 Changing landscapes and climate, Climate Engineering: greenhouse gas removal
76 Gut bacteria and immunotherapy and gene activity, Probiotic bacteria and depression
77 Low-cost carbon dioxide splitting
78 Quantum key distribution from orbit, Faster data rates, Blockchain
79 New-generation sensors, Man-machine synergy, Legislation, Connectivity
80 Neuromorphic chips for object recognition
81 New technologies for tidal and wave energy harvesting
82 Soup with 3D printed twist, Technology to help people with dysphagia
83 Bioplasics for Skin contact, Wound repair, electronics
84 Unscripted chatbots, Reuse & integration with major platforms, Enterprise & Customer Service Applications
85 Sepsis detection, Lab-on-a-stick, Cheap lab-on-a-chip manufacturing
86 Aquanaut technologies for hotels, Entering a sustainable underwater future
87 Methane Hydrate Gas in China, Energy from methane hydrate gas on a large scale
88 Community and indoor Gardening, Localised Food Systems, Permaculture
89 Unconditional Minimum Basic Income, National Referendum on unconditional basic income
90 Healthbank for Health information, Sharing scientific health data for money
91 Large-scale investigative journalism
92 Crypto-currencies traded world-wide, Giving up cash
93 Live caching as an industry, Scrapbooking
94 Banning cars from cities, New cities without cars
95 Breakdown of established gatekeepers, Ownership disruption
96 Online mediated sharing, Rise of the Commons, Based-peer production
97 Increase in diversity of actors in and forms of education
98 Makerspaces on the rise
99 Tools for tracking common devices, Body 2.0 – monitoring at the workplace
100 Data generation combined with participation via gaming, Physical Education and Health

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