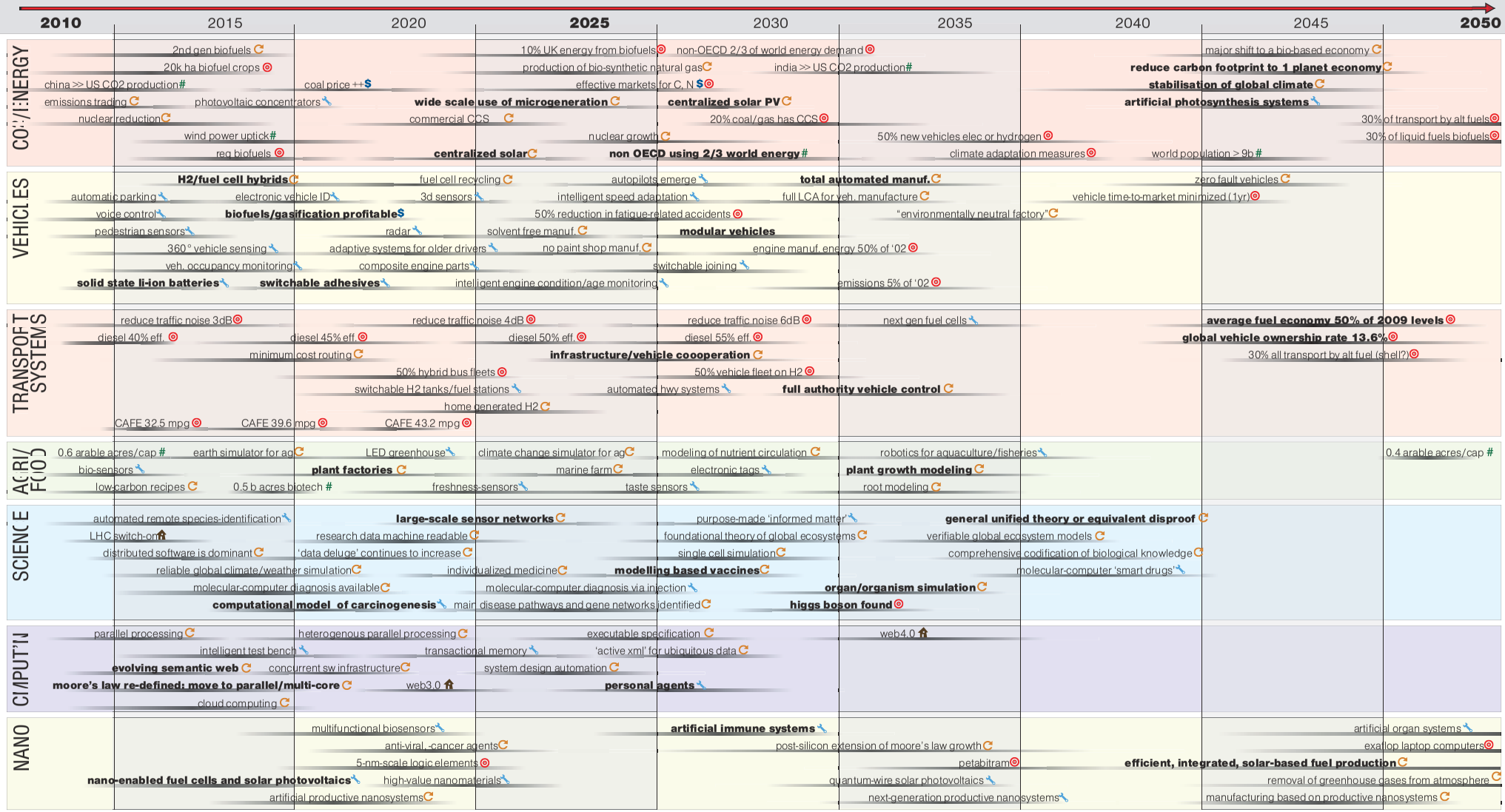
# TECHNOLOGIES ROADMAP TO 2050

KEY: TARGET/GOAL◎ STATISTIC# PROCESS↻ FINANCE$ TOOL/GADGET🔧 PLACE🏠

CYBERNETICS / AGRO&INDUSTRY / INFORMATION ACQ&DELIV / EMISSIONS ABATEMENT / PARADIGMS&FUNDAMENTALS / BIOLOGY&GROWTH / MATERIALS&MANUFACTURING

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# Technology Roadmap: **Where are we now?** 2010-2020


## ENERGY

What powers the world? Where are the offsets/drawbacks? Decentralized or hierarchical?

More energy demand, more renewables supply, fossil fuels price increase, innovation competition. Building sector orders of magnitude more efficient.

Electric vehicles dominant, high efficiency high torque motors, high efficiency regenerative braking, entirely composite, rapid recharge, 1000 mile range, ultra high density batteries.

All your energy has a cost; all your energy is measured and tracked. Individuals have kwh budgets, kwh credit cards, kwh 401Ks. Luxury = spending energy.

High efficiency wind generation, flexible photovoltaics, building-integrated PV.

## ENERGY PREDICTIONS

Peak oil, negawatts, extractable sources are more precisely mapped. PV efficiencies increase, PV production scales up orders of magnitude, energy sources and predictions drive economic cycles, china/india/global south dominant. EU/US at carbon neutrality but oscillate between surplus and deficit. Emissions markets on a par with financial markets.

## MOBILITY/TRANSPORTATION

Gradual dominance of hybrids and hydrogen in high performing economies, mass transit heavily influence all markets. Overall denser cities, transit oriented urban design, more population in less available space. Transport systems recognize users wirelessly, and integrate the borrowing/rental of small cars, bicycles along with typical train and bus fares. Safety systems are precise enough to autonomously operate most vehicles, and have obviated accidents due to driver error, but drivers' preferences mostly keep humans in control.

**HEALTHCARE/BIOLOGY/MEDICINE/ DISEASE/AGING**

People living longer, higher standard of living, more expensive end-of-life care. Insurance and capital/macroeconomic effects are dramatic.

Global health network gets better at dealing with epidemics, better early warning.

Genetic screening for diseases/syndromes, wide variety of ethical conundrums. Cancer and HIV relatively treatable, still no cure for the flu. Vat-grown organs available, as precise genetic fit to patient. The less rich see trickle-down health tech.

Portable health diagnostics, high resolution scanning, genechip analytics, rapid DNA analysis.

**WELLNESS**

Do larger social forces increase preventive medicine? Incentive structures and political decisions dominate. Hospitals and health care industry rewarded for fewer patients, so fund media campaigns for personal health and diet improvements. ("Exercise is medicine" - Dr. Walter Thompson, of the American College of Sports Medicine)

**GOVERNANCE**

How do political forces respond to various systemic inertias? Regime changes happen. National political issues compete with and sometimes overwhelm global commons issues. Climate changes lead to strict GHG emissions legislation, and variety of tax incentives direct investment to renewables and energy efficiency.

**BIOTECH/GENETICS/BIOSECURITY**

Genetic modification conflict occurring on agricultural, medicine, and organ [re]-production. Sophisticated cloning system for both food, pharmaceuticals, and organ replacement. Bioterror attacks occur, embargoes are put into place for 'dual use' biological technology. Seeds are genetically screened, and transgenic manipulation requires a federal license and background check.

**HUMAN [BODY] MODIFICATION**

Neurochip interfaces allow direct brain/computer interface. Artificially enhanced sight and hearing change the nature of communication. Athletes use custom pharmaceuticals to optimize particular performance aspects. Major injuries can be repaired with functionally equivalent or superior mechanical systems. Voluntary 'upgrades' are expensive but everyday occurrences.

**FINANCE**

New instruments, risk-averse cycle ends, insurance industry restructures to respond to climate issues, more uninsured. Carbon trading evolves into mature market. Economic cycles are recognized earlier and addressed through macro strategies. PWC's 'E7' emerging economies: China, India, Brazil, Russia, Mexico, Indonesia and Turkey dominate the global market. Barriers to trade are low, but risk is also shared. Infrastructure, economic stability, and political transparency continue to drive long term investment.

## WATER

There is intermittent water scarcity despite efficiency increases and strategic stockpiling/reserves. Various regional water wars occur, and global institutions struggle to mediate. Renewable-powered desalination plants provide for desert/arid regions, but at a high energy cost. Aquifer management is maturing but overextraction continues. Climate effects cause instability in seasonal cycles and major flooding is common in most low-lying estuaries.

## AGRICULTURE/FOOD/DRINK

Combination of GMOs and high tech fertilizer/water delivery increases efficiency of large scale agriculture (factory farms), along with continued trend toward locavores and community-based farms. Shortage of phosphorus for fertilizer production.

Vertical farms, community gardens, micro-gardening, increase of food production in dense environments.

Segregation of markets into commodity food and bespoke food, organics and 'by-hand' cultivated and grown. Micro-producers in a variety of niches, factories for mass market. Rich can afford to pay for local and organic food. Molecular gastronomy develops, better sensors reduce spoilage waste. Robotics more involved in harvesting, transit, preparation, serving. Auto-ordering systems for just-in-time delivery.

## EDUCATION

Internet penetration not magic bullet, but interconnected system allows better decentralized school systems. Learning nodes are spread throughout most cities, with net connectivity and a variety of flexible knowledge resources.

## COMPUTATION/COMPUTING

Grid and cloud more prevalent. Bio-based computing economically feasible. Tension between privacy and personal data storage. New copyright regime monetizes microcontent. Next gen encryption based on quantum mechanics approaches 'unbreakable' status. Moore's law begins to plateau, but research into advanced processing algorithms squeeze out some further orders of magnitude.

## ARTIFICIAL INTELLIGENCE AND ROBOTICS

Remote autonomous vehicles (see roomba, military UAVs, also vehicles, transportation) are more sophisticated and can act independently for long periods.

## COMMUNICATIONS

Networks are broadband and pervasive, but are vulnerable to security threats. Fiber optics go door to door, and broadband wireless is free in most densely developed areas. Most media is delivered via internet, and classical telecoms are all but extinct.

**CULTURE/LEISURE**

Net based, peer-funded art. Digital performances occur in simulated physical space. Pop artists have access to literally billions of children in their target demo. Parents install meme hygiene filters.

**RETAIL/SHOPPING/E-COMMERCE/MANUFACTURING**

Net based, virtual models, customized just in time fabrication.

**DEMOGRAPHICS/POPULATION SHIFTS**

BRIC nations, shifting pop. pyramids. Gender imbalances lead to various immigration/emigration waves.

**SCIENCE/TECHNOLOGY**

Simulation and modeling advances on both global and local scales. Better understanding of cell, organ, populations, and global systems. Still no grand unified theory of forces, but ultra-high energy research continues.

**ETHICS**

Cloning, genetic modification, mechanical augmentation, data transfer in/out of human minds, pharmaceutical intelligence/memory/focus boosts, disease screening, organ replacement.

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# Technology Roadmap: **Where are we now?** 2020-2030


**CO2/Energy:**
With the depletion of fossil fuels and the ever-increasing demand for energy the price of coal has reached record highs. To find alternative energy sources there is heavy investment in renewable energy. Microgeneration becomes a popular energy option for domestic and industrial use, and centralised solar power systems also become more widespread. Nuclear power is also explored more widely, amid significant work to break down negative social views which still hamper the widespread adoption of nuclear technologies. More popular is biofuel, and by the end of 2030 10% of the UK's energy is now provided by this source.

**Vehicles & Transport Systems:**
In a bid to power transport systems in a similarly efficient and non-fossil fuel reliant-manner hybrid buses now account for over 50% of the worldwide fleet. Diesel powered vehicles are now 50% more efficient than they were 20 years ago. Fuelling stations now cater to the hydrogen celled-vehicles, and many homes have home-generators to replenish their hydrogen cells. Traffic noise, now petrol and diesel are less common is up to 4dB quieter. Vehicles are fitted with 3D sensors and radar to make operation easier and safer. Older drivers have adaptive systems fitted to keep them (and other road-users!) safe. New vehicles are manufactured using solvent free methods, in attempts to curb CFC pollution.

**Agriculture & Food:**
Within agriculture energy changes are also visible. Greenhouses are powered by LED to maximise productivity and reduce costs and emissions. Sensors monitor levels of humidity, nutrients and sunlight across acres of arable crops, as well as in livestock facilities. In order to grow tropical crops in temporal climates, to meet increased global demand, agricultural climate simulators are appearing in large scale agri-businesses. Marine fish farms are getting larger and larger in attempts to curb the depletion of natural fish stocks.

**Nanotechnology & Computing:**
Web 3.0 has finally arrived. Computing systems reach new levels of intelligence, incorporating transactional memories and system design automation. Parallel processing

methods are now heterogeneous - computing is becoming even more personalised. Nano-technology is also developing, and becoming more detailed. Anti-viral and cancer drugs are in development, and nano-materials are now a valuable resource. Bio-sensors play an increasing role throughout society as they become more multi-functional than ever before.

**Science:**
Large scale networks of sensors appear, and the “data deluge” continues to increase; everything is monitored, from global climate to personal body temperature. The field of medicine is expanding constantly, identifying main disease pathways and genetic networks. Drugs can thus be personalised for the individual taking them. The methods in which research is gathered and analysed become increasingly automated; the human thought process is continually being replaced by that of a machine.

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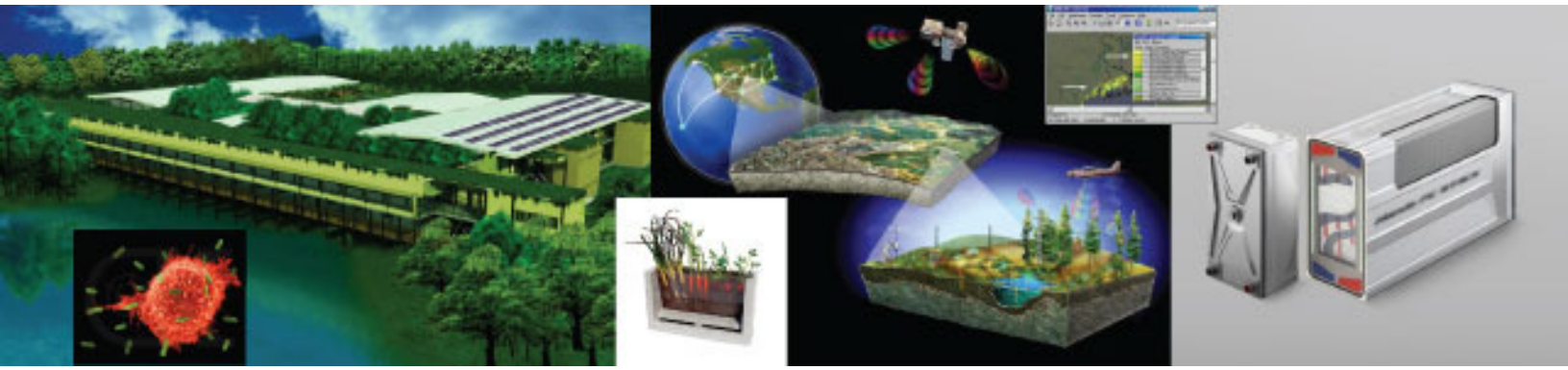
# Technology Roadmap: **Where are we now?** 2030-2040



**CO2/Energy:**

The USA is no longer the greatest global carbon offender – India now holds that dubious honour. In fact, two thirds of the world's energy demand is now from non-OECD countries, requiring radical new actions to curb carbon emissions. Climate adaptation methods are employed to cope with climate change and vehicles are increasingly powered by alternative fuel sources.

**Vehicles & Transport Systems:**

50% of all new vehicles now run on electricity or hydrogen, making use of the next generation of fuel cells; making them much quieter as well as less damaging to the Earth's atmosphere. The manufacture of these increasingly modular vehicles is now entirely automated and analysed by full life-cycle assessments; energy use in vehicular manufacture is thus now 50% of its 2002 levels, whilst vehicular emissions are now 5% of 2002 levels.

**Agriculture & Food:**

Agriculture too is becoming increasingly automated, as robots appear in aquaculture and fisheries to replace human farmers. Sensor and electronic tagging systems monitor growth rates and nutrient levels, as well as their circulation processes. Results produce models which study plant structure from root to tip and their growth patterns to increase intensity of agricultural output, to feed the ever-growing global population.

**Science:**

This population is currently benefitting from further leaps in science, as human survival rates continue to rise. Simulations of single cells have led to advanced medicines, and vaccines based on modelled viruses. Organs, and even simple organisms, can now be simulated, if not entirely reproduced. New levels of environmental understanding are also being obtained, with a new foundation theory of global ecosystems, which helps to inform global conservation and climate adaptation programmes.

**Nanotechnology & Computing:**

The world is now linked by the new 4.0 web; which makes yet more connections than ever before, allowing further global coordination. Computers are faster and faster, with vast petabyte RAM capabilities. The use of computing in energy technologies now allows the production of quantum-wire solar photovoltaics. Even computer technology is doing its bit for reducing energy consumption as we move to an increasingly ecological age.

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# Technology Roadmap: **Where are we now?** 2040-2050

**CO2/Energy:**

The world has witnessed a major shift from a carbon-based to a bio-based energy economy, which in turn has stabilised the global climate. Successful economic and political policies have curbed the ever-increasing global carbon footprint and the world now lives truly on one planet's worth of resources. Not only are carbon emissions halted but greenhouse gases can now be removed from the atmosphere thanks to new technologies. 30% of transport is powered by alternative fuel sources and biofuel constitutes 30% of all liquid fuels.

**Vehicles & Transport Systems:**

Vehicles themselves are now produced without fault – they never breakdown or malfunction. The time-to-market for vehicles is now shorter than ever, as manufacturing systems pick up speed, cutting costs and materials. Compared to 2009 levels, the average vehicular fuel economy is now 50% lower, and global vehicle ownership is now 13.6%, as urban areas increase and inhabitants take more public transport.

**Agriculture & Food:**

Agricultural production has slowed in line with recent population growth (by 2050 world population reaches 9 billion, however the increasing use of crop biomass for biofuels implies a significant increase in intensity of cultivation. Agri-businesses have totally taken over from smaller independent farms, and operate extensively across international borders, using the thus-far developed technology on a now global scale.

**Science:**

Within the field of science, even the methods of definition and knowledge are changing; there is now a recognised comprehensive codification of biological knowledge. We are now able to produce verifiable global modelling systems, such as those used to model the state of the world's ecosystems; modelling, in real-time, processes such as desertification and alterations in oceanic thermohaline systems.

**Nanotechnology & Computing:**

Nano-technology has driven computing and many other fields to achieve things of which society could only have dreamt in 2010. Small laptops contain staggering exaflop systems, running one quintillion floating point operations per second. Nanosystems have made manufacturing processes more efficient, computing processes faster than ever and helped medicine develop entire artificial organ systems, supporting human life on Earth in unprecedented symbiosis.

***The end of the road? Or is there more….? What comes next?***