



# OBSERVE APPROACH AND OUTCOMES

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This project has received funding from the European Union's Horizon 2020 FET Programme under grant agreement No. 665136

# Overview

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- OBSERVE RADAR Generation
- OBSERVE Radar Content
  - Level I: 171 Seeds of Change
  - Level II: 34 Hotspots of Change
- Using the Radar for exploring diverse futures



# OBSERVE RADAR GENERATION



# OBSERVE Conceptual Background I/III

Foresight: Structured dialogue on complex futures



To enhance capacity to unlock the potential of the present

NOW

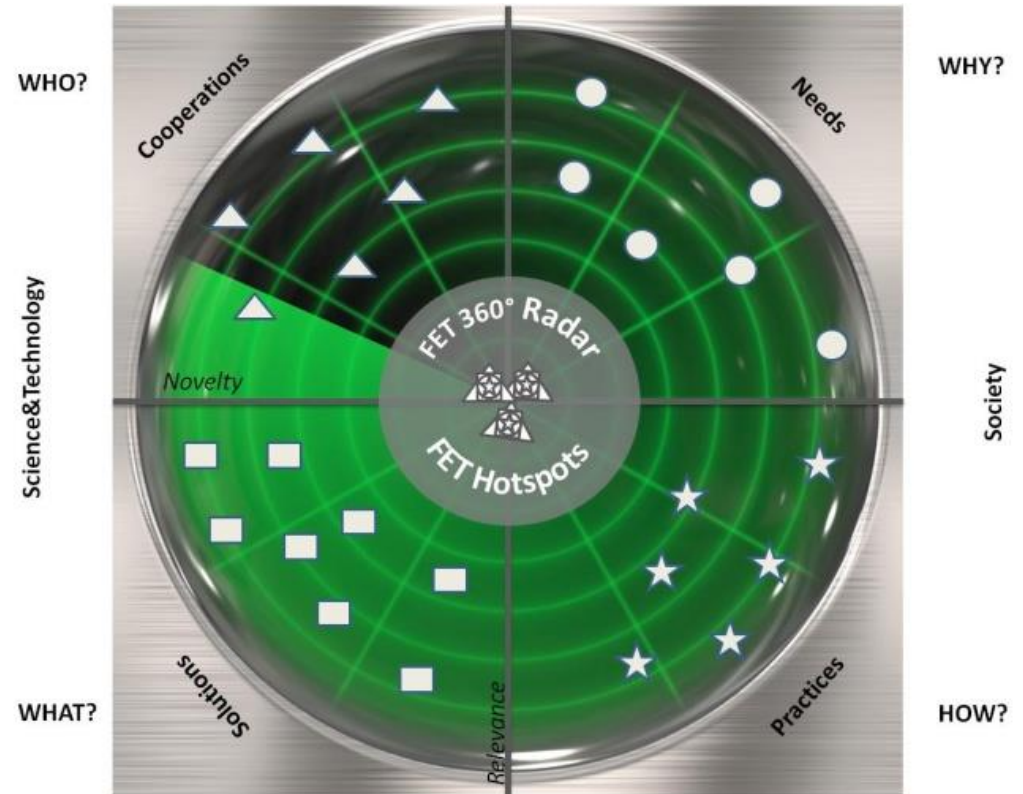


# OBSERVE Conceptual Background II/III

Insights from social science & innovation research looking at technology dynamics (STS):

Novelty emerges from an interplay of developments in different societal domains

- > No mere technology screening but
- > multi domain approach to capture emerging aspects of different types



# OBSERVE Conceptual Background III/III

- Innovation studies:

Innovation often emerges from the fringes of the innovation system – take into account “fringe sources” from the periphery of today’s innovation system discourse

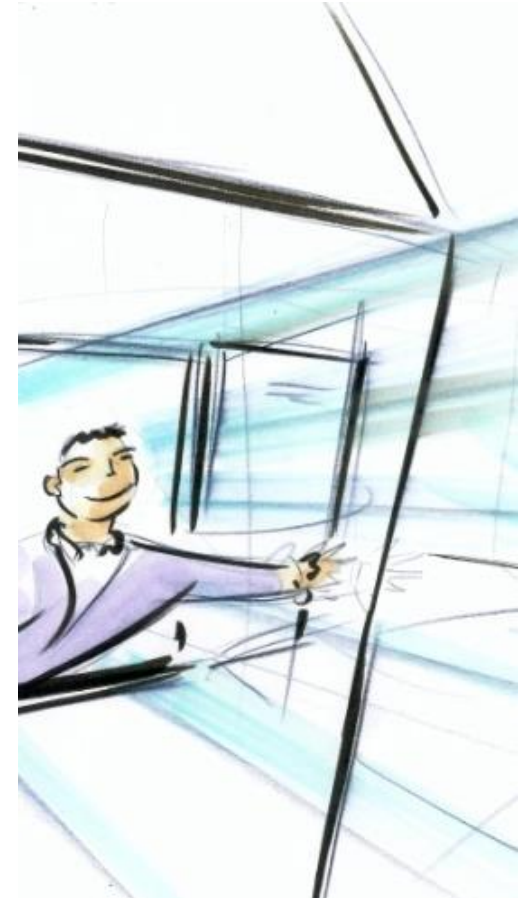
- Future Studies:

Constructivist approach to horizon scanning: Not possible to discern „signals from the future” BUT to widen perception for greater variety of developments

->Set up robust multi actor dialogue on „emerging seeds of change hypotheses” stemming from diverse sources

->systematically counteract cognitive biases to introduce a greater variety of aspects into the strategic conversation

-> Three Horizon Framework – Use Imagination to explore paradigmatic change



# OBSERVE Scouting Framework - How

Capture of emerging seeds of change hypotheses in access database

- Generated through scouting 06-12 2015
- Entry through structured mask by team of scouts. Capture of finding + metadata and sources in access database
- Constant revision and synthesis of entries (including by Advisory Board)
- Assessment of "Impact Level":  
Fundamental, Widespread, Mid Range, Local

-> Result: 618 entries from 106 sources with core information, sources and background information. 171 emerging topics hypothesis selected for OBSERVE.



Datensätze verwalten

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Potential Emerging Topics

Suche nach ID

ID:

Emerging change hypothesis short name:

found by:

Short description of the emerging change hypothesis:

Type of Change:

Source Type:

Date Publication:

Source:

Identification method:

Cluster:

Thoughts on the novelty of this entry:

Thoughts on relevance for society and EU competitiveness:

Thoughts on Foundational/Disruptive Potential:

Thoughts on the credibility of hypothesis eg quality of source:

link:

background material:

Project:

Date of entry:

# OBSERVE Horizon Scanning Approaches

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- **FET Portfolio Analysis**  
Analysis of proposals submitted to FET Open (FP7 and H2020) and currently running FET projects.
- **Publication Analysis**  
Automated screening of scientific journal publications in web of science
- **Web-mining**  
Semi-Automated analysis of tweets from a range of S&T blogs (eg. BBC SiTech, Wired)
- **Manual Scouting**  
Manual screening of a diverse range of fringe and antenna sources from different domains including news, blogs, magazines, science fiction and art (eg Ars Electronica, designboom, Monocle, IFTF, Royal Society, ...)





# OBSERVE Scouting Sources

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- News from 20 platforms (Antenna: eg. Ars electronica, designboom) as well as fringe sources (eg. instructables, treehugger), coverage of 13 human needs
- 11 events (eg. London Future Fest, POC 21)
- 11 Foresight sources (eg. IFTF, OECD, Radical Technology Inquirer, State of the Future)
- 71 Science Fiction Novels 2005-2015 (Wetzlar Library)
- TED talks tagged technology from 2015 TED conferences
- Kickstarter platform - funded projects in the category technology
- XPRIZE
- Twitter Analysis: 70250 Tweets from 27 channels
- Thomson Reuters Research Fronts
- FET Projects (67 running FET Open)
- FET Proposals (4035 submitted to FET Open (FP7 and H2020))

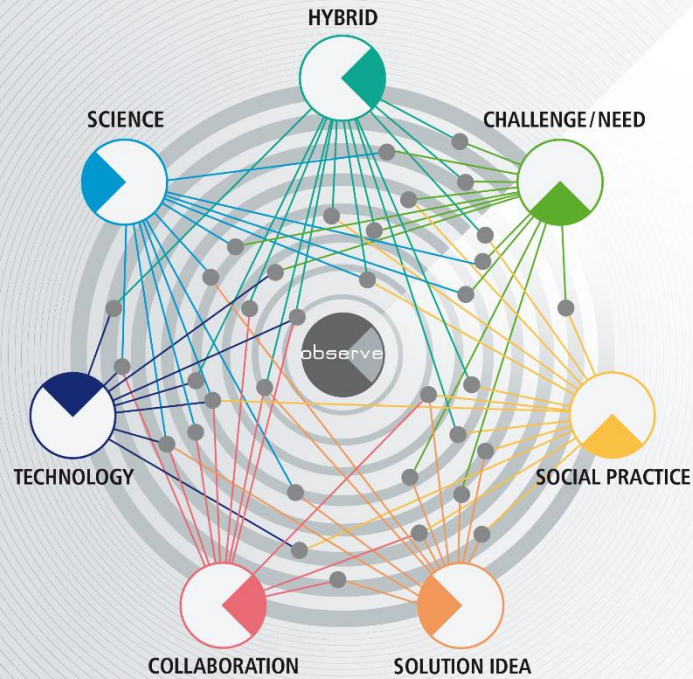


# OBSERVE RADAR CONTENT



# OBSERVE 360° RADAR

Horizon 2020-101015882



- 1 HPC System Disruptions
- 2 Game Change Enabling Materials
- 3 Bacteria Management Strategies
- 4 Biomimicry New Frontiers
- 5 Beyond, Within and Into the Brain
- 6 Zero Waste Technologies
- 7 Civilisational Transformation
- 8 Breathtaking Air Research
- 9 Infrastructures for Communicating in New Dimensions
- 10 Revolutionary Healthcare Diagnostics
- 11 Global Enabling Infrastructures for New Economic Patterns
- 12 Dormant Effects of Climate Change
- 13 Emergency Preparedness
- 14 Groundbreaking Food Supply Systems
- 15 Low Footprint Chemical Processes
- 16 Understanding Beneficial Human Machine Symbiosis
- 17 Socio-Technical Internet Futures
- 18 New Ways of Exploiting Functions of Living Organisms
- 19 Mixed Realities for Extended Human Sensation
- 20 Next Generation Energy Storage (Beyond Lithium)
- 21 Novel/unconventional Therapeutic Approaches
- 22 Privacy Providing Systems
- 23 Quantum Research
- 24 Unlocking Opportunities by Embracing Complexity
- 25 Re-Engineering Life
- 26 Shifts in Research Practices
- 27 Robotic Frontiers
- 28 Multi-Signal Sensing Systems
- 29 Shifting Understanding of Life and its Boundaries
- 30 Solar Age
- 31 Future Living Spaces
- 32 Diverse Unconventional Energy Supply Solutions
- 33 Underwater Operations
- 34 Water Challenge

[www.horizon-observatory.eu](http://www.horizon-observatory.eu)

# RADAR CONTENT LEVEL I

## 171 Seeds of Change



# 171 Seeds of Change

**Emerging seeds of change hypotheses** = Plausible claims for relevant novel developments. Out of the 618 individual observations we extracted 171 such seeds of different types.

## Types of seeds

- Challenge/Need (14)
- Science (21)
- Technology (36)
- Solution Idea (6)
- Social Practice (6)
- Collaboration (7)
- Combinations of two types (52)
- Hybrids (mix of all types) (29)



# Example: Seed of change emerging from three observations

## The Conversation May 21, 2015

*"The skyscrapers of the future will be made of wood"*

## Designboom July 20 2015

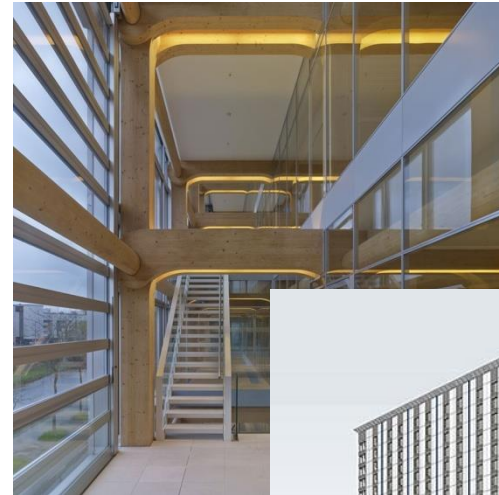
*"shigeru ban's first UK project to be a residential scheme composed of timber"*

## Motherboard October 9th 2015


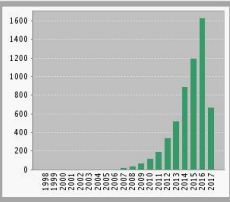

### The rise of the wooden skyscraper

*"Earlier this month, the University of British Columbia announced that construction on its new student residence was set to begin. No ordinary residence, the 18-story building will be constructed from wood."*

**→OBSERVE Seed of Change  
Wooden material on the rise (SP&T1)**



# Assessments for each Seed of Change

	Characteristic	Categories
	<p><b>DIV-Discourse Diversity</b> Diversity of underlying sources</p>	<p><b>Low:</b> 1-3 types of sources <b>Mid:</b> 4-6 types of sources <b>High:</b> 7-10 types of sources</p>
	<p><b>PUB-Scientific Publications:</b> Level and dynamics of scientific publications in Web of Science 1997-2017</p>	<p><b>Low:</b> 1-100 <b>Mid:</b> 100-1000 <b>High:</b> 1000-10.000 <b>Very High:</b> &gt; 10.000</p>
	<p><b>IMP-Impact Level:</b> Level of potential impact of the emerging development</p>	<p><b>Local:</b> impact in a specific domain <b>Mid Range:</b> impact across several domains <b>Widespread:</b> impact across society <b>Fundamental:</b> impact on the long-term future of human civilisation.</p>



# Seed of Change Examples

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# Seed of Change Examples

## *Type Science*

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- **S4 Molecular communication**

Use of molecules for communication has been successfully applied by scientists in a very basic setting using a battery-powered liquid sprayer. This could be useful for cases where electronic transmission fails (e.g. communication between robots in disaster recovery or in-body communication).

Source: The Economist Technology Quarterly;

IMP: Local; DIV: Low; PUB Mid

- **S20 Nanolattices**

Strong, lightweight, and recoverable three-dimensional ceramic nanolattices are being developed at the University of Cambridge. Some expect that these materials could revolutionise a wide number of applications from battery electrodes to growing bones. The bottleneck is the large scale production of the material. Source: MIT EmTech 2015;

IMP: Mid-Range; DIV: Low; PUB: Low



# Seed of Change Examples

## *Type Challenge/Need*

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- **N9 Threat of “space weather”**

The threat of space weather is more and more important because our life has a strong dependence on satellites. The UK government has developed a Space Weather Preparedness Strategy. Understanding of the mechanisms at play is still poor. Source: DEEPSTUFF.ORG;

IMP: Widespread; DIV: Low; PUB: High

- **N14 Particle pollution may be the main cause for brain degenerative diseases**

Scientists have collected evidence that particle pollution may be the main cause for brain degenerative diseases. A recent study in the peer-reviewed journal Environmental Health and Technology estimated that we could avoid two million deaths globally by cleaning up the world's air. Source: Mother Jones;

IMP: Widespread; DIV: Low; PUB: Mid



# Seed of Change Examples

## *Type Technology*



- **T8 Bio-sensors: Using plants as environmental sensors and connecting them to sensor networks**

Plants can be used as sensors to monitor environmental parameters, such as temperature, humidity, air quality, etc. In the future, the sensing information of plants may be accessed by a technical device and the signal will be transferred over a wireless network. This way, many new applications become possible as data will be available to monitor any environment of interest. Source: FET Projects

IMP: Local; DIV: Low; PUB na

- **T17 Fully autonomous production organism**

If industry 4.0 becomes bigger and more connected, this could mean the end for industrial production as we know it. In science fiction it is envisaged that all production is accomplished by an artificial organism that works fully autonomously. Source: Science Fiction Novel "Herr aller Dinge";

IMP: Fundamental; DIV Low; PUB none



# Seed of Change Examples

## *Type Social Practice*



- **SP2 Time as money**

Artist Gustavo Romano carried out a series of actions in public spaces utilizing a monetary system based on units of time (Spot#1. Lost time refunded, Spot#4 Buying time, Time Notes). The actions refer to different local and global issues: the exchange systems, the over-employment and unemployment, the increasing virtualization of the economy, and the existential relationship of the human being with his own lifetime. Source: Exhibition: A brief history of the future;

IMP: Fundamental; DIV: Low; PUB Low

- **SP1 Cycling Futures**

The bicycle is emerging as a central component of urban and avantgarde lifestyles. Several of the most advanced concepts in city planning and mobility are centering on the bicycle. Highly interdisciplinary research is exploring ways to establish cycling centred city transport systems. Source: Monocle

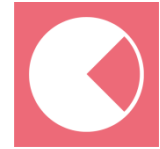
IMP: Mid Range; DIV: Low; PUB: Very high



# Seed of Change Examples

## *Solution Idea*

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- **SI5 Long-term timekeeping**

The Long Now initiative is establishing a clock that would still be readable for 10,000 years. The clock is an icon for long-term thinking, envisioned as a way to get people to think in very long terms about the consequences of their choices.

Source: American Libraries Magazine;

IMP: Fundamental; DIV Low; PUB: na

- **SI1 Local energy production will power the smart grid**

As the smart grid begins to take shape, a big push is emerging for more localized energy production. The idea is to deploy cheaper and more climate-friendly solar, wind, and fuel cell technology at the neighbourhood scale, with smart routing and storage. Watch for widespread decentralization of energy grids as digital intelligence and renewable energy technologies drive power production to the edges of our networks. Source: Institute For The Future IFTF;

IMP: Widespread; DIV Low; PUB na



# Seed of Change Examples

## *Type Collaboration*

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- **C3 Urban catalysts**

Architects and designers around the globe are adopting a new mode of intervention into urban development called tactical urbanism. At the core is the use of micro interventions that function as catalysts for change. A creative and resourceful appropriation of the city's conflictual conditions expressed in terms of informal urban objects and habitats.

Source: Vienna Biennale/MoMa

IMP: Local; DIV: Low; PUB none

- **C7 Astronomy and geology collaborate**

Geologists have found iron 60 in a rock sample from the sea floor. This has given new insights on the dying of supernovas. The link between geology and astronomy is little exploited yet but could be more relevant in the future. Source: Intelligent Life

IMP: Local; DIV Low; PUB Low



# Seed of Change Examples

## *Mixed Types*

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- **Social Practice&Science SP&S1 Bugs not drugs**

Increased understanding of the microbiome - the community of microorganisms in our bodies-is challenging our long-running obsession with antibacterial measures. New approaches to staying healthy will be based on balancing the ecologies of microorganisms: think "bugs, not drugs." Indiegogo-funded uBiome is already helping people better understand their germs by sequencing the bacteria in their bodies. Source: Institute For The Future IFTF;

IMP: Widespread; DIV: Low; PUB: Very High



- **Need & Technology N&T7: Carbon nanofibres from CO2 in the air**

Scientists in the US have found a way to take carbon dioxide (CO2) from the air and make carbon nanofibres. The team says it can be "scaled up" and could have an impact on CO2 emissions, but other researchers are unsure. The basic idea of "harvesting" materials from the air has also been brought forward in science fiction. Source: Motherboard;

IMP: Mid Range; DIV: Low; PUB: none



# Seed of Change Examples

## *Type Hybrid*



- **H 15 Human animal relationship**

The relationship between animals and human beings is changing. Firstly, there is a kind of technical domestication apparent in developments like remotely controlled bugs (biodrones), fish-guiding robots or genetically altered pets. With science increasingly pointing to animal culture and self awareness there is debate on (human) rights for animals and ever more people adopt vegetarianism and veganism. Source: Several;

IMP: Mid Range; DIV: Mid; PUB: Mid

- **H 20 Solar age**

The reinforced search for renewable energy sources forwards the solar technology and solar installations in generally. Many advanced technologies and techniques emerge: New designs and materials for solar cells, solar powered devices and monitoring of favourable conditions for solar panel installation (e.g. in space) were key topics in the current debate. Social scientists are discussing patterns of life in solar age e.g. new strategies to better use daylight. Source: Several;

IMP: Widespread; DIV High; PUB: High





# Examples for Seeds of Change with high discourse diversity

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## H2 Biomimicry new frontiers:

- BBC Futures,
- Country Living,
- The Engineer,
- Motherboard,
- The New York Times,
- Sciencemag,
- FET Projects +
- Webmining +
- Antenna Interview

## H23 Understanding and influencing human behavior:

- intelligencesquared,
- BBC Futures (4),
- Monocle,
- Sociological Review (2),
- Intelligent Life,
- The Verge,
- discover society,
- Catalysts for Change (IFTSF),
- Nesta,
- The sociological imagination,
- FET Proposals (2),
- FET Projects (1) + Webmining

## H9 Distributed Collaboration Platforms:

- The Verge,
- FET Tweet,
- Nesta,
- shareable,
- The Guardian,
- Monocle,
- OuiShare Fest,
- Creative Construction



# RADAR CONTENT LEVEL II

## 34 Hotspots



# 34 OBSERVE Hotspots of Change I/II

	<b>Title</b>	<b>DIV*</b>	<b>PUB*</b>	<b>IMP*</b>
1	HPC System Disruptions	Mid	Very high/rising fast	Widespread
2	Game Change Enabling Materials	Low	High/rising fast	Midrange
3	Bacteria Management Strategies	Mid	High/rising fast	Widespread
4	Biomimicry New Frontiers	High	Mid	Widespread
5	Beyond, Within and Into the Brain	Mid	Very high	Fundamental
6	Zero Waste Technologies	High	High/rising fast	Widespread
7	Civilisational Transformation	High	-	Widespread
8	Breathtaking Air Research	Low	Mid	Local
9	Infrastr. for Communicating in New Dimensions	Mid	Mid	Local
10	Revolutionary Healthcare Diagnostics	Low	Very high/rising fast	Midrange
11	Enabling Infrastructures for New Economic Patterns	High	Mid/rising fast	Fundamental
12	Dormant Effects of Climate Change	High	High/rising fast	Fundamental
13	Emergency Preparedness	High	High	Widespread
14	Groundbreaking Food Supply Systems	High	Mid	Widespread
15	Low Footprint Chemical Processes	Low	High/rising fast	Midrange
16	Understanding Beneficial Human Machine Symbiosis	High	High	Widespread
17	Socio-Technical Internet Futures	High	High	Widespread



\*DIV=Discourse Diversity, PUB = Publication Level, IMP=Impact level

# 34 Hotspots of Change II/II

	<b>Cluster Title</b>	<b>DIV*</b>	<b>PUB*</b>	<b>IMP*</b>
18	New Ways of Exploiting Functions of Living Organisms	Mid	Very high/rising fast	Midrange
19	Mixed Realities for Extended Human Sensation	Low	High	Widespread
20	Next Generation Energy Storage (Beyond Lithium)	Low	Very high/rising fast	Widespread
21	Novel/unconventional Therapeutic Approaches	Low	High/rising fast	Midrange
22	Privacy Providing Systems	Mid	Mid/rising fast	Widespread
23	Quantum Research	Low	Mid/rising fast	Widespread
24	Unlocking Opportunities by Embracing Complexity	High	Very high	Widespread
25	Re-Engineering Life	Mid	High/rising fast	Fundamental
26	Shifts in Research Practices	Mid	High/rising fast	Widespread
27	Robotic Frontiers	Low	Mid/rising fast	Midrange
28	Multi-Signal Sensing Systems	Low	High/rising fast	Widespread
29	Shifting Understanding of Life and its Boundaries	Mid	Mid /rising fast	Midrange
30	Solar Age	High	High	Widespread
31	Future Living Spaces	High	High/rising fast	Widespread
32	Diverse Unconventional Energy Supply Solutions	High	Very high/rising fast	Widespread
33	Underwater Operations	High	Very high	Midrange
34	Water Challenge	High	High/rising fast	Fundamental



\*DIV=Discourse Diversity, PUB = Publication Level, IMP=Impact level

# The 34 Hotspots

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# HPC System Disruptions

Current patterns of high performance computing (HPC) are challenged by a number of disruptive technologies such as Quantum Computing, Non-volatile Memory (NVM) technologies (including spintronics), Photonics, Resistive Computing, Neuromorphic Computing, Quantum Computing, Nanotubes, Graphene and Diamond Transistors but also Biocomputing approaches. At the same time also computing practices may bring about changes. Research could explore radically novel HPC concepts in an integrated vertical approach.

1

## Related OBSERVE Seeds of Change

- Plasmonics T3
- Photonic crystals for optical computers T15
- Neuromorph computing T20
- Spintronics: New principles for new, ultra-high capacity storage devices T26
- Combination of scientific advances in nanotechnology, optics and spintronics with conventional electronics T29
- Combining quantum technology and photonics to realize a quantum computer T33
- Quantum computing challenges cryptography N&T8
- Biomanufacturing C4
- Distributed collaboration platforms H9
- DIY printing of circuits SP&T3
- Universal software bug N8

## Related FET Proactive Consultation Contributions

- Impact of Disruptive Technologies on High-Performance Computing in Next Decade
- SPIN COMPUTING: ultrafast, ultralow power, highly enduring and radiation hard
- Spin-orbitronics and topology for a new generation of low power reconfigurable spintronic devices
- Spin Orbit Effects for ultimately efficient spin dynamics/structures; Spintronics and Nanomagnetism for Brain-Inspired Computing
- Hybrid organic/inorganic spintronics; Spin: Advancing the art of electronics
- Developing the synergy between magnetism and light
- Exploring magnonics and spin charge conversion



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# Game Change Enabling Materials

Several of the most dynamic research fronts with highly recognized scientific publications are located in material sciences. While some of these present basic research on synthesis and properties of new materials, many focus on specific game changing applications especially in energy storage but also health, robotics, environmental technologies and ICT. In many cases sustainability considerations are an important aspect of the research.

2

## Related OBSERVE Seeds of Change

Emerging research front: Analysis of dynamic and static behaviour of functionally graded material S1  
Research front: Graphene and graphene oxide in biomedical application S11  
Emerging research front: Synthesis of functional gold nanorods (applications: biomedical, spectroscopies, optoelectronics) S13  
Nanolattices S20  
Plasmonics (light-matter interaction) T3  
Self-Propelled particles to treat severe bleeding T12  
Autonomous and soft materials for robot parts T22  
Use recently discovered graphene characteristics in novel applications T32  
Smart materials for shape-changing mobile devices and other interfaces T34

## Related FET Proactive Consultation Contributions

Molecular Materials in Spintronics and other Magnetic applications  
Magnetic Nanohybrids: Nanomagnets and nanomagnetic devices for energy con-serving applications  
Functionalized Magnetic Nanoparticles for Bio- and Biomedical Technologies (drug delivery)  
Next generation smart textiles  
Soft Robotics: the way for bringing science-based robotics to Society  
New materials for life  
Supramolecular chemistry and mesotechnology



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# Bacteria Management Strategies

Several of the OBSERVE findings relate to the way humanity deals with bacteria. One of the most prominent aspects is the rise of antibiotic resistance which poses a severe threat to many established practices of today's societies. All the more relevant, seem other ways of dealing with bacteria such as antibacterial shields but also better understanding of the role of bacteria for human life (microbiome) and ways to influence bacteria e.g. through genome editing. At the same time bacteria are increasingly being used in manufacturing processes.

## Related OBSERVE Radar Elements

Post antibiotics N&S12  
Water based nano-bacteria shields N&S6  
Antibacterial bio-microfilm N&S3  
Understanding the microbiome S7, SP&S1  
Emerging research front: CRISPR/CAS Genome-editing technology S8  
Biomanufacturing C4

## Related FET Proactive Consultation Contributions

Infection-free medical devices would save lives!



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4

## Biomimicry New Frontiers

A rapidly growing number of technologies are inspired by biological functions and solutions. One driver of the new momentum for biomimicry is the advance in simulation and freeform manufacturing (3D printing). Current examples of cutting edge biomimicry innovations include smell-guided-navigation, jellyfish inspired locomotion, insect-inspired robot design (vision and movement) and research into animal system behaviour (e.g. ants) that could help us develop the internet – or even understand how cancer spreads. Furthermore, biological principles and characteristics could be used for better computing. There are already many attempts to emulate biological systems in order to enhance computer chip performance or binary communication processes as well as bioinspired parallel and neuromorphic computing. In the 2015 Lift China Conference there was a focus in biomimicry as the next generation sustainability concept.

**Related OBSERVE Radar Elements**  
Biomimicry New Frontiers H2



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5

## Beyond, Within and Into the Brain

The findings from the OBSERVE screening include several topics related to the brain. On the one hand research on understanding the human brain and brain related innovation such as direct brain to brain communication is fast advancing. At the same time, several societal questions are emerging such as understanding the co-evolution of the human brain and the digital society and dealing with mental illness.

### Related OBSERVE Radar Elements

- Brain networking H28
- Artificial brain S12
- Brain cell transplantation N&S4
- Mental illness controversy N12
- The human brain in the digital society C6
- Global Challenge: Education and learning N4
- Measuring Imagination S10
- Timekeeping mechanism of human brain uncovered S6
- Brain understanding S19
- Understanding and influencing human behaviour H23
- Non-invasive brain influencing T28
- Treating phantom pain with a mirror SP&S2
- Particle pollution may be the main cause for brain degenerative diseases N14
- Brain interfaces and implants T18



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# Zero Waste Technologies

Approaches towards a sustainable and circular cradle2cradle economy feature prominently in the debate among scientists, innovators, actors from civil society and policy makers. Establishing fully circular resource flows is however extremely demanding both for design and production. Circular solutions are bound to disrupt established patterns of science and engineering on the one hand and production and consumption on the other.

## Related OBSERVE Radar Elements

Circular material flows H5

Wooden material on the rise SP&T1

Carbon nanofibres made from CO<sub>2</sub> in the air N&T7

6



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# Civilisational Transformation

Some of the OBSERVE screening results reflect on possibly upcoming fundamental transformations of human civilisation. Drivers of the debate include both severe threats such as antimicrobial resistance and decline of global forests and opportunities such as exploration of space and underwater territories as new human habitats.

## **Related OBSERVE Radar Elements**

Future of civilization H12  
Technological singularity H16  
Forest health H27  
Underwater operations H24  
Long term preservation of knowledge and timekeeping SI4/5  
Post antibiotics N&S12  
Extraordinary advances in facial recognition cause huge privacy issues N&T9  
Space exploration H21



# Breathtaking Air Research

Air pollution is a key topic in current futures debates. Monitoring air pollution as well as better understanding its evolution and effects pose substantial challenges to current research. For combating air pollution radical solutions are required.



## **Related OBSERVE Radar Elements**

Research front: Atmospheric aerosol nucleation and growth  
N&S16

Carbon nanofibres made from CO<sub>2</sub> in the air N&T7

Moss walls for air cleaning SI2

Particle pollution may be the main cause for brain degenerative diseases N14

Bio-sensors: Using plants as environmental sensors and connecting them to sensor networks T8



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# Infrastructures for Communicating in New Dimensions

The OBSERVE screening revealed a diverse set of items related to the way we communicate ranging from highly technical aspects like molecular communication and spectrum overcrowding to cultural changes like the rise of active audiences and compressed communication through emoticons.

## **Related OBSERVE Radar Elements**

Compressed conversations SP4  
Terahertz communication enables a new range of wireless applications in the fu-ture T14  
Spectrum overcrowding N11  
Active audiences H3  
Molecular communications S4

## **Related FET Proactive Consultation Contributions**


Misinformation Spreading  
Automatic Fact Checking Technology for Improving our Society  
Molecular Communication



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# Revolutionary Healthcare Diagnostics

In the field of diagnostics disruptive advances may be upcoming through a combination of several developments. On the one hand diagnostic technology is able to analyse ever more parameters with ever lighter and cheaper equipment and in less time. At the same time more diseases can be detected through analysis of fluids especially blood, due to advances in life sciences.

10

## **Related OBSERVE Radar Elements**

Microfluidics advancing Lab-on-a-Chip-technologies & other new applications T5  
Enhanced bloodtest functionality N&T11  
Fast HIV detection N&T10  
Micromotors in nano-scale micro-electro-mechanical systems T36  
Cancer-detection in real-time T31

## **Related FET Proactive Consultation Contributions**

IDAlert (self diagnosis device)  
Biosensors for Point-of-Care Applications  
Detecting risk factors for Alzheimer's disease decades before disease onset to enable early therapeutic intervention



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# Global Enabling Infrastructures for New Economic Patterns

A number of items captured in the OBSERVE radar reflect on emerging new economic models, the related modes of production and consumption and associated societal and technical transformations. One aspect often stressed is the emergence of a new type of distributed infrastructures for these emerging patterns.

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## **Related OBSERVE Radar Elements**

Time as money SP2

Postcapitalist economy H10

Global Challenge: Transnational organized crime N3

Distributed collaboration platforms (eg. blockchain) H9

## **Related FET Proactive Consultation Contributions**

How much is a bitcoin worth, and why?



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# Dormant Effects of Climate Change

The dynamics and effects of climate change are subject to intense research in many disciplines. Researchers from all-over the world point to the increasing likelihood of yet unknown catastrophic events as well as severe health risks and urge acting now. While some aspects are widely researched and discussed, the OBSERVE screening brought up also less explored aspects such as the rise of wildfires, possible emergence of super-storms and effects on soil bacteria.

**Related OBSERVE Radar Elements**  
Effects of climate change N&S24

12



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# Emergency Preparedness

Several of the findings of the OBSERVE screening point to possible disruptive events that may lead to emergency situations for human societies. At the same time the findings include strategies to deal with and prepare for specific threats and for disruptive change in general.

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## **Related OBSERVE Radar Elements**

- Post antibiotics N&S12
- Threat of “space weather” N9
- Pandemics strategy N13
- Big data supported crisis management N&T17
- Submarine Cables for Environmental Monitoring H8
- Decline in solar activity by 2030 N10
- Universal software bug N8
- 3D printed emergency shelter N&T5
- Distributed collaboration platforms H9

## **Related FET Proactive Consultation Contributions**

- FORMAL VERIFICATION OF SAFETY-CRITICAL DISTRIBUTED SYSTEMS
- Protection of the Sun against energy informational fields
- Development of the telescope for supervision in a range of vibrations of zero energy
- Detection of tunnels with hydrocarbons which will rescue a civilization from de-struction





# Groundbreaking Food Supply Systems

Feeding the world without transgressing the earth's carrying capacity is one of the key challenges of the future that is also deeply related to other challenges such as water, energy, housing and health. In the near future we have to produce 70% more food than today without harming the environment. Meanwhile, the decrease in variety in plant and animal based food (eg rice/apples) is making food systems more susceptible to pests and diseases. Globally dependency on grain imports is on the rise. Production of meat and fish is rising steeply. At the same time ever more people advocate fundamental changes in human animal relationships. Technical approaches to food production such as smart floating farms, high-tech urban farming (e.g. vertical aquaponic growing system), fully automated and artificial food abound. Another angle is the reduction of food waste. Finally, there is a growing threat from foodborne diseases. Research addressing infection or intoxication caused by pathogenic factors entering into human bodies through food is one of the most dynamic fields in agricultural, plant and animal sciences.

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## Related OBSERVE Radar Elements

Food systems H11

Synthetic food H22

Automated indoor farming T11

Human animal relationship H15



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# Low Footprint Chemical Processes

Already in 1998 scientists developed 12 principles of “green chemistry” underpinning more environmentally benign chemical processes with e.g. less waste, higher efficiency and toxicity to human health and the environment. Several findings of the OBSERVE analysis relate to these principles indicating that this domain is still a highly active and future relevant domain for research and innovation with room for disruptive and foundational approaches with substantial sustainability benefit.

15

## Related OBSERVE Radar Elements

Emerging research front: Metal organic materials with optimal adsorption thermo-dynamics and kinetics for CO<sub>2</sub> separation S14

Emerging research front: Magnetically retrievable nanocatalysts S16

Research front: Functional metal organic frameworks N&S20

Emerging research front: Synthesis of copolymers by direct arylation polycondensation S15

Emerging research front: Enhanced Visible Light photocatalysts N&S23

Research front: Synthesis of pillar [5/6] arenes & their host guest chemistry S9

Emerging research front: Photoinitiated polymerization and Photoinitiators S17



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# Understanding Beneficial Human Machine Symbiosis

New forms of machine-human-symbiosis emerge on all levels and across types of activities. Aspects range from automation in all spheres of human activities to augmentation of intimate functions within the human body. In spite of frantic research in many of the aspects many argue that there is still little progress in understanding human machine interaction patterns that truly benefit our societies.

## **Related OBSERVE Radar Elements**

- Machine Society H18
- Modelling the human SP&T2
- Automation H4
- Technological Singularity H16
- Human enhancement H1
- Robot reasoning H26
- Virtual Personal Assistant Bots T1
- Fully autonomous production organism T17
- Rise of the drones T2
- Cognitive overburden through perpetual evaluation SP6
- The human brain in the digital society C6
- Implants that store and transfer data SP&T5
- Optical implants N&T14
- Automated indoor farming T11
- Brain interfaces and implants T18
- Robots will become more human-like as their vocabulary comes closer to that of real humans T25
- Insights from cognition research and biology may enable better Ambient Intelligence (Aml) systems T27

## **Related FET Proactive Consultation Contributions**

- Home in a networked world; or rethinking architecture
- Adaptive bioelectronics



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# Socio-Technical Internet Futures

The internet will change in a technical and in a social way. Several debates are evolving around its long-term future. Some expect that smaller and more specific networks may emerge where processing power and intelligence is distributed to “smart-hotspots” that facilitate seamless local interaction between diverse networked people and things (IFTF). Others speculate about the way the digital and physical world may be interwoven in the future e.g. in a screenless “Internet **in** things” or a fully ambient user experience. At the same time some observers warn that even today’s expectations on the “Internet of Things” may be inflated and serious infrastructure bottlenecks are looming. Finally, efforts are under way to provide remote and mobile internet access points to the internet e.g. through drones or even satellites. On the societal side, the rise of non human traffic, trolls, viruses and abusive behaviour is raising concerns that trust in virtual communication is being undermined. Media and artists are increasingly pointing to the dark sides of the internet. Implementation of the “right to be forgotten” in the internet remains controversial. Attempts to create “offline spaces” are on the rise.

**Related OBSERVE Radar Elements**  
Internet Futures H17

**Related FET Proactive Consultation Contribution**  
Internet of People

17



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# New Ways of Exploiting Functions of Living Organisms

Several of the findings from the OBSERVE screening point towards novel ways of using living organisms such as bacteria or plants for fulfilling useful functions. Approaches range from using plants as environmental sensors and connecting them to sensor networks to bacteria-robot model systems.

18

## Related OBSERVE Seeds of Change

Biomanufacturing C4

Bacteria-robot model systems T21

Yeast that makes opiate-like molecules out of sugar N&S2

Bugs not drugs/the Microbiome S7, SP&S1

Moss walls for air cleaning SI2

Bio-sensors - Using plants as environmental sensors and connecting them to sensor networks T8



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# Mixed Realities for Extended Human Sensation

Several sources argue that we are entering the age of multiple realities. Technologies and practices which allow us to experience augmented or virtual reality are extremely prominent in the current discourse: 360 degree videos, advanced vr-gaming, vr-therapy, a real time painting 3D-model translator, vr development tools for animations, paint applications for oculus rift and space experiences. Virtualization and wearable computing devices are expected to combine to create a new wave of social technology. Oculus Rift already allows users to virtually explore real environments from the perspective of a child, and wearable recording devices are beginning to capture the details of everyday life. Developments like the personal headphones which can filter out unwanted noise point to a world where “reality will be in the eye (and ear) of the beholder”. VR and augmented reality topics are one of the most popular areas on Kickstarter. Science fiction novels envisage nano-cells on the skin that simulate an environment for the body that can be felt, heard and seen. Some observers argue that long term visions for “virtual reality societies” are lacking and several challenges remain.

**Related OBSERVE Radar Elements**  
Mixed Realities H25

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## Next Generation Energy Storage (Beyond Lithium)

Research and innovation in energy storage is highly dynamic driven by the rise of decentralised and renewable energy solutions. Important aspects are energy conversion efficiency, speed of storage, cost effectiveness and use of materials with low environmental and social impact. The field includes several potentially disruptive developments that go beyond today's lithium battery based solutions.

20

### **Related OBSERVE Radar Elements**

Organic flow batteries N&S7

Emerging research front: Supercapacitors from nanoporous carbon electrode N&S22

Research front: Electrode materials for sodium-ion batteries N&S19

Global Challenge: Energy demand N2

Reversible heat pump for energy storage N&T1

Decentralisation of energy supply N&T2



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# Novel/unconventional Therapeutic Approaches

Several of the OBSERVE findings refer to novel unconventional therapies for different diseases ranging from functionalised nanoparticles for bio- and biomedical technologies to rising interest of scientists in traditional medicine.

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## Related OBSERVE Radar Elements

- Prevent/repair heart attack N&S1
- Nano needles in regenerative medicine N&S5
- New methods for drug delivery inside the body N&S9
- Spontaneous regression N&S11
- Treating phantom pain with a mirror SP&S2
- Rising interest in traditional medicine C5
- Self-tracking pill N&T19
- Self-Propelled particles for treating severe bleeding T12
- Emerging research front: Control and treatment of schistosomiasis in Africa using the drug praziquantel N&S13
- Research front: Newly emerging psychoactive substances (new designer drugs) N&S17

## Related FET Proactive Consultation Contributions

- Electromagnetic medicine (EMF-MED)
- Emergent personalized nanomedicine
- Functionalized Nanoparticles for Bio- and Biomedical Technologies



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# Privacy Providing Systems

Privacy issues are an important element in current future oriented debates especially in the context of the rising use of big data analytics, face recognition and concepts like the internet of things or industry 4.0 on the one hand and concentration of user data in the hands of very few private companies on the other. Two OBSERVE emerging topics highlight the type of disruptive pathways that may be emerging both in terms of privacy threats and privacy solutions.

22

## Related OBSERVE Seeds of Change

Extraordinary advances in facial recognition cause huge privacy issues N&T9

Privacy preserving technologies N&T12



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# Quantum Research

A number of topics that emerged in the OBSERVE screening deal with quantum research. Aspects cover basic research needs and novel applications but also possible consequences for society such as challenges to established cryptography approaches.

23

## **Related OBSERVE Radar Elements**

Physicists set a new fiber-optic quantum teleportation record S5  
Research front: Synthesis and application of graphene quantum dots S21  
Quantum computing challenges cryptography N&T8  
Quantum squeezing S3  
Quantum technology will move from basic research to applications T30  
Quantum Computing: Combining advances in quantum technology and Photonics to realize a quantum computer T33

## **Related FET Proactive Consultation Contributions**

Quantum Nanophotonics  
NanoPhononics for Europe: Position, Strategic Agenda and Roadmap



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# Unlocking Opportunities by Embracing Complexity

Complexity is increasingly recognised both as a challenge and an opportunity in a wide range of science and practice domains. In the very rich and often controversial debate three aspects could be distinguished: Recognising and observing complex processes, decision making in the face of uncertainty, and approaches to embracing and even governing complexity. A central crosscutting aspect is the exploration of human thinking, decision making and behaviour as such.

## Related OBSERVE Radar Elements

Rise of complexity science H7  
Multi-disciplinary simulation research C2  
Data vs. Intuition? N7  
Freakthinking SP&S3  
Invisible human impact N&T18  
Global ethics N1  
Global foresight/decision making N5  
New kinds of sensors and their smart connection will give us a new level of control over our surroundings T16  
Intelligent combination of sensor-data replaces traditional technologies for authorization, monitoring and observation T10  
Brain understanding S19  
Understanding and influencing human behaviour H23  
Faster computers and newly available massive data hold the key for problems deemed too difficult to solve in the past T35

## Related FET Proactive Consultation Contributions

Foundations and Engineering of Collective Adaptive Systems (FoCAS)  
Beyond Digital; Algorithms under Uncertainty  
Predictable components, systems and systems of systems  
Global Systems Science; The Big Switch  
Theory of Evolving Systems; Practice and the Dynamism of Form  
A “game changing” science of structures

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# Re-Engineering Life

Several findings of the OBSERVE screening can be grouped under this heading as these approaches are actively attempting to push current boundaries of synthetically modifying or even creating life or else reflecting on the societal implications of such activities. Examples are debates on synthetic DNA, artificial brains and the emergence of an artificial superintelligence (technological singularity).

25

## **Related OBSERVE Radar Elements**

Emerging research front: CRISPR/CAS Genome-editing technology S8  
Synthetic DNA S2  
Bio patent conflicts - who owns your body? SP&T6  
Artificial brain S12  
Brain cell transplantation N&S4  
Technological Singularity H16  
Robot reasoning H26

## **Related FET Proactive Consultation Contributions**

3D BIOPRINTING EUROPE



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# Shifts in Research Practices

The OBSERVE screening revealed debates around changes in research practices. Some are driven by societal demands such as gender equality, transparency, citizen participation and animal rights others stem from shifts in scientific approaches such as increasing use of computational methods and integration of arts into research practices.

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## **Related OBSERVE Seeds of Change**

Distributed collaboration platforms H9  
Scientists share their embarrassing #fieldworkfail stories SP5  
Gendering in research innovation H13  
Human animal relationship H15  
Bioinformatics S18  
Research front: Human disease analysis using Genome Wide Association studies N&S18  
Digital humanities C1  
Multi-disciplinary simulation research C2

## **Related FET Proactive Consultation Contributions**

Fully integrating Arts in the S&T research and innovation agenda: the role of imagining and making in the creation of knowledge for innovation



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# Robotic Frontiers

Throughout the OBSERVE screening period robotics was an extremely dynamic field both in S&T sources and wider public debate. This was driven on the one hand by spectacular breakthroughs most notably in the field of deep learning and autonomous robotics. On the other hand social experiments and art projects such as the hitchhiking robot and the trust inspiring robot (Boxie) as well as popular fiction and movies featuring robots and AI fuelled the robotics discourse. Finally, in the ongoing debates around automation of ever more human activities and industry 4.0 robots form a core element. Aspects related to new forms of interactions between humans and machines are captured under human machine symbiosis.

## Related OBSERVE Radar Elements

- Robot to robot collaborations T23
- Robot learning T24
- Robot reasoning H26
- Bacteria-robot model systems T21
- New materials for robot parts T22
- Interdisciplinary research to build context-aware robots T7

## Related FET Proactive Consultation Contributions

Soft Robotics: the way for bringing science-based robotics to Society



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# Multi-Signal Sensing Systems

Novel developments in sensing are mainly driven by the use of new materials and new concepts. This includes social innovations such as citizen driven measuring and monitoring initiatives. At the same time urgent requirements such as measurement of ocean acidification are calling for novel solutions.



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## Related Seeds of Change

- New sensors to measure ocean acidification T13
- Emerging research front: Synthesis of copolymers by direct arylation polycondensation S15
- Motion microscope N&T16
- Distributed collaboration platforms H9
- Intelligent combination of sensor-data replaces traditional technologies for authorization, monitoring and observation T10
- Bio-sensors - Using plants as environmental sensors and connecting them to sensor networks T8

## Related FET Proactive Consultation Contributions

- Drone technology for conservation



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# Shifting Understanding of Life and its Boundaries

Our perception of what it means to be human and what characterises other species is shifting. Boundaries between humans and animals on the one hand and humans animals and machines on the other are blurring. Also plants are increasingly viewed in a new perspective e.g. as active communicators. New research methods transform the way we analyse species evolution.

29

## **Related OBSERVE Radar Elements**

Plant communication H14

Human animal relationship H15

Technological Singularity H16

Robot reasoning H26

Research front: Models for predicting potential distributions of species N&S15

Bacteria-robot model systems T21



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## Solar Age

The reinforced search for renewable energy sources forwards the solar technology and solar installations in generally. New designs and materials for solar cells, solar powered devices and monitoring of favourable conditions for solar panel installation (e.g. in space) were key topics in the current debate. Several research aspects in chemistry, material science but also social sciences emerged.

30

### Related Seeds of Change

Solar Age H20

Research front: Graphene-based photocatalysts N&S21

Emerging research front: Synthesis of copolymers by direct arylation polycondensation S15

Decline in solar activity by 2030 N10



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## Future Living Spaces

Several emerging topics relate to sustainable living spaces both in urban and rural areas. A particular focus could be on the question of how to dwell in a networked world. As highlighted by one contribution to the FET Proactive consultation there is an urgent need to rethink our approaches to the “built environment” and realise the high potential of cross-disciplinary research on adaptation of spaces to human needs.

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### **Related OBSERVE Seeds of Change**

Sustainable Housing H29

Urban catalysts C3

Urban system design H6

Cycling Futures SP1

Moss walls for air cleaning SI2

Bee highway SI6

Wooden material on the rise SP&T1

Personal Heating N&T13

Mobility futures H19

Rise of the drones T2

### **Related FET Proactive Consultation Contributions**

Home in a networked world; or rethinking architecture



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# Diverse Unconventional Energy Supply Solutions

Meeting global energy demand in a sustainable manner is one of the most discussed global challenges. In parallel to the mainstream lines of research for new energy technologies and concepts more unconventional approaches are followed by several research and innovation teams. In line with the diversification of energy technologies, innovations in grids and overall system designs are key topics of the debate on energy futures. A particular focus is on the decentralisation of energy supply.

32

## **Related OBSERVE Radar Elements**

Global Challenge: Energy demand N2  
Unconventional energy sources N&T15  
Local energy production will power the smart grid S11  
Decentralisation of energy supply N&T2  
Wireless transfer of electricity T9  
Energy Harvesting T4  
Energy from oxidation in human bodies N&T4

## **Related FET Proactive Consultation Contributions**

Energy sustainable ICT  
Powering the Internet of Things  
Demonstration Project of full scale floating prototype for Offshore Wind Market



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# Underwater Operations

Preparing for underwater operations emerges as a highly dynamic domain for research and innovation in a wide range of fields.

Key issues are underwater:

-gardening, -living, -(mini)robots, -cities, -streetview, -radio (graphene), -chemical plants, -charging, -flight, -volcanoes, -farms, -archaeology, - screening radar, -energy (wave/wind farms) and materials for underwater use.

**Related OBSERVE Radar Elements**  
Underwater H24

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# Water Challenge

Water and especially clean water is becoming a scarce resource in ever more areas as climate change threatens water security. We need global strategies to prevent this or deal with.

Implementation of existing strategies such as the European Water Framework Directive (WFD) requires suitable tools and methods. Water was one of the most addressed topics in 2015 science related tweets. Topics were water: -generation, -cleaning, -recycling, -pollution, -splitting, -based energy generation, -saving and -quality monitoring as well as measures dealing with droughts. Ways of measuring the quality of oceans, coastal and transitional waters is becoming an important research front in ecology. Another strand of debate is focussing on the future of oceans. Research on the impact of ocean acidification on marine ecosystems is growing fast. Artists such as Maarten Vanden Eynde (plastic reef) point towards the rise of plastic debris in the ocean – a topic that is also much discussed in science publications and media in general.

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## Related OBSERVE Radar Elements

Water Challenge N&S14

Decline of microscopic plant-life in oceans N&S10

Electric bio rocks save coral reefs N&T3

New sensors to measure ocean acidification T13

Noise pollution in sea threatens whales N6

Research front: Effects of ocean acidification on marine ecosystems N&S 24

## Related FET Proactive Consultation Contributions

FET in water and for water



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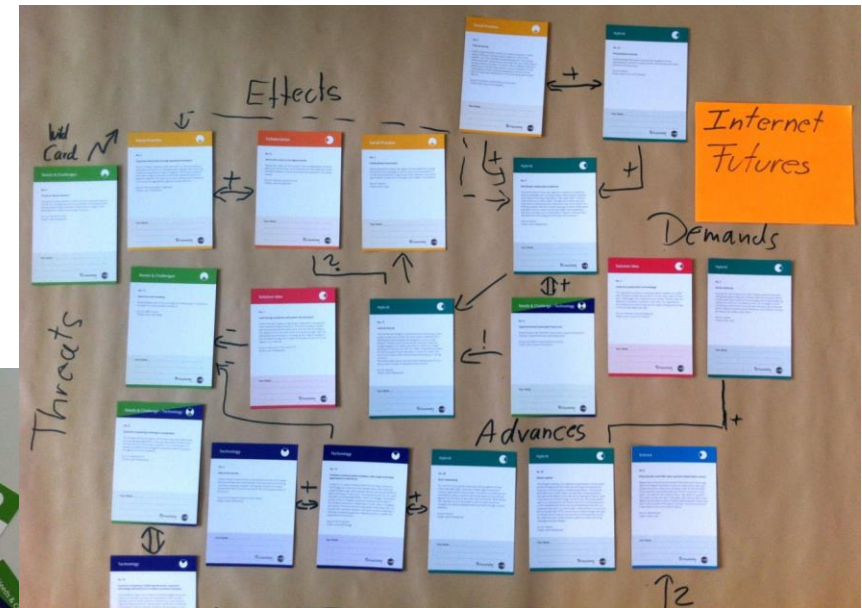


# Using the OBSERVE Radar

The radar elements on both levels i.e. emerging seeds of change and potential hotspots can be used by all types of organisations wishing to reflect on future directions.

Typical processes could be:

- System mapping
- Strategy building
- Idea generation





# Key Material Available for download

<https://www.horizon-observatory.eu/radar-en/downloads/>

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- **OBSERVE Toolkit** (Deliverable 4.3)  
*171 Emerging topics on cards & manual for using them in strategic conversations*
- **OBSERVE Potential Hotspot Report** (Deliverable 2.1)  
*All 34 Potential Hotspots, related emerging issues descriptions and assessments*
- **OBSERVE User Brief 2** (Deliverable 4.5)  
*All 34 Potential Hotspots descriptions and assessments*
- **OBSERVE User Brief 3** (Deliverable 4.6)  
*Description of a strategic workshop using the full radar material to identify relevant upcoming hotspots*
- **OBSERVE 360°Radar** (Deliverable 3.1)  
*Lists of full radar content, description of 11 hotspot topics elaborated in OBSERVE sense making workshop, indicators assessing characteristics of the overall set of hotspots.*
- **OBSERVE Roadshow**  
*Poster visualizing the radar and listing the 34 potential hotspots, 34 Cards each with a description of a hotspot and list of related emerging issues, OBSERVE presentation*





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More Information: [www.horizon-observatory.eu](http://www.horizon-observatory.eu)  
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This project has received funding from the European Union's Horizon 2020 FET Programme under grant agreement No. 665136