

***Foresight Europe Network
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**Using Foresight Knowledge and Practice
To Assess the Emergence of Bioeconomy**

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Programme POLONEZ
Project BIO-TSUNAMI:

**The New Tsunami of Socio-Technical
Change: Foresight of Agro/Bio/
/Chemo/Eco/Cogno... Convergence**

Presentation of Selected Results
Cartoons by Ondrej Valenta (TC, CZ)

Defining Bio-Economy

- ❖ *The term “bioeconomy” includes all industrial and economic sectors that produce, manage and otherwise exploit biological resources, and related services, supply or consumer industries, such as:*
 - Agriculture; fisheries; forestry; aquaculture;
 - Agro-, food, wood, fibre and other bio-industries;
 - Human and animal health; pharmaceuticals;
 - Biochemicals; biomaterials; “green” bio-chemistry;
 - Bioenergy; biofuels; other bio-products;
 - Bio-remediation; bio-waste management;
 - Bio/eco-systems management; rural development.

Strategic Opportunities of the EU

(SOURCE: EC Bioeconomy Panel)

- **High Stakes to Protect**
- **Change Dynamics Waves to Ride**
- **Innovation Potential to Utilize**
- **Environmental Aspects to Green**
- **Climatic Change to Limit**
- **Substitutes of Fossil Carbon to Offer**
- **Employment to Generate (Rural, Other)**
- **Quality & Security, e.g. of Food, to Target**
- **New SMEs and Other Business to Grow**
- **Policy Coordination to Achieve**
- **Smart Regional Specialisation**
- **European Value**
- **Global Co-operation & Development**

Major Risks and Threats

- **Soil Erosion – Desertification**
- **High-intensity Farming (Energy, Chemicals)**
- **High Intensity Animal Farming (Inputs)**
- **Global Food Imbalance (Malnutrition vs. Wastes)**
- **Food Chain and Water Supply Risks**
- **Further Degradation of Fragile Areas**
- **Societal Reactions to Some Biotechnologies**
- **Extreme Pressure on Forests & Bio-Resources**
- **Aggressive Introduction of New Energy Plants**
- **Dominant Culture of Youth & Beauty at all Costs**
- **Centralised Governance of Bio-Systems**
- **Unauthorised Use of Genetic Information**
- **Bio-Ethics and Morality Questions**

Key Challenge: Fragmentation vs. Integration - Role of Vision



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Roadmap to the Future

- **Implementing sustainable bioeconomy will depend upon new agricultural practices, new industrial technologies, new business models, and new skill profiles.**
- **This task requires a sense of urgency to move forward timely, and mobilize human and other key resources on this procedure, i.e., a true Copernican Revolution!**
- **A forward-looking approach is needed ...**

Main Approaches Followed

- **Kondratiev (K) Cycles** – Search for K6
- **Converging Technologies** (EC, NSF, OECD)
- **Radical Technology Inquirer (RTI)**
 - Global Value Producing Networks (GVPNs)
 - Radical Technology Solutions (RTS)
- **Horizon Scanning**
 - Problems & Opportunities - Clustering
 - Questionnaire (PL, GR, IT, EN) – Card Game
- **Drivers & Barriers – Emergence Scenarios**
- **Policy/R&D Conclusions/Recommendations**

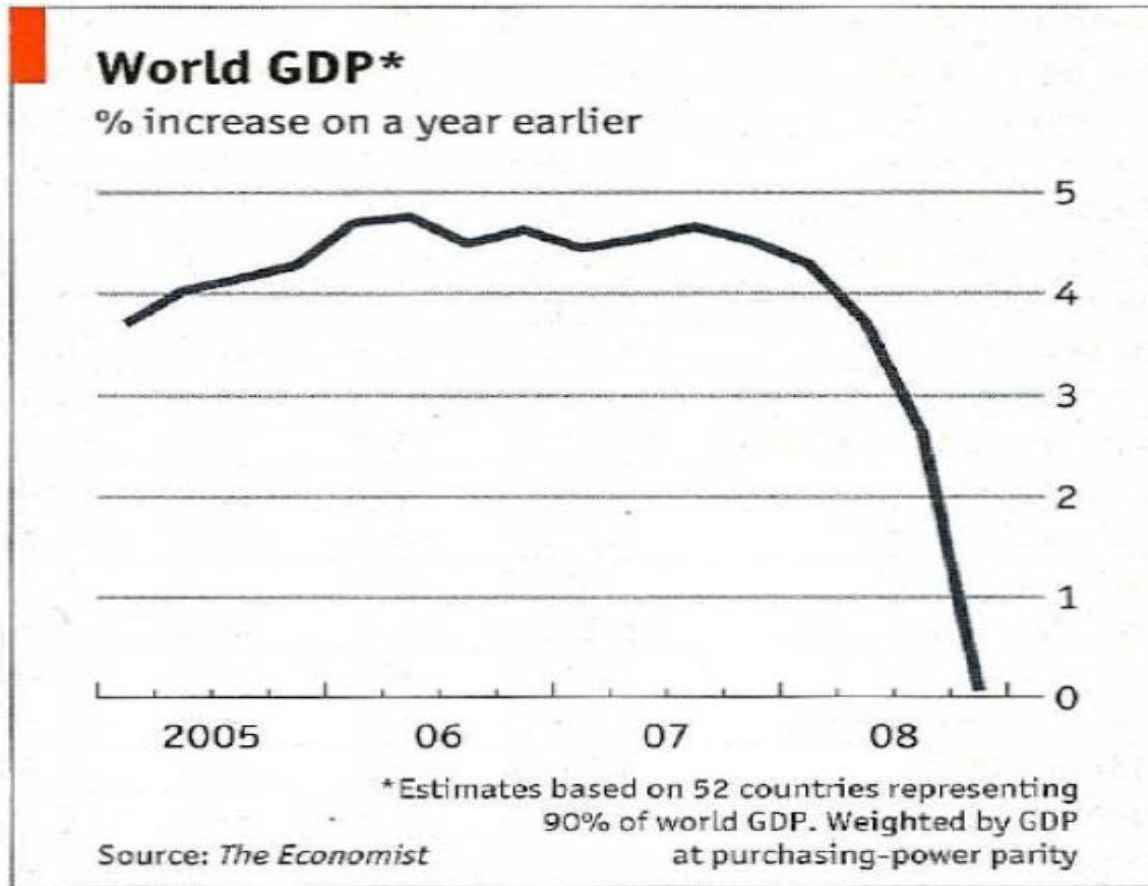
Nikolai Kondratiev (1892-1938)

The Long (or K) Waves of Socio-Technical Change

Wave Leading Sectors – Starting Year

- #1 Industrial Revolution – 1771 (0)
- #2 Steam and railroads – 1829 (58)
- #3 Steel and heavy engineering – 1875 (46)
- #4 Oil, electricity, automobiles and mass production – 1908 (33)
- #5 Information and telecommunication – 1971 (63)
- #6 To be determined – 2009 (40?)

2008: Falling into the Pit of Hell



With Only Limited Recovery...



Economist.com

The K-Waves with K6 Shift

Josef Schumpeter: Definition of a "Kondratieff"-Unit

**"applicable" to a national economy in general,
not applicable to all participants in a "market"**

Phase shift and overlap

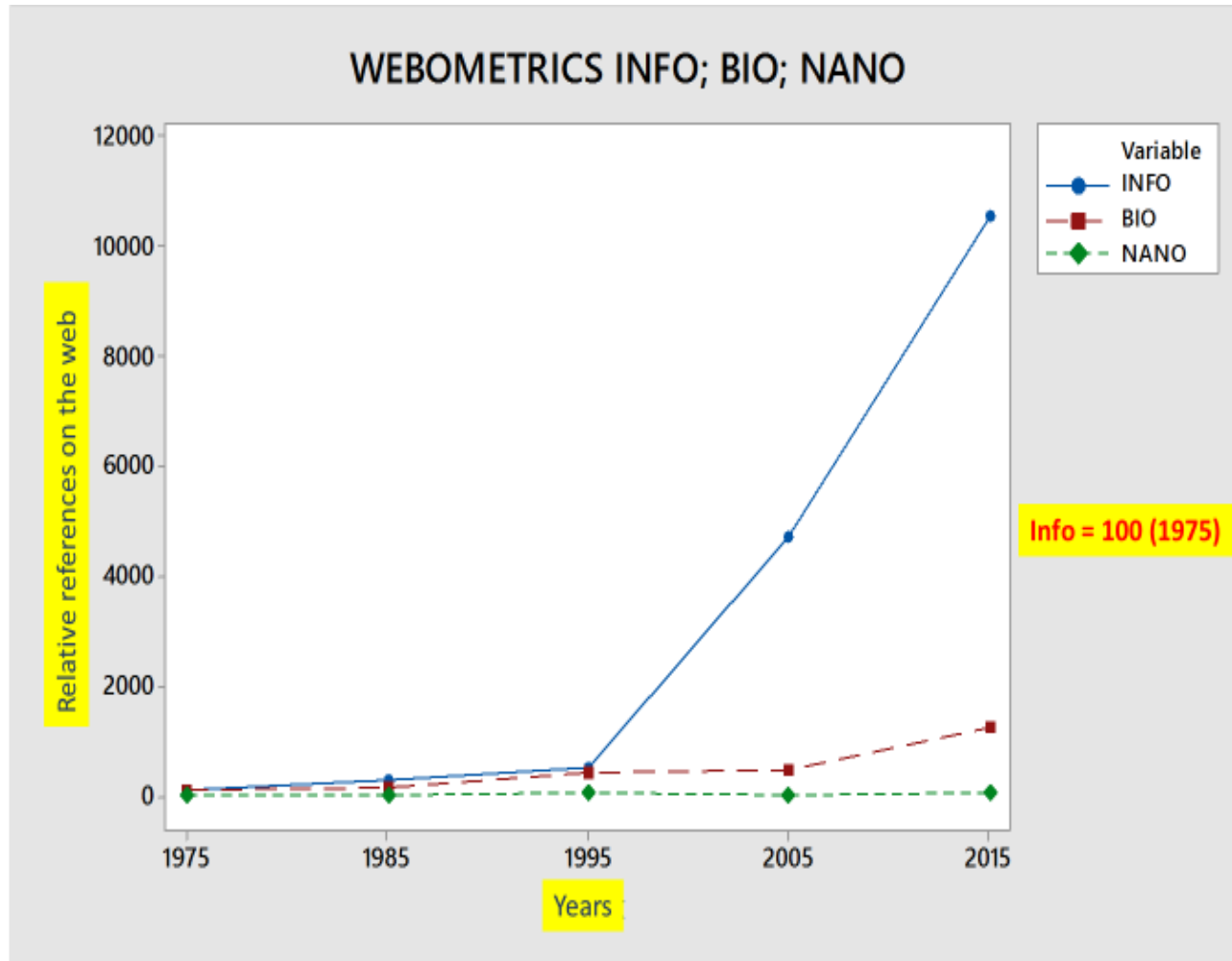


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Main Suggestions for K6 Elements

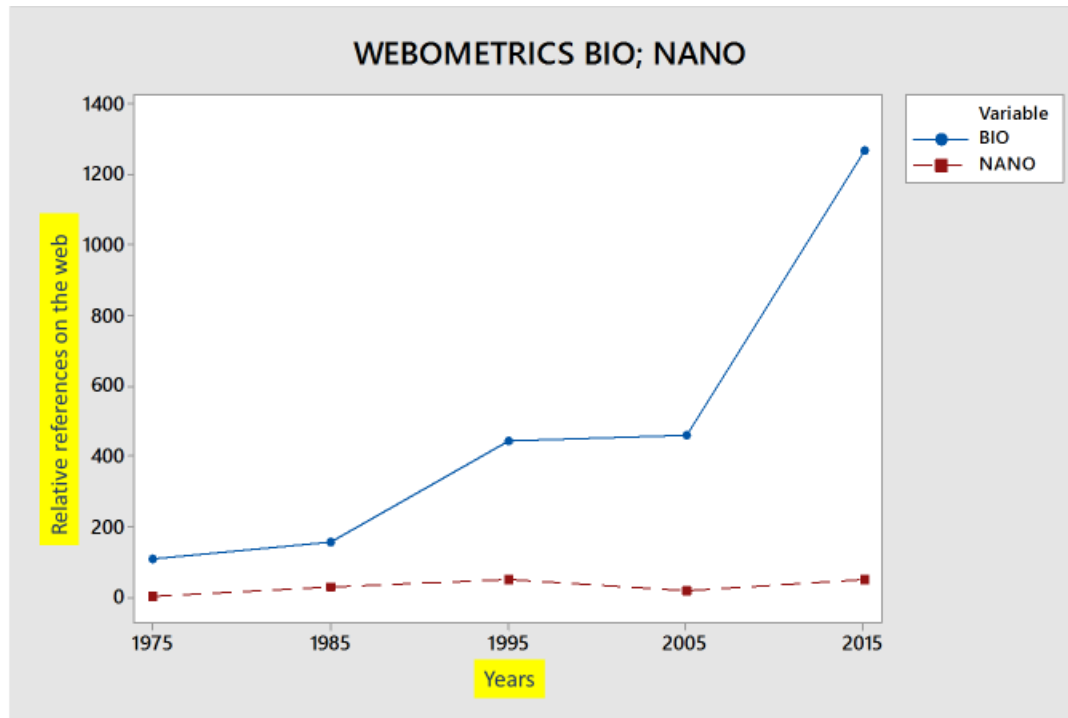
- **Health, especially Holistic Health Applications**
- **Psycho-Social Health**
- **Biotechnology**
- **Biomedical Applications**
- **Nano-molecular Applications**
- **Nuclear Energy Developments**
- **Renewable Energy Breakthroughs**
- **Hydrogen Energy**
- **Robotics, Intelligent Machines**
- **Artificial Intelligence**
- **New Leadership & Management**
- **ICT to support the above – Post-Info Applications**
- **Converging Technologies (info-bio-nano-...)**

The Info Tsunami (1975-today)



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Early Formation of the Bio Tsunami (1975-today)



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The Radical Technology Inquirer Approach *(RTI, by Osmo Kuusi et al., Finland, 2014)*

- **Global Value-Producing Networks (GVPNs) are clusters of demand and areas of change that have been created by global mega-trends and the needs of citizens, considered with a 2030 time horizon.**
- **They act as the “demand pull” side of socio-technical change, expected to be met by 2020-2030 technological breakthroughs.**
- **They represent the most innovative element of the RTI toolbox**
- **The 20+1 GVPNs of RTI were assessed for their Bio-Economic relevance and emergence impact**

GVPNs Mapping the Landscape - 1

(A) The Hard Core of Bioeconomic Demand – 8 GVPNs:

- **Local or functional food (FOOD)**
- **Self-care based and personalized health care (HEALTH)**
- **New capabilities for those who have lost their functional health (LIFE)**
- **Functional materials and new material technologies (MATERIALS)**
- **Functional added value of intelligent goods (GOODS)**
- **Sustainable energy technologies (ENERGY)**
- **Operation models for self-organizing Communities (GOVERNANCE)**
- **Eco-system functions of economic, social & environmental value (ECO-SYSTEMS)**

GVPNs Mapping the Landscape - 2

(B) The Soft Layer of Bioeconomic Demand – 8 GVPNs:

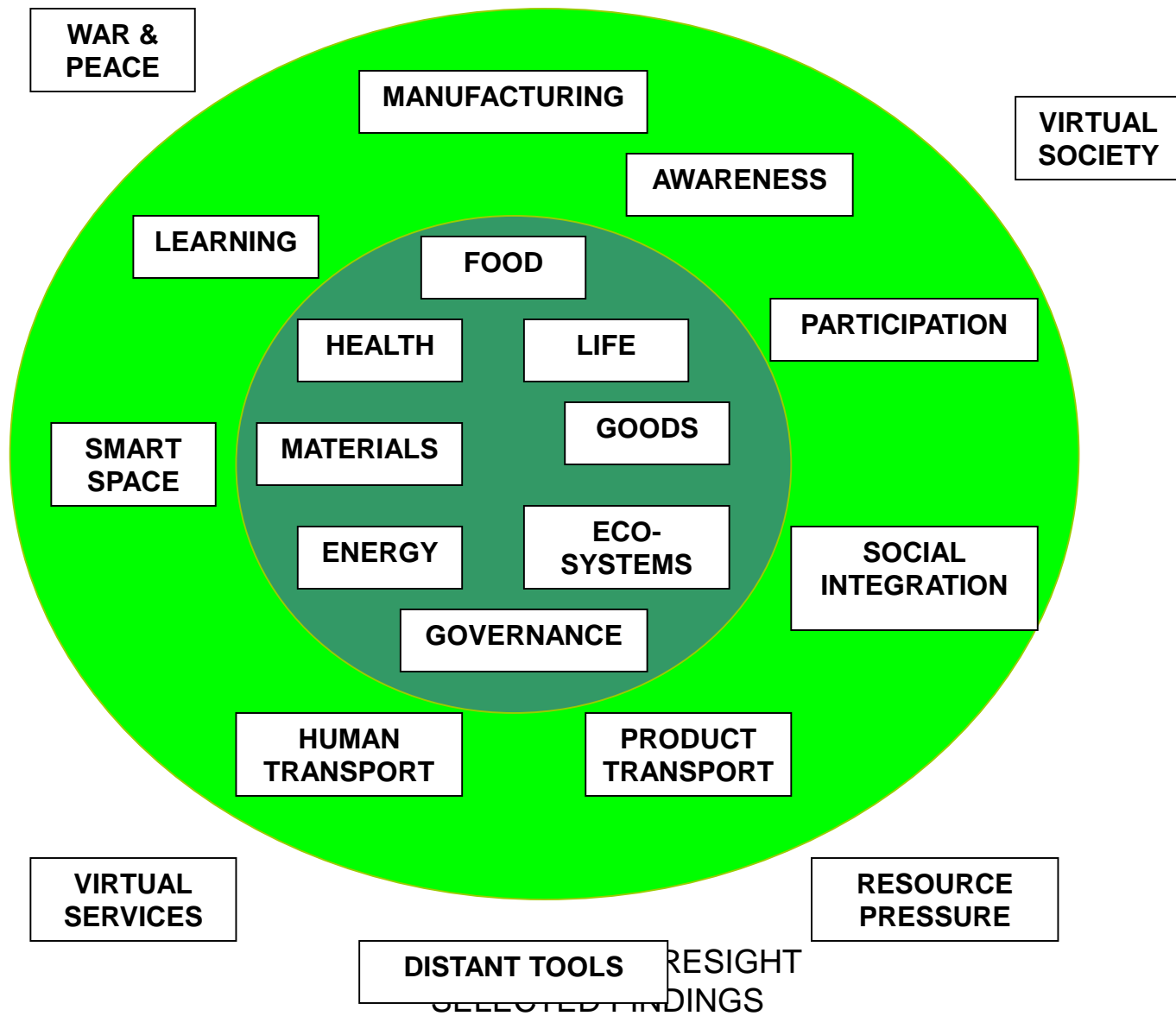
- **Automation of passenger vehicle traffic (HUMAN TRANSPORT)**
- **Automation of commodity transport (PRODUCT TRANSPORT)**
- **Manufacturing close to customers (MANUFACTURING)**
- **Individualisation of learning and guidance (LEARNING)**
- **Equipment for awareness of the environment (AWARENESS)**
- **Participatory entertainment, culture and influence (PARTICIPATION)**
- **Functionalization of spaces and structures (SMART SPACE)**
- **Democracy, freedom and social cohesion (SOCIAL INTEGRATION)**

GVPNs Mapping the Landscape - 3

(C) The Periphery of Bioeconomic Demand – 5 GVPNs:

- **Virtualisation of retail trade and services (VIRTUAL SERVICES)**
- **Distance presence and remote control of tools (DISTANT TOOLS)**
- **Raw materials from untapped areas and space (RESOURCE PRESSURE)**
- **National defense and anti-terroristic activities (WAR AND PEACE)**
- **Virtualisation of identities and social structures (VIRTUAL SOCIETY)**

GVPNs: Demand Forces for BioEconomic Innovation



The Radical Technological Solutions

(RTS, by Osmo Kuusi et al., Finland, 2014)

- **Our source describes the 100 most promising RTS, which might lead to major world-changing products or services, and are expected to be available by 2020, at the latest**
- **The impact of these technologies could be vast by the year 2030**
- **RTS are clustered in 11 Technological Groups**
- **11 new RTS were added to the 100 of the RTI**
- **The 100+11 RTS of RTI were assessed for their Bio-Economic relevance and emergence impact**

The 11 Groups of RTS (Bio-relevance)

- **Control of metabolism of human beings and other organisms (***)**
- **Social innovations (**)**
- **Human-machine interface technologies (**)**
- **Algorithms and systemic solutions based on the information technology (*)**
- **Measuring and imaging (*)**
- **Movement and transportation (*)**
- **Robots (*)**
- **Mimicking of nature and cyborgs (*)**
- **Essential enabling materials & industrial raw materials (**)**
- **Energy technology (***)**
- **Messaging technologies and protocols (*)**

The 13+1 Radical Technological “Protagonists” of the Bioeconomy Emergence - 1

(i) DNA-based

DNA sequencing

DNA memory

(ii) Biosensors-oriented

Biochips to diagnose diseases

Printed cheap biosensors

(iii) Bio-based production

Drugs based on GMOs

GMOs producing other products

Production of biofuels

The 13+1 Radical Technological “Protagonists” of the Bioeconomy Emergence - 2

(iv) Health/Ageing-oriented

Longer life slower aging

Monitoring personal health

Repair/regrow human organs

3D organs printing

Artificial cells - Life simulation

(v) Brain-functioning

Smart anti-depressants

Brain simulation/mapping of brain

Matching Selected GVPNs & RTS

Highest Bioeconomy Relevant RTS	Highest Bioeconomy Relevant Demand Sectors as GVPNs								TOTAL Xs/8
	Food	Health	Life	Materials	Goods	Energy	Governance	Ecosystem	
DNA sequencing	XXX	XXX	XX	XX	XX	XX	X	XXX	2.3
DNA memory	0	X	X	X	XX	0	X	X	0.9
Biochips to diagnose diseases	X	XXX	XX	X	X	0	XX	XX	1.5
Printed cheap biosensors	X	XXX	XX	XX	XXX	X	X	XX	1.9
Drugs based on GMOs	0	XXX	X	0	0	0	XXX	X	1.0
GMOs to other products	X	X	XX	XXX	XXX	XXX	XXX	X	2.1
Production of biofuels	X	0	0	X	X	XXX	XX	XX	1.3
Longer life slower aging	XXX	XXX	XXX	0	X	0	XXX	X	1.8
Monitoring personal health	X	XXX	XXX	X	X	0	XX	X	1.5
Repair/regrow human organs	0	XXX	X	0	0	0	XXX	X	1.0
3D organs printing	0	XXX	X	X	X	0	XXX	X	1.3
Artificial cells – Life simulation	0	X	X	0	0	0	XX	X	0.6
Smart anti-depressants	0	XXX	XX	0	0	0	XX	0	0.9
Brain simulation/ mapping	0	XX	XX	0	0	0	XX	X	0.9
TOTAL Xs/14	0.8	2.3	1.6	0.9	1.1	0.6	2.1	1.3	1.3/ 1.4

The Horizon Scanning Approach



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The Horizon Scanning (HSc) Approach

- The HSc inputs assessed for their Bioeconomic relevance and emergence impact include
 - 100 Identified Problems
 - 100 Identified Opportunities
 - 100 Results of a Questionnaire
- The results of the HSc inputs assessment reveal
 - **9 Clusters**, strongly but clearly interacting, representing the strong HSc signals power or less than 50% of total HSc power
 - **1 “Mystery” Cluster** representing >50% of the HSc power corresponding to the weak signals

The Main Clusters of Emerging Bioeconomy

- **#1: The Silver Society** – *Ageing and Demographic Barriers*
- **#2: The Cure & Care Practice** – *Towards Holistic Health*
- **#3: The Horn of Affluence** – *Food for 10B+ People on Earth*
- **#4: The Garden of Mother Earth** – *Green BioBased Economy*
- **#5: The Green Governance** – *New Type of Managers & Leaders*
- **#6: The Human Re-Engineering** – *Re-Designing Nature*
- **#7: The New Risk Bio-Society** – *Re-Setting Boundaries*
- **#8: Shaping the Future** - *Smart-to-Wise Research Priorities*
- **#9: For a Skillful Society** – *Training Brains for the 10 Clusters*
- **#10: “Mystery” Game Changers** – *Surprise Disrupting Factors*

Cluster #1: The Silver Society (*Gilgamesh*)

Achievement of longevity

SCIENCE & TECHNOLOGY:

- Biomedicine and life prolongation

SOCIAL, FAMILY, WORKING LIFE:

- Ageing as Silver Fleet
- Ageing actively



Cluster #2: The Cure & Care Practice



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Cluster #3: The Horn of Affluence

(Amalthea)

Quality foods

Fighting hunger and obesity

Hyper-intensive farming of species

Genetically modified foods

FOOD – AGRICULTURE:

- **Strategic function of agriculture**
- **Modern craftsmanship**
- **Healthy, eating patterns-based, functional foods**

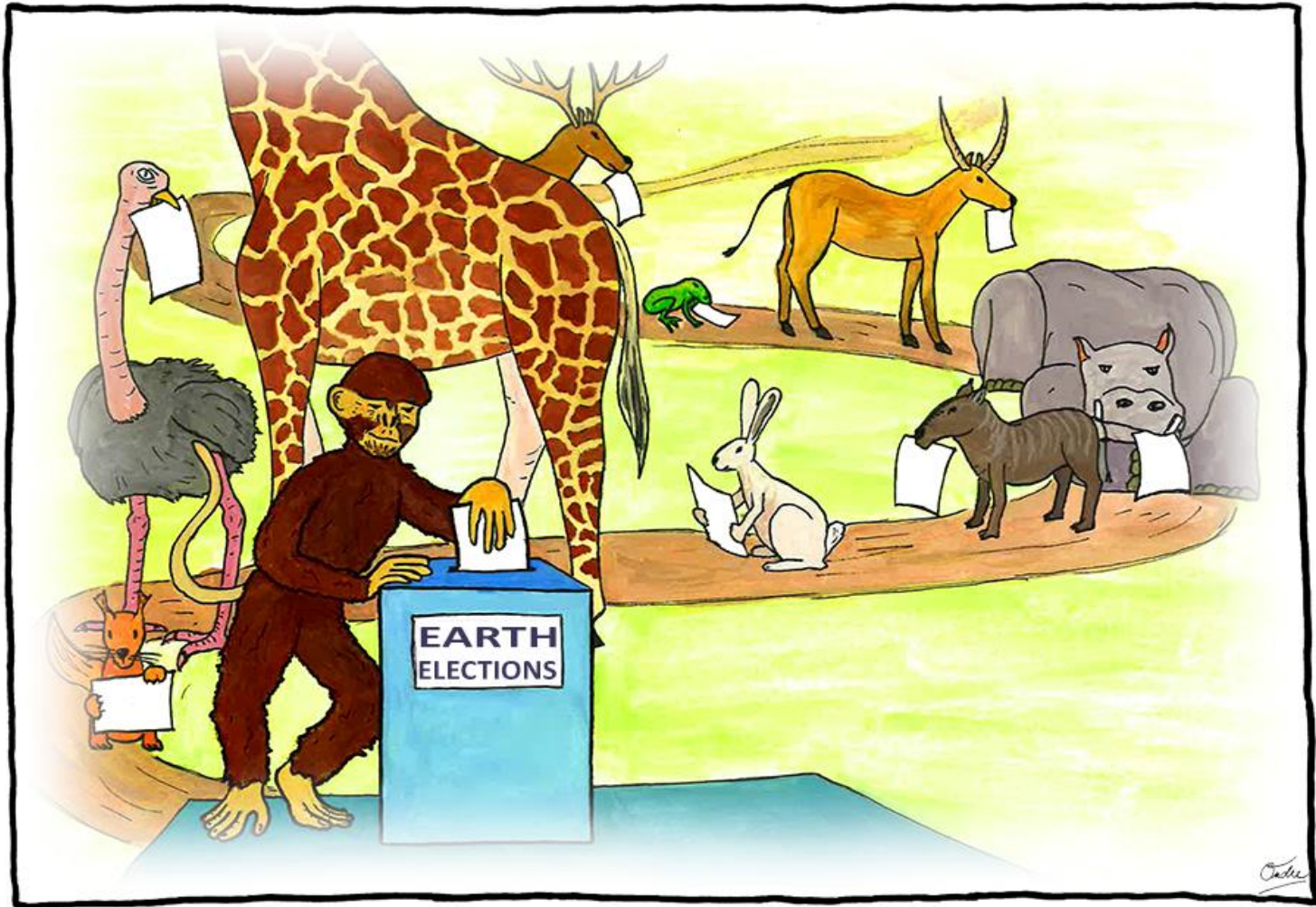


Cluster #4: The Garden of Mother Earth (*Gaia*)



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Cluster #5: The Green Governance



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Cluster #6: The Human Re-Engineering



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Cluster #7: The New Risk Bio-Society (*Sphinx*)

Biological weapons – Bio-risks

Domination of large multi-national companies

Control of bio-innovations through patents

Lack of protection of personal biological data

Bio-ethics and morality issues

Social tasks and initiatives

SAFETY AND EMERGENCY SYSTEMS

- Crisis control

SECURITY: No rational security policy

BUSINESS OF S&T: Threat to intellectual property rights

SCIENCE & TECHNOLOGY: New risks, ethical issues and social problems, Developments give criminals opportunities, Threats as leitmotif for innovation, National security

TENSIONS: Shortage, a breeding ground for conflicts



Cluster #8: Shaping the Future

(Leonardo)

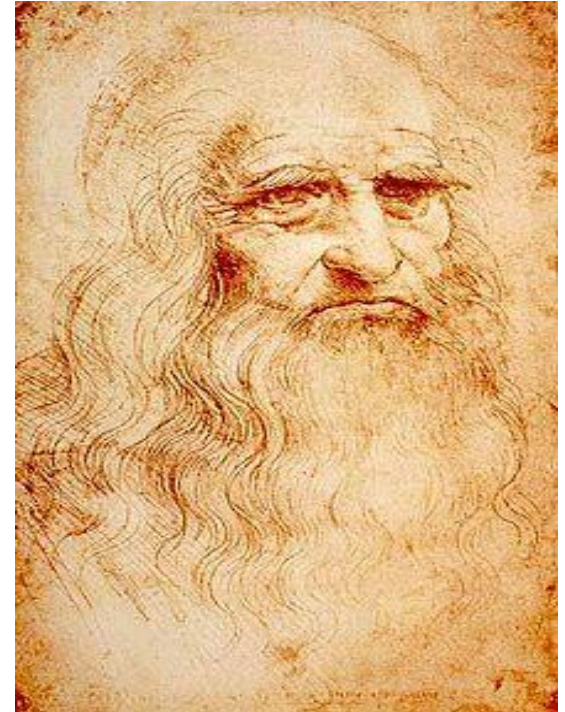
Research and Innovation

BUSINESS OF S&T:

- **Insufficient knowledge management**
- **The leading role of Europe is in danger**

SCIENCE & TECHNOLOGY:

- **Robots ousting humans**
- **Threats as leitmotif for innovation**
- **Promising new fields of science**
- **Converging technologies (CT)**
- **CT for human cognition and communication**
- **CT to improve group and social processes**
- **CT for health and longevity**



Cluster #9: For a Skillful Society

(J. Piaget)

Education and training

Art and culture

Youth initiatives

Citizens information/awareness

BUSINESS OF S&T:

- **Insufficient knowledge management**
- **The leading role of Europe is in danger**
- **Decreasing confidence in science**



**EDUCATION: Insufficient educational level of population,
Educational system not attuned to the educational biography,
Educational system keeping up with global knowledge increase,
Creativity in education**

Cluster #10: The “Mystery” Cluster



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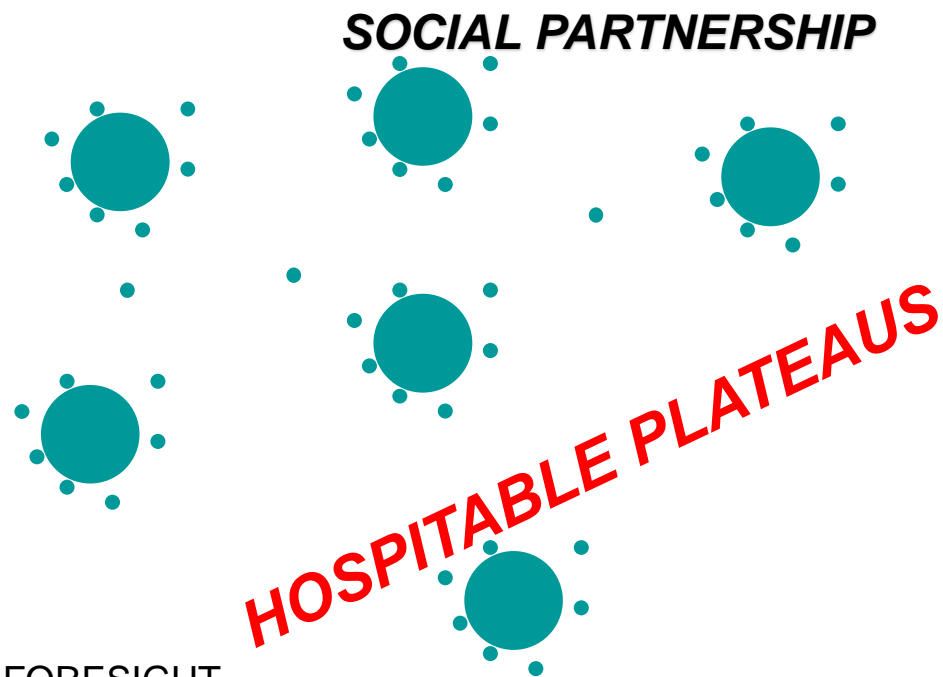
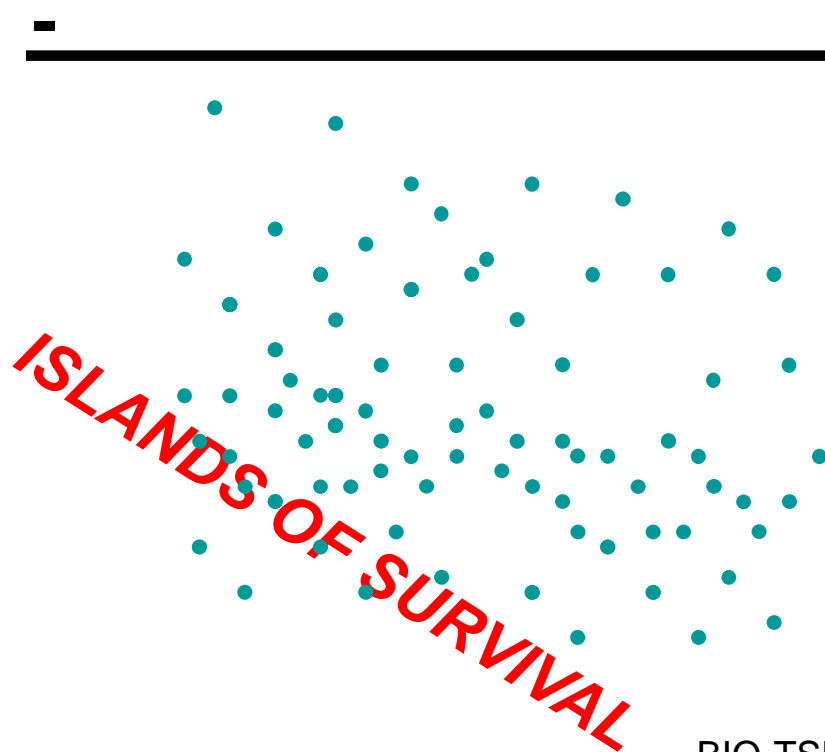
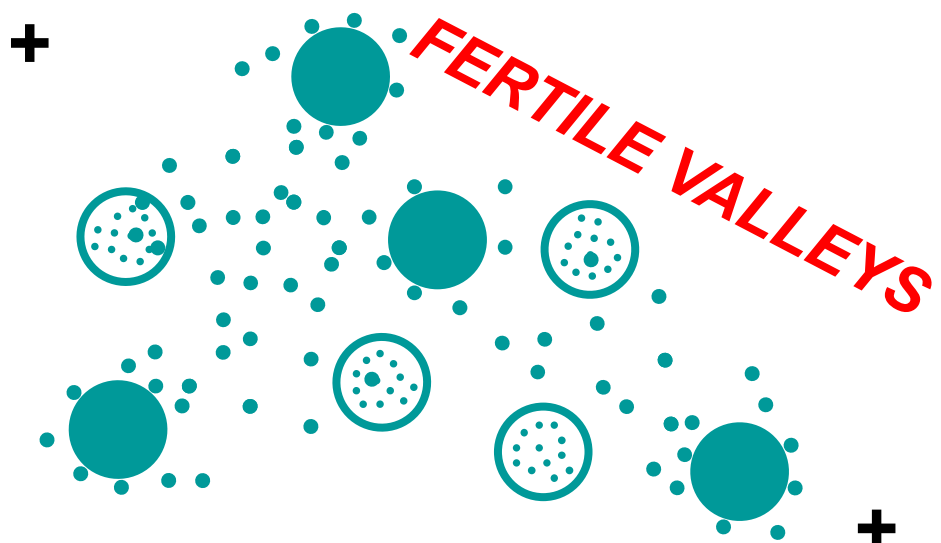
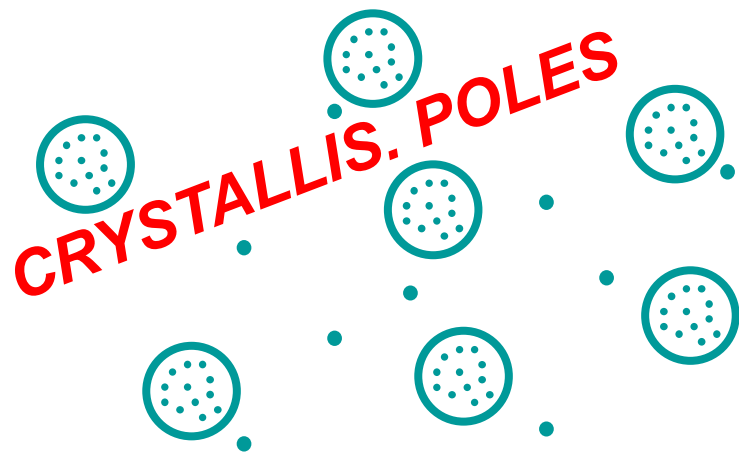
Main Suggestions for K6 Elements

- **Health, especially Holistic Health Applications # 1, 2**
- **Psycho-Social Health # 2, 7**
- **Biotechnology # 3, 4**
- **Biomedical Applications # 1, 2**
- **Nano-molecular Applications # 4, 8**
- **Nuclear Energy Developments # 4, 7**
- **Renewable Energy Breakthroughs # 4, 8**
- **Hydrogen Energy # 4, 8**
- **Robotics, Intelligent Machines # 6, 9**
- **Artificial Intelligence # 6, 9**
- **New Leadership & Management # 5, 7**
- **ICT to support the above – Post-Info Applications # 8**
- **Converging Technologies (info-bio-nano-...) # 8, 9**

Identification of Key Drivers & Barriers And Formulation of Scenarios for the Emergence of Bioeconomy in 2030:

- **Feasibility vs. Sustainability/Desirability**
- **Socio-Economic Acceptance/Partnership vs. Scientific/Technological Excellence**
- **Poland, Greece, Southern Italy, Southern Europe (P, ES, IT, GR, CY), EU**
- **Polish Scenario Workshop: Radom, 26 June 2017**

S&T EXCELLENCE / S&T POLICIES



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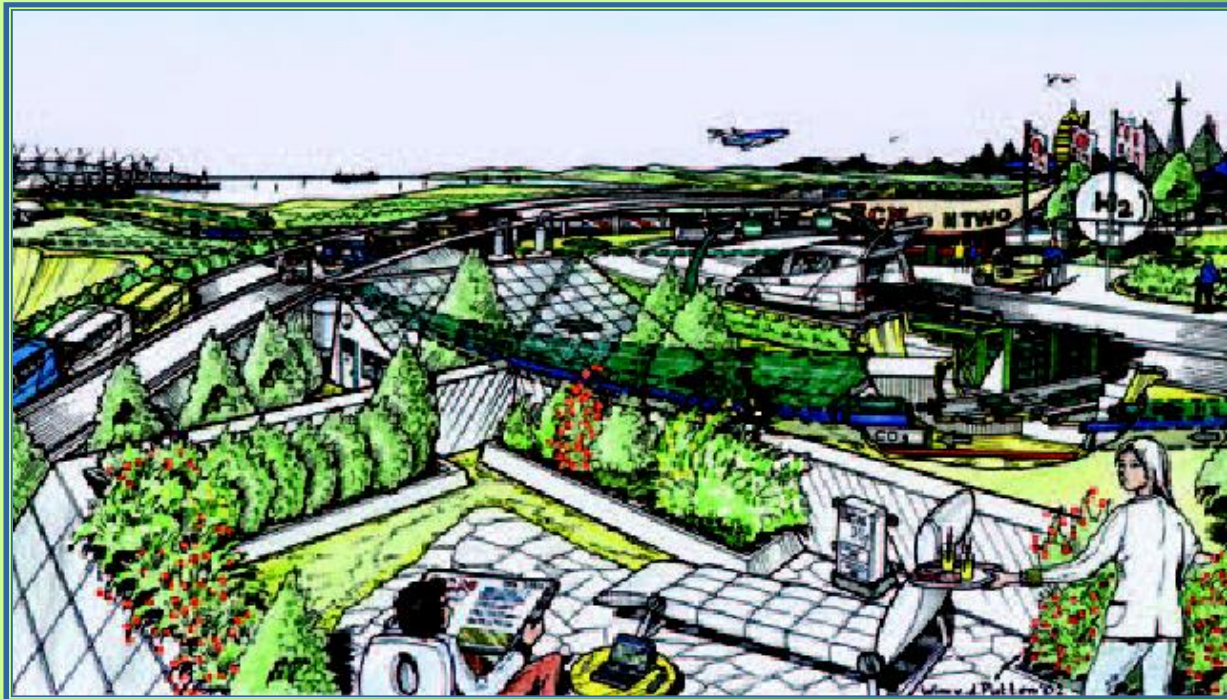
The Tsunami as a Model of Change



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A “Green” Post-Tsunami World in 2050

A View of the Future – A Green Utopia?



A “Black” Post-Tsunami View in 2004!



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For More Information:

www.biotsunami.itee.radom.pl

Thank you for your attention!