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EVALUATION OF CRITICAL AND EMERGING SECURITY TECHNOLOGIES FOR THE ELABORATION OF A STRATEGIC RESEARCH AGENDA

DELIVERABLE D4.1

List of Emerging Technologies with Security Implications

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1 Preface

This document presents a list of emerging technologies that are considered to become relevant for civil security issues in the time frame within years 2020 to 2030. These technologies were identified in an elaborate process involving different foresight methods and research institutions.

The presented list of emerging technologies is founded on the experience of technology foresight ~ and technology experts. However it is the result of an effort limited in time and personal budget and represents a time dependent vision on a future issue. The dynamics of technology development as well as the comprehension of the term “security” or “security implications” will be subject to changes in time. The content of this list consequently will be affected if this activity is repeated in future years.

The first paragraph of next section details the list of emerging technologies with security implications. The technologies were selected out of 127 technologies identified in a prior task of work package 4 of the Etcetera project, listed in deliverable WD4.1 “Report on the scanning for emerging technologies with three different methods, including a provisional list of emerging technologies for security purposes”. Altogether they cover 13 technology areas. The second paragraph shows the influence different criteria can have on the prioritisation of technologies inside this list.

The last section in two paragraphs gives brief insight in the methodology that was applied to produce this technology list and touches the limitations of this process.

A detailed discussion on the methodical aspects of the process that led to the list presented in this document D4.1 can be found in deliverable D4.2 “Report on the Comparative Analysis of Three Methods to assess Emerging Technologies” of the EU FP7 project Etcetera.

2 List of Emerging Technologies

The results from the three methods employed for scanning of Emerging Technologies in WP4 task 4.1 require harmonisation. Since a plenum discussion about all technologies with the respective technology experts was impractical, the Weighted Bit Assessment Method (WBAM) was applied to assist in sorting of technologies. The resulting list is shown in paragraph 2.1. Some alternative sortings – depending on the choice of the interesting parameters – are depicted in paragraph 2.2. The precise meaning of these parameters and the way they were determined is explained in section 3.

2.1 Technologies sorted by Thematic Areas

The following table lists only those technologies out of a list of 127 technologies contained in document WD4.1 that fulfill some basic criteria. Those basic criteria are:

- rating of value “Security Relevance” ≥ 1
- rating of value “Time Frame” ≥ 0
- rating of value “Ethical Rating” ≥ 0

Application of these criteria in some technology areas eliminates any emerging technology found. Those areas (i.e. TA1,TA3 and TA6) are listed here for clearness but are without any entry. The table is structured in thirteen technology areas. In each area the technologies are ordered corresponding to:

- 1st sorting criterion = value “Security Relevance”
- 2nd sorting criterion = value “Market Potential”

Table 2.1.1: Complete prioritised list of emerging technologies with security implications in time frame years 2020 to 2030.

	TA1: Biometrics	SecRel	Time	Market	Appl	Ethics
	TA2: Communication Technology	SecRel	Time	Market	Appl	Ethics
1	Homomorphic Encryption	6	6	3	3	4
2	Post-Quantum Cryptography	6	1.5	3	3	3
3	Quantum Cryptography	6	3	-1	3	2
4	Chaos based Cryptography	5	3	1	3	4
5	Identity-based Encryption	4	0	-1	3	2
6	Clean-Slate Future Internet	3	0	-1	1	4
7	Artificial Immune Systems	2	3	1	1	4
8	V2X-Communication	1	3	3	-1	0
9	Cognitive Radio	1	3	-1	-1	6
	TA3: CBRN Identification	SecRel	Time	Market	Appl	Ethics

	TA4: Energy Technology	SecRel	Time	Market	Appl	Ethics
10	Smart Power Grid	4	0	3	3	0
11	Hydrogen Production and Storage Technologies	3	3	3	1	6
12	Small-scale Energy Harvesting	2	6	3	3	4
13	Electrochemical Energy Storage Materials	2	3	3	3	6
14	UUV/USV – Energy Storage and Propulsion	2	3	-1	1	6
15	Biomass-to Liquid Biofuel / Fischer–Tropsch Synthesis	1	0	3	-1	6

	TA5: Environmental Security	SecRel	Time	Market	Appl	Ethics
16	Earthquake Prediction	6	1.5	-3	3	6
17	Climate Engineering	3	1.5	3	0	6
18	Carbon Sequestration	1.5	6	3	0	6
19	Nanocomposites for Oil Removal	1.5	6	1.5	0	3

	TA6: Human Machine Interface	SecRel	Time	Market	Appl	Ethics

	TA7: Human Science	SecRel	Time	Market	Appl	Ethics
20	Automated Human Behaviour Analysis	5	3	3	3	0
21	Dark Web Terrorism Research	5	0	-3	3	0
22	Broad-Spectrum Antiviral Therapeutics	4.5	6	3	3	6
23	Reality mining - Machine Perception and Learning	1	3	3	-3	0
24	Agent based Modelling	1	3	1	-1	4

	TA8: ICT and Electronics	SecRel	Time	Market	Appl	Ethics
25	Quantum Computers	3	3	-1	1	4
26	Nanocomputers	1	0	1	-3	6

	TA9: Mobile Platform Technologies	SecRel	Time	Market	Appl	Ethics
27	Semantic 3D Scene Interpretation	6	3	1	3	0
28	Exo-Sceletons	5	3	1	1	2
29	Small Satellites	5	6	1	3	2
30	Stratospheric Platforms	5	6	-1	3	0
31	Autonomuous Passenger Cars	4	3	3	1	4
32	Kinodynamic Motion Planning	4	4	3	-3	6
33	Active Protection Systems	4	6	-1	1	4
34	Indoor Navigation	3	3	3	1	0
35	E-Enabled Aircraft	2	3	3	3	6
36	Walking Machines	2	0	1	1	4
37	Chemical Robots – ChemBots	2	3	-1	1	0
38	Space Debris Removal	2	3	-1	-3	6
39	Biomimetic UUVs	2	6	-1	3	4
40	UUV/USV – Collision and obstacle avoidance technologies	2	3	-1	1	4
41	Ducted Fan Air Vehicles	1	6	3	1	2
42	Personal Air Vehicles / Flying Cars	1	0	-1	3	4
43	UUV/USV – Advanced Algorithms for Classification	1	3	-3	-1	6

	TA10: New and Smart Materials	SecRel	Time	Market	Appl	Ethics
44	Smart Textiles	5	3	3	3	2
45	Metamaterials	4	3	1	1	2
46	Reinforced Light Alloys	3	0	3	1	4
47	SHM Systems	3	3	1	3	6
48	Liquid Armour	3	3	-1	3	6
49	Nanostructured Ceramics	2	3	3	-1	4
50	Polymeric Nanocomposites	2	0	3	1	4
51	Graphene	2	6	1	1	4
52	Fuzzy Fibers – CFK modified by CNTs	1	3	1	1	4
53	Smart Materials	1	0	1	-1	4

	TA11: Non-lethal Means	SecRel	Time	Market	Appl	Ethics
54	Non Lethal Means to Preclude non Authorized Access	4	0	1	3	2

	TA12: Sensor Technologies	SecRel	Time	Market	Appl	Ethics
55	Terahertz (Imaging and Substance Identification)	6	3	1	3	2
56	Carbon Nanotube Sensors	5	6	3	3	6
57	Nano Particle Sensors	5	3	3	3	6
58	Through the Wall Radar	5	3	-1	3	0
59	Explosive Traces Integrated Sensors	5	0	-1	3	6
60	Muon Tomography	5	0	-1	3	4
61	Medical Tricorder	4	6	3	3	0
62	Cantileverbased Nanosensors	4	6	3	3	6
63	Sensors on Unconventional Flexible Substrates	4	6	3	3	6
64	OTFT Sensors (Organic Thin-Film Transistors)	4	3	3	3	6
65	Hyperspectral Sensors and Signal Processing	4	0	-3	3	6
66	Femto-Photography	2	6	1	3	2
67	Electrical Impedance Tomography	1	0	-1	-1	4

	TA13: Cross Sectional Themes	SecRel	Time	Market	Appl	Ethics
68	Power System Security	6	6	3	3	3
69	Effective Water Ressources Management	6	6	3	0	3
70	(Trust in) Online Business	4.5	1.5	3	0	0

2.2 Technology Assessment with Respect to different Criteria

In order to ease the assessment of the influence of the different parameters on the resulting technology sorting different tables are presented below, which show alternative rankings of the technologies. This shall underline the fact that in table 2.1.1 all technologies appear in one of a number of possible orders and that the order in table 2.1.1 is not meant as an overall indication of the individual technology potential.

Tables 2.2.1 to 2.2.3 list the first ten technologies with respect to primary criterion "Security Relevance" and different secondary criteria. The first and second columns show the order number and technology area of each technology in table 2.1.1.

Table 2.2.1: Ten highest ranking technologies with "Market" as 2nd , "Application Potential" as 3rd criterion. "Ethical Rating" not considered here.

No.	TA	Technology	SecRel	Market	Appl	Ethics
1	TA2	Homomorphic Encryption	6	3	3	4
2	TA2	Post-Quantum Cryptography	6	3	3	3
68	TA13	Power System Security	6	3	3	3
69	TA13	Effective Water Ressources Management	6	3	0	3
27	TA9	Semantic 3D Scene Interpretation	6	1	3	0
55	TA12	Terahertz (Imaging and Substance Identification)	6	1	3	2
3	TA2	Quantum Cryptography	6	-1	3	2
16	TA5	Earthquake Prediction	6	-3	3	6
20	TA7	Automated Human Behaviour Analysis	5	3	3	0
44	TA10	Smart Textiles	5	3	3	2

Table 2.2.2: Ten highest ranking technologies with "Application" as 2nd , "Market Potential" as 3rd criterion. "Ethical rating" not considered here.

No.	TA	Technology	SecRel	Appl	Market	Ethics
1	TA2	Homomorphic Encryption	6	3	3	4
2	TA2	Post-Quantum Cryptography	6	3	3	3
68	TA13	Power System Security	6	3	3	3
27	TA9	Semantic 3D Scene Interpretation	6	3	1	0
55	TA12	Terahertz (Imaging and Substance Identification)	6	3	1	2
3	TA2	Quantum Cryptography	6	3	-1	2
16	TA5	Earthquake Prediction	6	3	-3	6
69	TA13	Effective Water Ressources Management	6	0	3	3
20	TA7	Automated Human Behaviour Analysis	5	3	3	0
44	TA10	Smart Textiles	5	3	3	2

Table 2.2.3: Ten highest ranking technologies with "Ethical Rating" as 2nd , "Market Potential" as 3rd criterion. "Application Potential" not considered here.

No.	TA	Technology	SecRel	Ethics	Market	Appl
16	TA5	Earthquake Prediction	6	6	-3	3
1	TA2	Homomorphic Encryption	6	4	3	3
2	TA2	Post-Quantum Cryptography	6	3	3	3
68	TA13	Power System Security	6	3	3	3
69	TA13	Effective Water Ressources Management	6	3	3	0
55	TA12	Terahertz (Imaging and Substance Identification)	6	2	1	3
3	TA2	Quantum Cryptography	6	2	-1	3
27	TA9	Semantic 3D Scene Interpretation	6	0	1	3
56	TA12	Carbon Nanotube Sensors	5	6	3	3
57	TA12	Nano Particle Sensors	5	6	3	3

The above tables contain two entries from technology area TA13 "Cross Sectional Themes", which actually does not name technologies, but identified societal demands with respect to technology and security. Paragraph 3.2 refers briefly to this point. An elaborate discussion of the particular meaning of technology area TA13 can be found in deliverable D4.2.

Tables 2.2.4 to 2.2.6 list the first ten technologies with respect to different primary criteria and secondary criteria in order of appearance in table. Columns with light grey title were not considered for sorting.

Table 2.2.4: Ten highest ranking technologies with "Application Potential" as 1st criterion.

No.	TA	Technology	Appl	SecRel	Market	Ethics
1	TA2	Homomorphic Encryption	3	6	3	4
2	TA2	Post-Quantum Cryptography	3	6	3	3
68	TA13	Power System Security	3	6	3	3
55	TA12	Terahertz (Imaging and Substance Identification)	3	6	1	2
27	TA9	Semantic 3D Scene Interpretation	3	6	1	0
3	TA2	Quantum Cryptography	3	6	-1	2
16	TA5	Earthquake Prediction	3	6	-3	6
56	TA12	Carbon Nanotube Sensors	3	5	3	6
57	TA12	Nano Particle Sensors	3	5	3	6
44	TA10	Smart Textiles	3	5	3	2

Table 2.2.5: Ten highest ranking technologies with "Market Potential" as 1st criterion.

No.	TA	Technology	Market	SecRel	Appl	Ethics
1	TA2	Homomorphic Encryption	3	6	3	4
2	TA2	Post-Quantum Cryptography	3	6	3	3
68	TA13	Power System Security	3	6	3	3
69	TA13	Effective Water Ressources Management	3	6	0	3
56	TA12	Carbon Nanotube Sensors	3	5	3	6
57	TA12	Nano Particle Sensors	3	5	3	6
44	TA10	Smart Textiles	3	5	3	2
20	TA7	Automated Human Behaviour Analysis	3	5	3	0
22	TA7	Broad-Spectrum Antiviral Therapeutics	3	4,5	3	6
70	TA13	(Trust in) Online Business	3	4,5	0	0

Table 2.2.6: Ten highest ranking technologies with "Ethical rating" as 1st criterion.

No.	TA	Technology	Ethics	SecRel	Appl	Market
16	TA5	Earthquake Prediction	6	6	3	-3
56	TA12	Carbon Nanotube Sensors	6	5	3	3
57	TA12	Nano Particle Sensors	6	5	3	3
59	TA12	Explosive Traces Integrated Sensors	6	5	3	-1
22	TA7	Broad-Spectrum Antiviral Therapeutics	6	4.5	3	3
62	TA12	Cantileverbased Nanosensors	6	4	3	3
63	TA12	Sensors on Unconventional Flexible Substrates	6	4	3	3
64	TA12	OTFT Sensors (Organic Thin-Film Transistors)	6	4	3	3
32	TA9	Kinodynamic Motion Planning	6	4	-3	3
65	TA12	Hyperspectral Sensors and Signal Processing	6	4	3	-3

Tables 2.2.7 and 2.2.8 list the first ten technologies with respect to the sum of the different parameters as primary criterion and secondary criteria in order of appearance in table. The value “sum” in the last column is the simple sum of all listed values (Security Relevance, Application and Market in table 2.2.8 and Ethics in addition in table 2.2.7).

In table 2.2.7 the values of the ethical rating are included in the sum value, whereas in table 2.2.8 they are not.

Table 2.2.7: Ten highest ranking technologies with “Sum of 1-4” as 1st criterion.

No.	TA	Technology	SecRel	Appl	Market	Ethics	Sum
56	TA12	Carbon Nanotube Sensors	5	3	3	6	17
57	TA12	Nano Particle Sensors	5	3	3	6	17
22	TA7	Broad-Spectrum Antiviral Therapeutics	4.5	3	3	6	16.5
1	TA2	Homomorphic Encryption	6	3	3	4	16
62	TA12	Cantileverbased Nanosensors	4	3	3	6	16
63	TA12	Sensors on Unconventional Flexible Substrates	4	3	3	6	16
64	TA12	OTFT Sensors (Organic Thin-Film Transistors)	4	3	3	6	16
2	TA2	Post-Quantum Cryptography	6	3	3	3	15
68	TA13	Power System Security	6	3	3	3	15
13	TA4	Electrochemical Energy Storage Materials	2	3	3	6	14

Table 2.2.8: Ten highest ranking technologies with “Sum of 1-3” as 1st criterion.

No.	TA	Technology	SecRel	Appl	Market	Sum
1	TA2	Homomorphic Encryption	6	3	3	12
2	TA2	Post-Quantum Cryptography	6	3	3	12
68	TA13	Power System Security	6	3	3	12
56	TA12	Carbon Nanotube Sensors	5	3	3	11
57	TA12	Nano Particle Sensors	5	3	3	11
44	TA10	Smart Textiles	5	3	3	11
20	TA7	Automated Human Behaviour Analysis	5	3	3	11
22	TA7	Broad-Spectrum Antiviral Therapeutics	4.5	3	3	10.5
55	TA12	Terahertz (Imaging and Substance Identification)	6	3	1	10
27	TA9	Semantic 3D Scene Interpretation	6	3	1	10

3 Annotations

This section gives brief insight in the methodology that was applied to produce the prioritised technology list and touches the limitations of this process.

3.1 Methodology

After completion of the technology scanning phase at AIT, Isdefe and Fraunhofer INT a synchronised list of emerging technologies was produced. This complete list was assessed by technology experts in the three institutions by filling in an Excel sheet with the possibility to rate certain aspects of each technology by ticking boxes. The following screen shot gives an example on how the Excel sheet was organised.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1			Security Relevance								Time frame					Application Potential					Market Potential				Ethical Rating				
2	TA0: Technology XY		How do you rate the impact this technology could have on future security issues?					Is the development of this technology mainly driven by security demands?			When do you expect this technology to be so mature that any impact on security issues will become valid?					Does this technology offer significant benefits for security agencies and the protection of society?			Does this technology offer significant opportunities for criminal acts and terrorists attacks?			Is there a large market for products based on this technology in the future?			Could this technology raise privacy issues?		Is it likely that this technology will be used to provoke any physical or mental harm to humans?		
3			strong	moderate	weak	neglectable		yes	no		before 2020	2020 to 2025	2025 to 2030	after 2030		yes	no		yes	no		yes	no		yes	no	yes	no	
4	Technology 1		X					X				X				X				X			X			X	X		
5	Technology 2					X			X					X			X		X							X		X	
6	Technology 3				X				X				X			X			X			X	X		X			X	
7																													
8																													

Fig. 3.1.1: Structure of the Excel file used for technology assessment.

For each category one out of two resp. four possible answers could be selected. The categories, the content of the questions, possible answers that could be given and an explanatory help text are detailed in the following table 3.1.1.

Table 3.1.1: Criteria that were used to assess the identified emerging technologies.

Category	Question text	Possible answers	Explanation (as a cell box comment)
Security Relevance	How do you rate the impact this technology could have on future security issues?	• strong • moderate • weak • neglectable	If you think that this technology will substantially enhance or even enable new capabilities of security agencies (e.g. stand-off detection of explosives would be much more reliable, or explosives undetectable before can now be detected) you should rate the technology strong. If you think that this technology will to some extend contribute to enhance the capability of security agencies or security applications (e.g. stand-off detection of explosives now at an extended range) you should rate it moderate. If you think that this technology will to some extend contribute to enhance the application or usability of this technology (e.g. the stand-off detection of explosives could become cheaper or quicker) you should rate it moderate. If you see no or no noticeable influence of this technology on security issues, choose neglectable. Please do also take into account the potential for misuse of technologies.
	Is the development of this technology driven by security demands?	• yes • no	Question here is, whether there is a direct or more indirect impact of this technology on security issues. If e.g. a technology enables new sensors with enhanced capabilites this would have direct influence on security applications and therefore could imply specific security related research. Choose 'yes' then. If e.g. a technology enhances basic system capabilities like the endurance of a mobile security system by raising its energy storage capacity, it addresses general technology development that probably will be propelled by demands of consumer (mass) markets. Choose 'no' then.

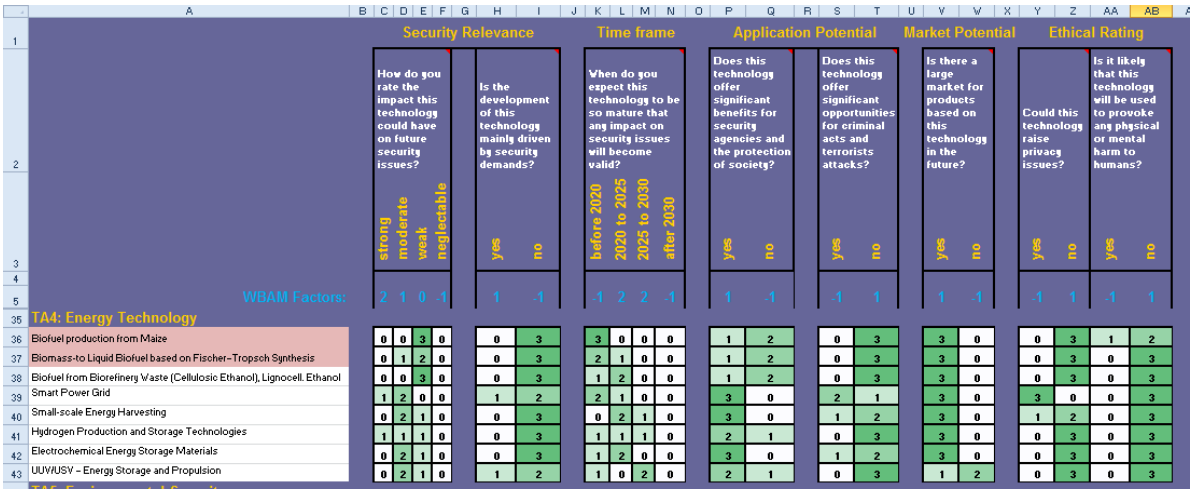
Category	Question text	Possible answers	Explanation (as a cell box comment)
Time Frame	When do you expect this technology to be so mature that any impact on security issues will become valid?	• before 2020 • 2020 to 2025 • 2025 to 2030 • after 2030	Question here is, when do you expect that first security applications respectively criminal or terrorists acts using this technology might be possible? If you think this already happened or will be in short time, choose "before 2020". If you doubt that this will ever be the case, choose "after 2030".

Category	Question text	Possible answers	Explanation (as a cell box comment)
Application Potential	Does this technology offer significant benefits for security agencies and the protection of society?	• yes • no	More or less the question is: is this technology a chance or a threat for security issues? If you think it is a mere chance choose 'yes' here and 'no' in the next question. For example the ability to analyse blood directly at a crime scene is a chance for security applications, but offers no benefit for criminal use. If you think it is both, chance and threat, choose 'yes' here and 'yes' in the next question. For example a new method to encrypt data can serve security agency needs and criminal intentions as well. If you think it has only potential for criminal acts or terrorists attacks, choose 'no' here and 'yes' in the next question. For example the ability to alter biometric characteristics of a person clearly would favour criminal use.
	Does this technology offer significant opportunities for criminal acts and terrorists attacks?	• yes • no	Please refer to previous question for an explanation.

Category	Question text	Possible answers	Explanation (as a cell box comment)
Market Potential	Is there a large market for products based on this technology in the future?	• yes • no	Please try to take into account here a global perspective for security related products. For example, a biomimetic Unmanned Underwater Vehicle (UUV) certainly is an attractive solution for underwater applications, however compared to Unmanned Aerial Vehicles (UAV) the market and application potential is rather small. If undetermined, choose 'yes' and 'no'. If you have no opinion, leave it open.

Category	Question text	Possible answers	Explanation (as a cell box comment)
Ethical Rating	Could this technology raise privacy issues?	• yes • no	Please do not only consider here ICT or communication related technologies, but think wider. For example small Unmanned Aerial Vehicles in the size of insects and mass produced at very low costs could be used by everyone to watch people, maybe neighbours, inside their houses.
	Is it likely that this technology will be used to provoke any physical or mental harm to humans?	• yes • no	Please rate here, whether it can be expected that this technology could either by intentional usage (e.g. laser weapon) or accidentally (e.g. laboratory research on a deadly virus) pose health of human beings at risk. Please choose 'yes' if you think that this is not only possible, but likely or nearby to happen.

After the assessment of the identified 127 emerging technologies in the individual institutions the results were summarised in one file. The number of votes for each category and technology accounted to three, with the exception of a few technologies were only two votes were available. In order to avoid imbalance effects for the later assessment in the case of only two given votes those votes were multiplied by a factor of 1.5. Since in some cases the gathered judgements concerning some technology criteria were conflicting the Weighted Bit Assessment Method (WBAM) was introduced as a means to foster the prioritisation of the numerous technologies. The advantage of the WBAM method is the possibility to keep conflicting ratings and nevertheless produce a concrete value representing the assessment of a certain technology quality. The alternative, a plenum discussion to prioritise the technologies, would have been very time consuming and hard to realise. Instead a net based discussion forum was set up in a collaborative wiki platform "Etcetera CoWiki", maintained by the project leader institute.



	Security Relevance						Time frame						Application Potential				Market Potential		Ethical Rating			
	How do you rate the impact this technology could have on future security issues?				Is the development of this technology mainly driven by security demands?		When do you expect this technology to be so mature that ang impact on security issues will become valid?						Does this technology offer significant benefits for security agencies and the protection of society?		Does this technology offer significant opportunities for criminal acts and terrorists attacks?		Is there a large market for products based on this technology in the future?		Could this technology raise privacy issues?		Is it likely that this technology will be used to provoke ang physical or mental harm to humans?	
	strong	moderate	weak	neglectable	yes	no	before 2020		2020 to 2025	2025 to 2030	after 2030		yes	no	yes	no	yes	no	yes	no	yes	no
WBAM Factors:	2	1	0	-1	1	-1	-1	2	2	-1			1	-1	-1	1	1	-1	-1	1	-1	1
TA4: Energy Technology																						
Biofuel production from Maize	0	0	3	0	0	3	3	0	0	0			1	2	0	3	3	0	0	3	1	2
Biomass-to Liquid Biofuel based on Fischer–Tropsch Synthesis	0	1	2	0	0	3	2	1	0	0			1	2	0	3	3	0	0	3	0	3
Biofuel from Biorefinery Waste (Cellulosic Ethanol), Lignocell. Ethanol	0	0	3	0	0	3	1	2	0	0			1	2	0	3	3	0	0	3	0	3
Smart Power Grid	1	2	0	0	1	2	2	1	0	0			3	0	2	1	3	0	3	0	0	3
Small-scale Energy Harvesting	0	2	1	0	0	3	0	2	1	0			3	0	1	2	3	0	1	2	0	3
Hydrogen Production and Storage Technologies	1	1	1	0	0	3	1	1	1	0			2	1	0	3	3	0	0	3	0	3
Electrochemical Energy Storage Materials	0	2	1	0	0	3	1	2	0	0			3	0	1	2	3	0	0	3	0	3
UUV/USV – Energy Storage and Propulsion	0	2	1	0	1	2	1	0	2	0			2	1	0	3	1	2	0	3	0	3

Fig. 3.1.2: Depiction of the technology assessment file, showing the applied WBAM factor values and the gathered ratings for technology area "Energy Technology".

In fig. 3.1.2 the first two entries in column A are in background colour red, meaning that they are excluded from the prioritised list. Reason is the low value for category "Time Frame", which was postulated to be bigger than zero, meaning that two of three ratings concerning "Time Frame" had to estimate period years 2020 to 2030 for first applications.

As can be further seen the entry for "Smart Power Grid" has value zero for "Time Frame" too, however here the discussion in the CoWiki lead to the conclusion to preserve this technology in the resulting list. Argument is the importance of the thematic complex for the near future in European societies, spanning from escape from nuclear energy, peak oil, regenerative or green energy to decentral energy production, electro mobility and security of energy supply.

3.2 Meaning of Results

As emphasized before the values calculated by the WBAM method only serve as indicators for the relative importance of a certain technology compared to another in the list. They cannot supersede the assessment of the complete technology list by a discussion among a group of technology experts.

As an example the technology “Smart Power Grid” was already mentioned. Figure 3.2.1 shows the rating of “Smart Power Grid” in comparison to “Power System Security”, named in TA13.

	TA4: Energy Technology	SecRel	Time	Market	Appl	Ethics
10	Smart Power Grid	4	0	3	3	0

	TA13: Cross Sectional Themes	SecRel	Time	Market	Appl	Ethics
68	Power System Security	6	6	3	3	3

Fig. 3.2.1: Comparison of ratings for technology “Smart Power Grid” and the societal demand for “Power System Security”.

Although a “Smart Power Grid” was rated as an important technology (security relevance value is 4, on a scale from -3 to 6), it was judged by two out of three evaluators as coming into reality before year 2020 (thus value “time frame” is zero, on a scale from -3 to 6). This would mean it comes too early for the purpose of the Etcetera project, which focuses on technologies with security implications in time frame years 2020 to 2030. Concerning “Market Potential” it was rated with the maximum value of three (on a scale from -3 to 3). That means there should be a big market chance for this technology. The same is true for the “Application Potential”, which reaches the maximum value of three too. A number of applications should therefore benefit from such a technology, what is obvious in the case of a basic infrastructure oriented technology.

Since the somehow arbitrary estimation concerning the “time frame” can be regarded as a weaker argument than the potential role of a technology, that complements a strong societal demand, it therefore seems reasonable to preserve the technology in the resulting list.

The WBAM based values of the categories used to characterise the identified technologies therefore should be regarded with sound scepticism. On the other hand, the prioritisation of such a large number of technologies solely based on a discussion among experts probably would also lead to near endless discussions and some remaining incompatible assessments.

Insofar, the application of the WBAM method was very useful, however it cannot deliver an absolute objective, definitive and “true” result.