The Opportunity for an Estonian Center for Applied Research

Discussion/Feedback Meeting

13 February 2019

Meeting Objectives

- Discuss the opportunity for creating an Estonian Center for Applied Research (ECAR)

- See where there is agreement
- And where there is disagreement

- And get your input on action items, next steps

Personal Background

BCG The Boston Consulting Group

Sun microsystems

AirTight Networks

SRI International

Stanford Graduate School of Business

Network Equipment Technologies

nexthop

SiLock™

McKinsey&Company

ensim An Ingram Micro Company

Renewable Funding

IBM

Princeton University

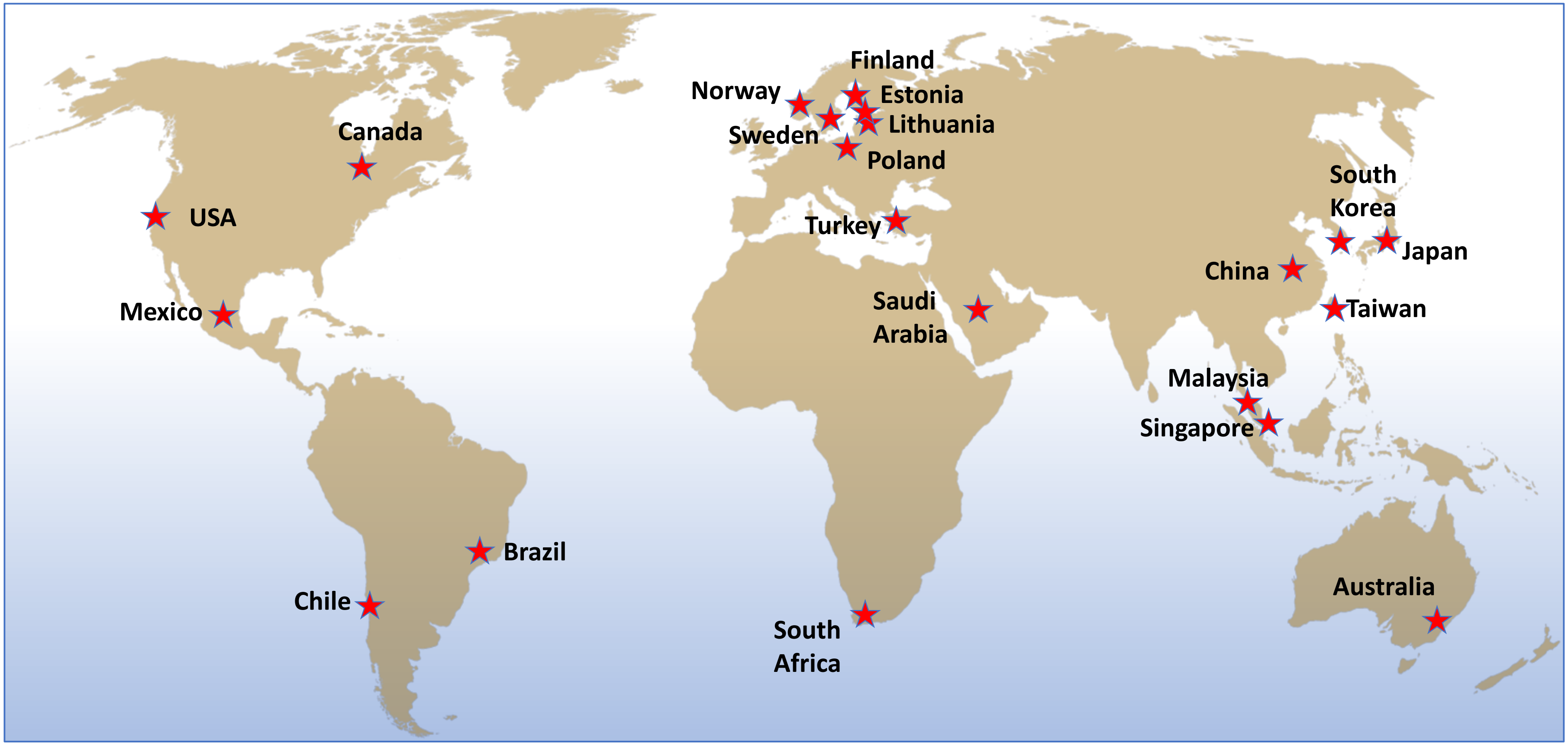
cisco

Cardinal Solar Capital

ROLM

infoGear

Global Perspective on Innovation



Innovation Perspectives

ECAR Opportunity

- Objectives for this meeting
- Agenda

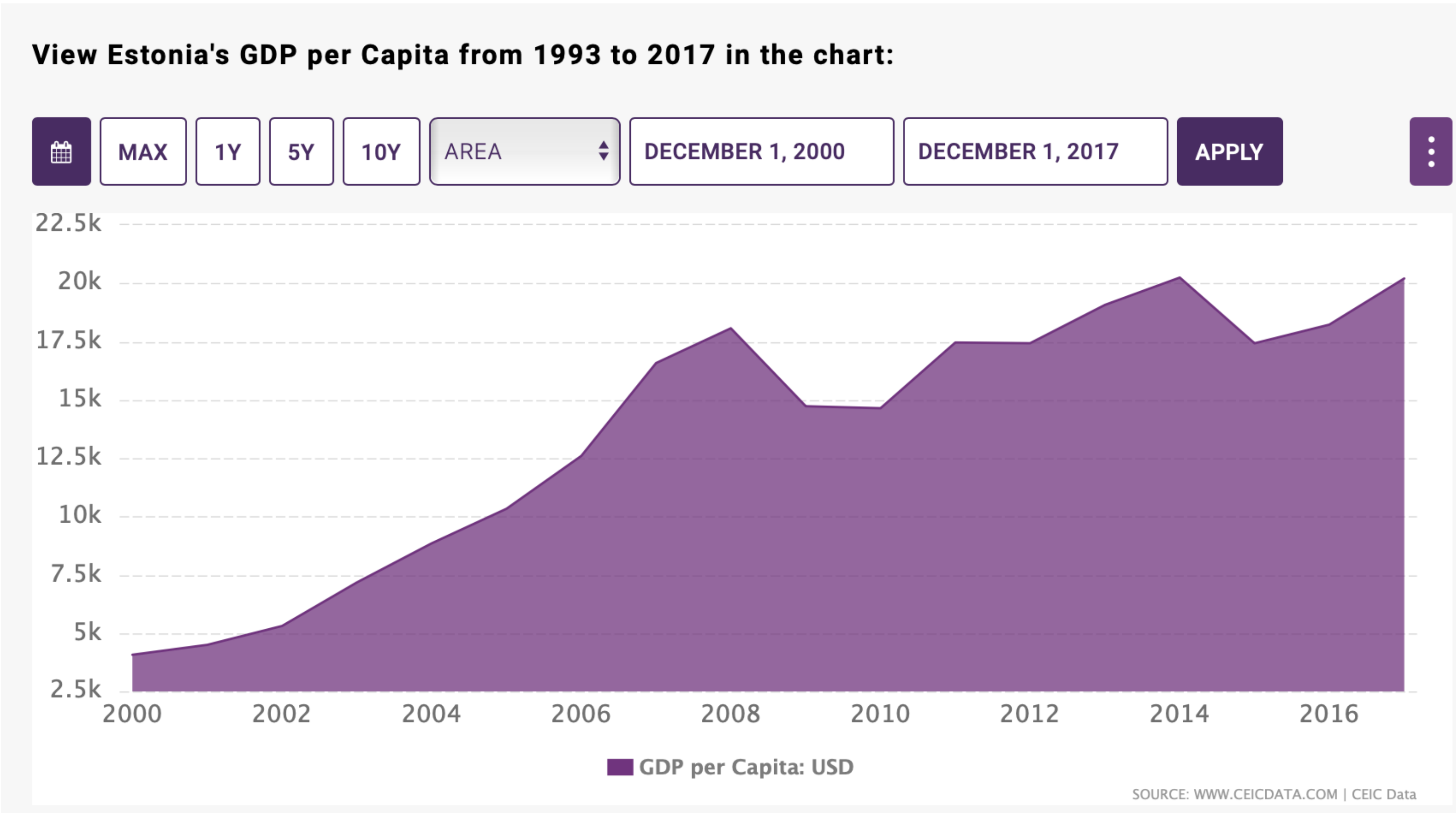
- The Challenge for Estonia
- The Need for Applied Research
- Interviews/Preliminary Conclusions

- Alternative Scenarios for Estonia
- Lessons from Other Countries
- Alternative Scenarios for ECAR
- Next Steps

The Challenge for Estonia

- How to advance GDP/person to EU average or above?

Estonia – Great Progress

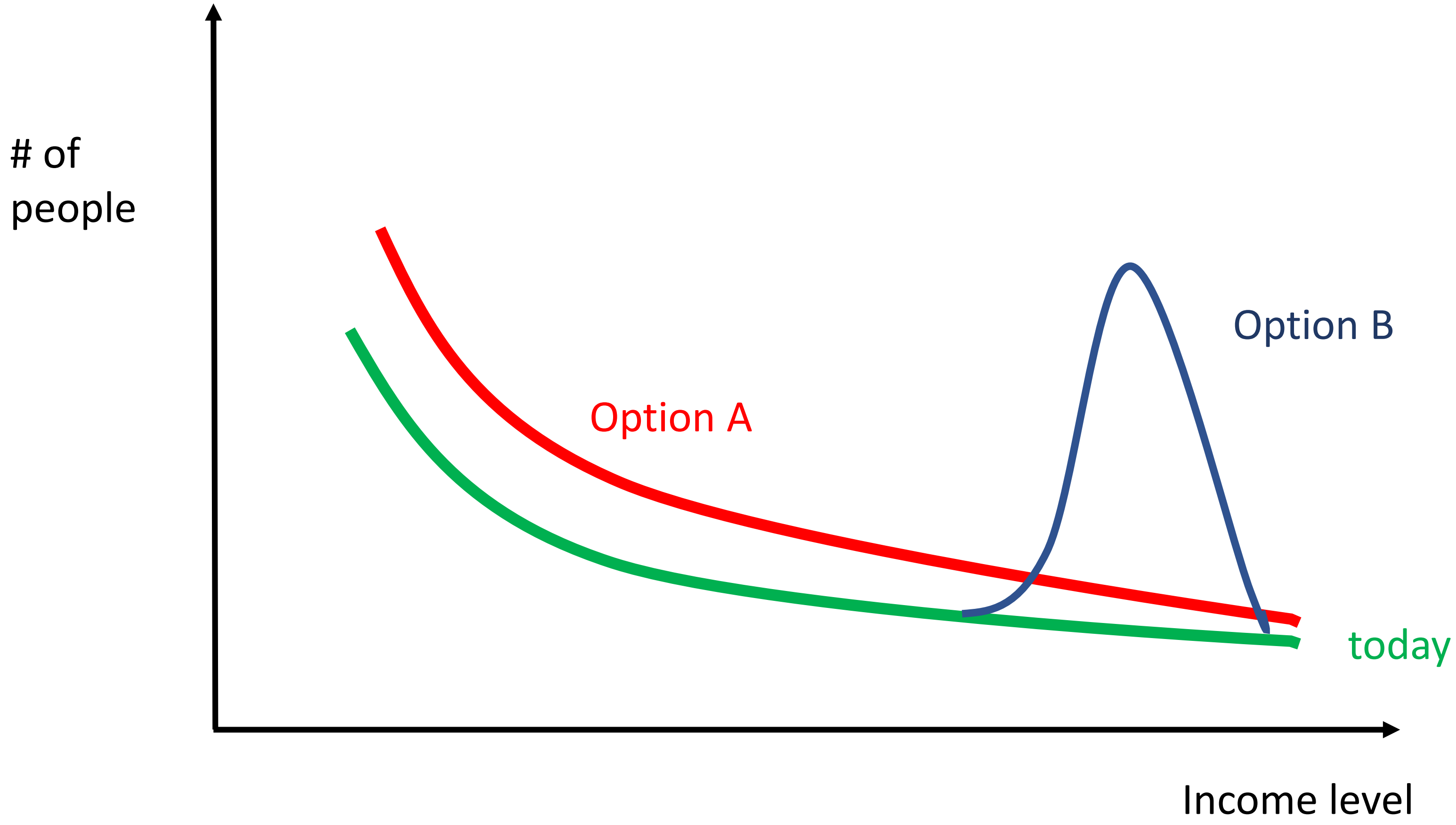


Estonia – not yet at EU average

GDP/Person - 2014

Source: Eurostat

How to Grow GDP/Person?



Stages of Economic Development

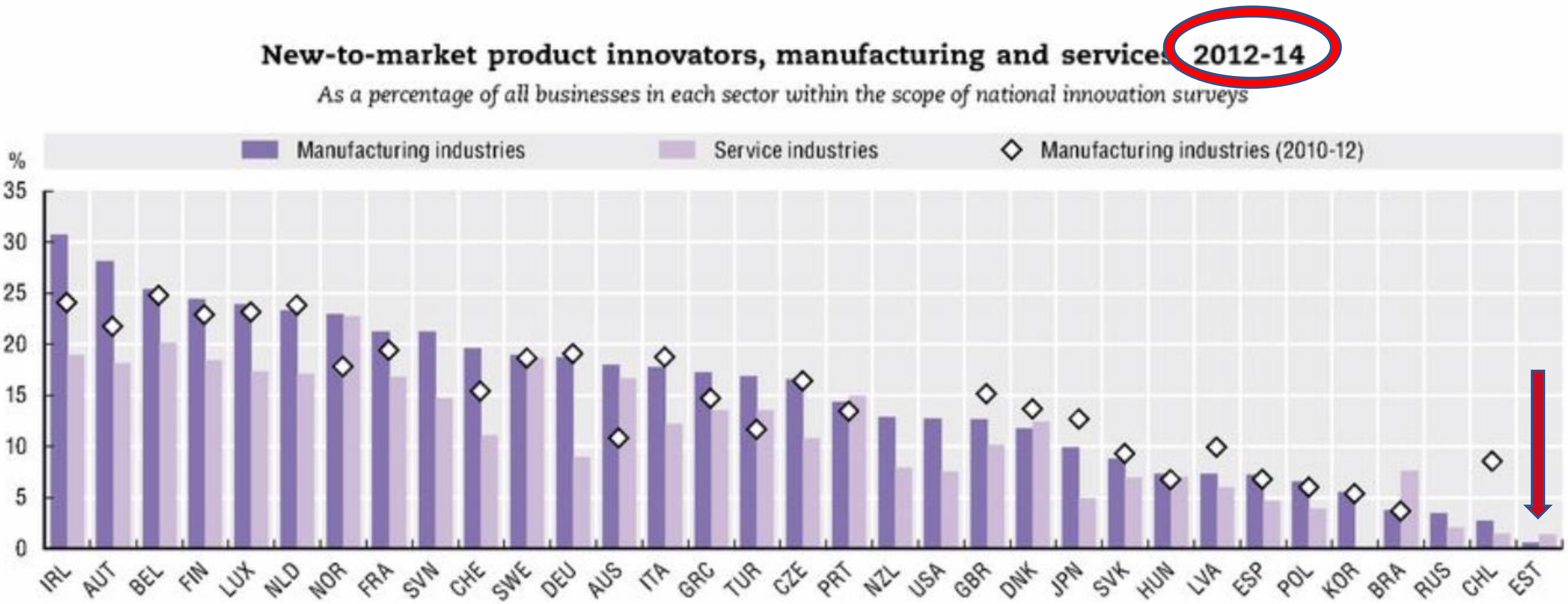
Factor driven

Efficiency driven

Innovation driven

Source: World Economic Forum

Estonia Lagging in Innovation



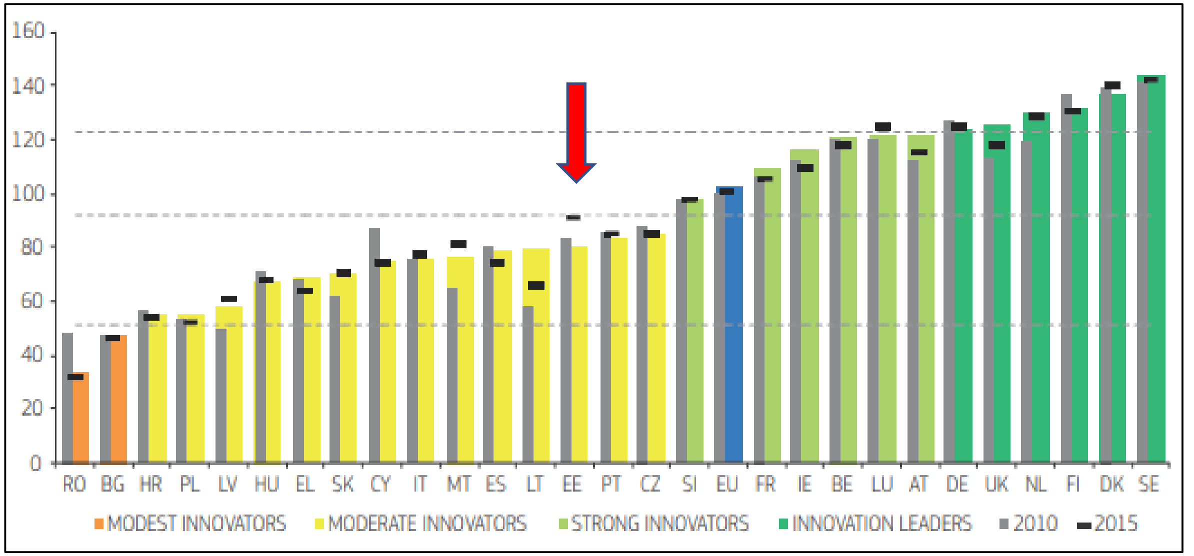
Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey.

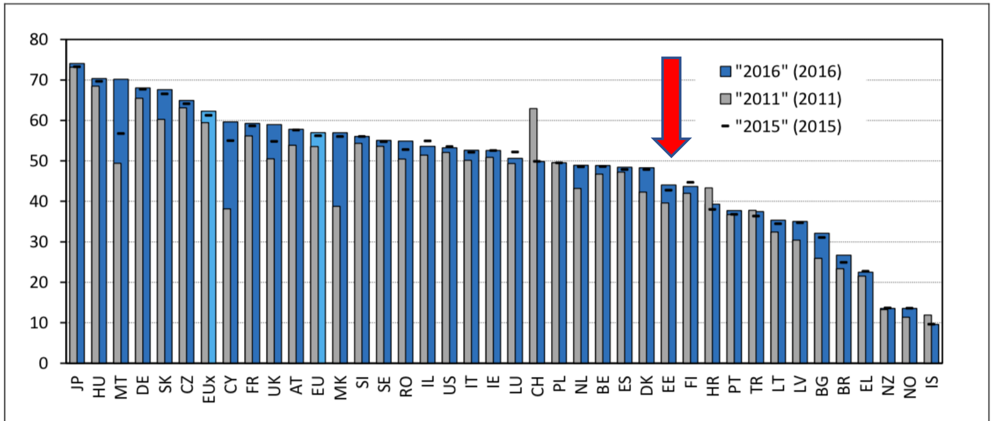
Source: OECD, based on the 2017 OECD survey of national innovation statistics and the Eurostat, Community Innovation Survey (CIS-2014), *http://oe.cd/inno-stats*, June 2017. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888933619372*

Innovation = Improving

European Innovation Scoreboard 2016

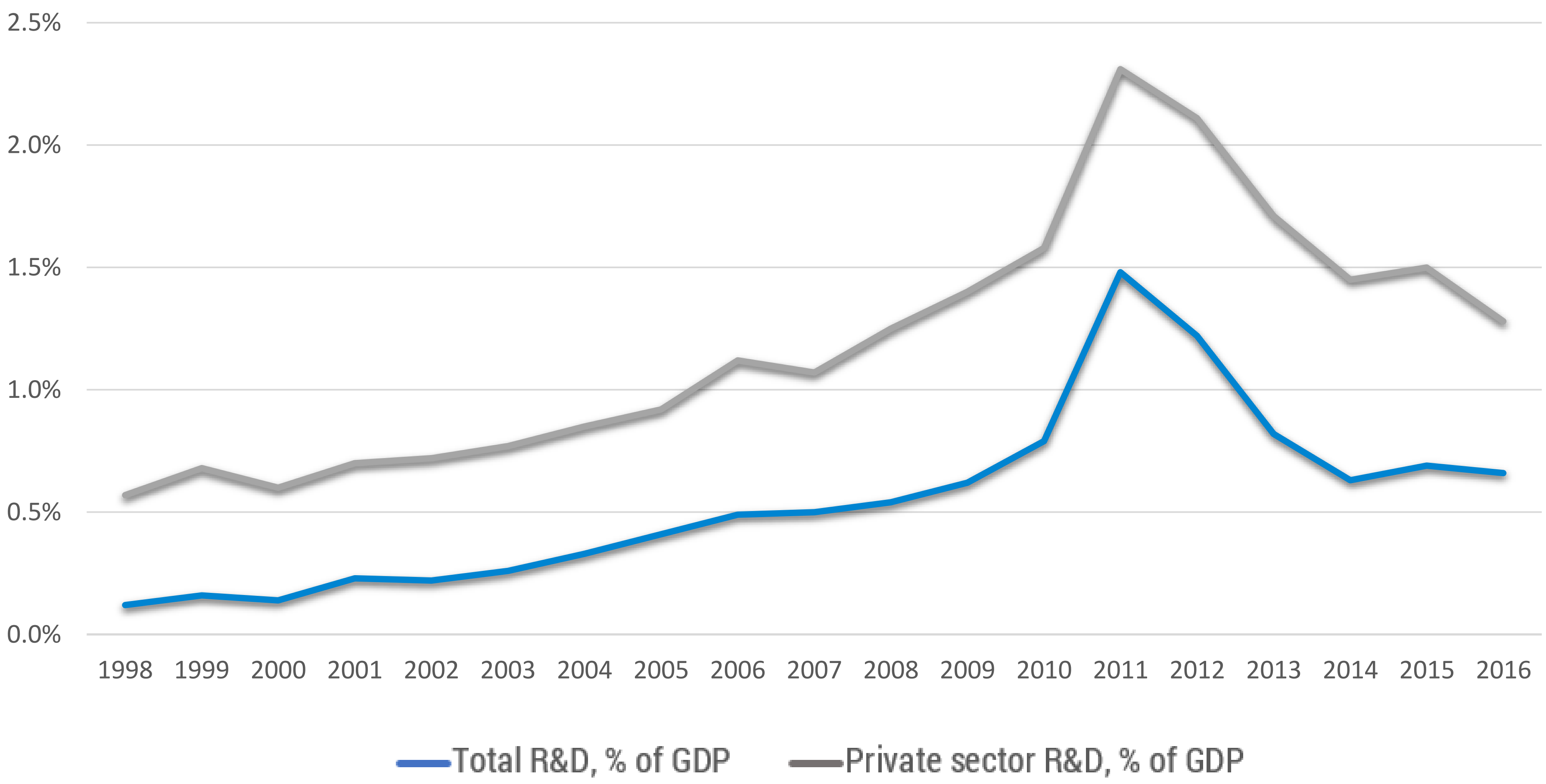




Source: see Table 5. *Notes:* The EU28 aggregate is represented by two values: 'EU' refers to intra- plus extra-EU trade; 'EUx' refers to Extra-EU trade only. For MS both intra- and extra-EU trade are included. Years in quotation marks indicate actual year of data

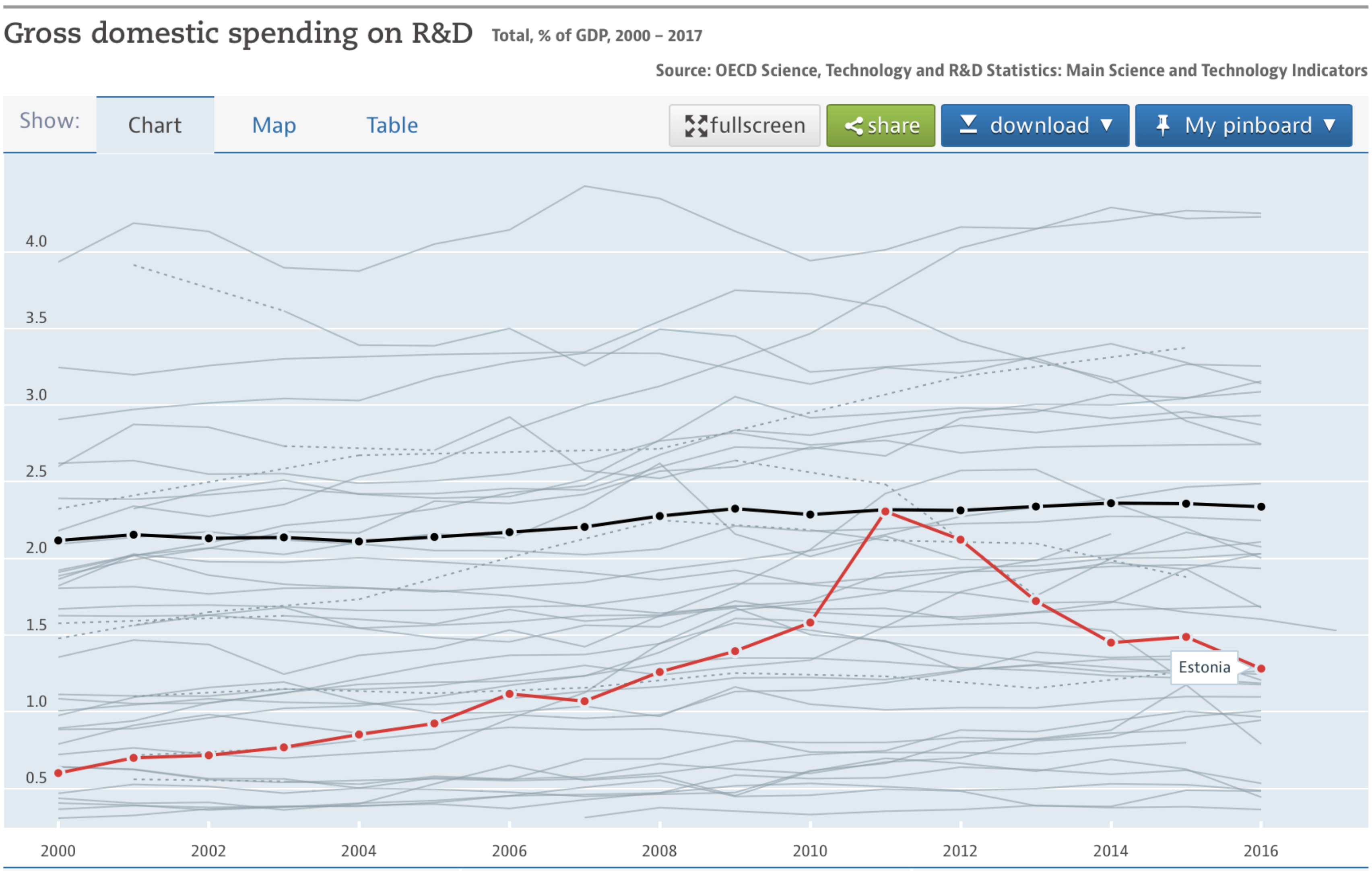
Figure 5 The share of medium- and high-tech products in total exports (in %)

Innovation in part driven by R&D

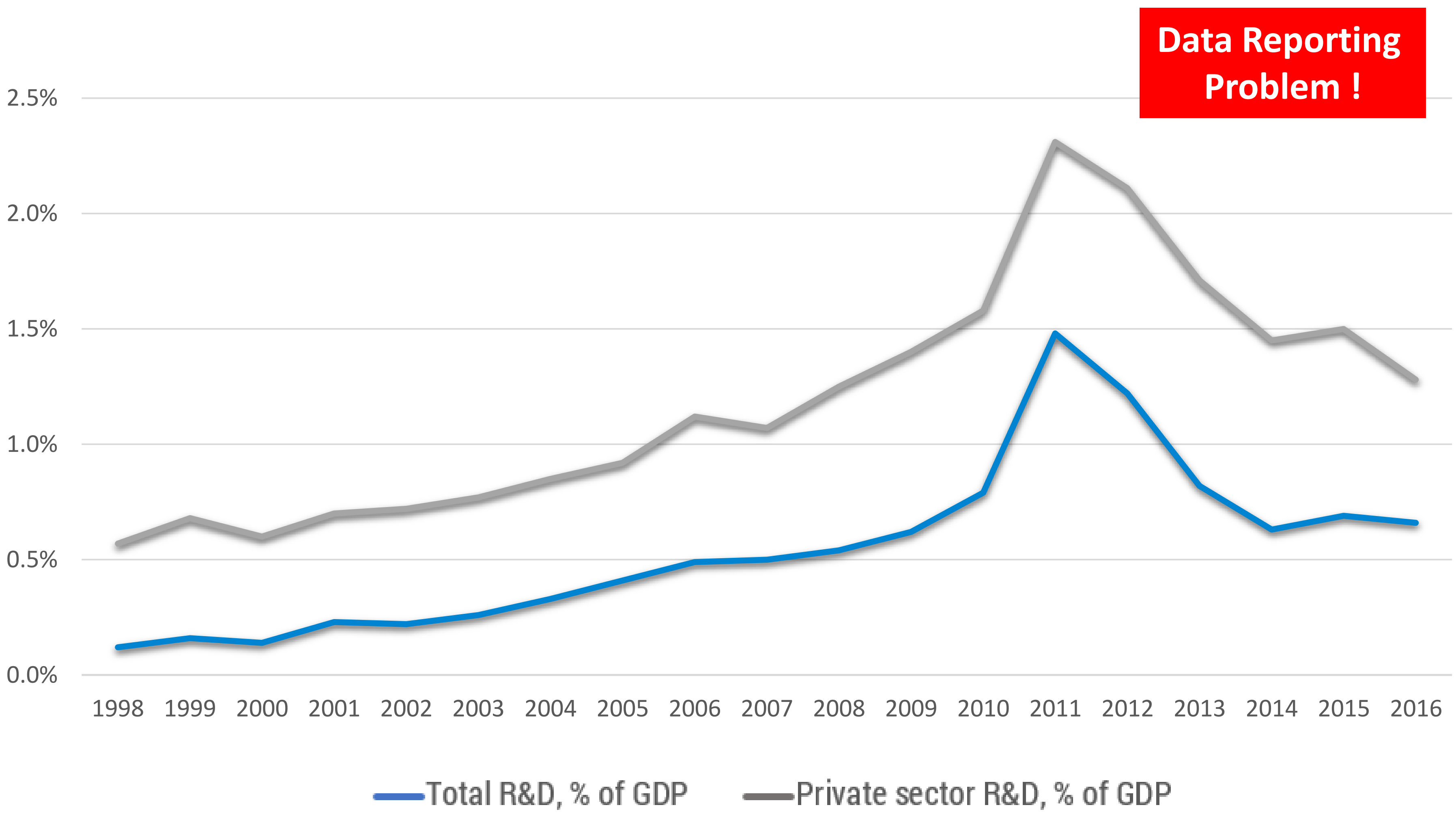


Source: Statistical Office of Estonia

EU – R&D Spending



Innovation in part driven by R&D



Source: Statistical Office of Estonia

Estonia Private R&D Spending

Total PRIVATE sector external and internal R&D (kEUR)										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total	103,154	103,861	133,930	254,019	239,209	173,592	145,472	153,699	162,389	166,357
Agriculture	326	*	*	158	*	*	*	*	*	*
Mining	*	*	*	*	*	*	*	*	*	*
Manufacturing	22,992	19,646	44,422	156,178	96,343	61,020	32,521	39,465	34,831	43,755
Energy	4,663	5,741	4,444	3,207	4,726	6,251	16,758	9,679	12,592	12,990
Utilities	*	*	*	*	*	*	*	*	*	*
Construction	*	*	*	352	3,097	*	*	83	649	1,209
Wholesale, retail, sale of vehicles	6,908	7,690	4,872	3,912	3,354	2,012	3,642	188	1,386	2,360
Transport and logisitics	3,199	1,215	*	*	*	*	*	*	2,531	2,501
Accomodation and restaurants	*	*	*	*	*	*	*	*	*	*
ICT	38,564	33,527	32,231	36,926	64,226	50,395	44,856	58,758	72,784	64,060
Finance and Insurance	8,503	10,906	15,786	12,650	11,972	13,504	14,001	14,280	12,523	17,823
Real estate	*	*	*	*	*	*	*	*	*	*
Prof. Scientific & Technical Activities	16,273	22,319	29,500	26,993	38,311	35,939	27,622	24,687	21,716	20,229
Public administration & defence, compulsory social security	*	*	*	*	*	*	*	*	*	*
Healthcare	0	1,085	.	1,312	1,303	1,131	2,071	1,338	*	*
Social services	0	0	0	0	0	0	0	0	0	0
Art, entertainment and leisure	0	0	0	0	0	0	0	0	0	*
Other service sectors	0	0	0	0	0	0	0	0	0	0
GDP	16,508	14,158	14,708	16,661	17,928	18,926	20,051	20,646	21,675	23,603
Private R&D expenditure	0.6%	0.7%	0.9%	1.5%	1.3%	0.9%	0.7%	0.7%	0.7%	0.7%

* Did not report, less than 4 companies reporting

Discussion

Summary of the challenge:

- Improving Estonia's economy by doing more R&D, creating more technology-based products for export

- Do we agree?

The Need for Applied Research

<u>Academic Research</u>

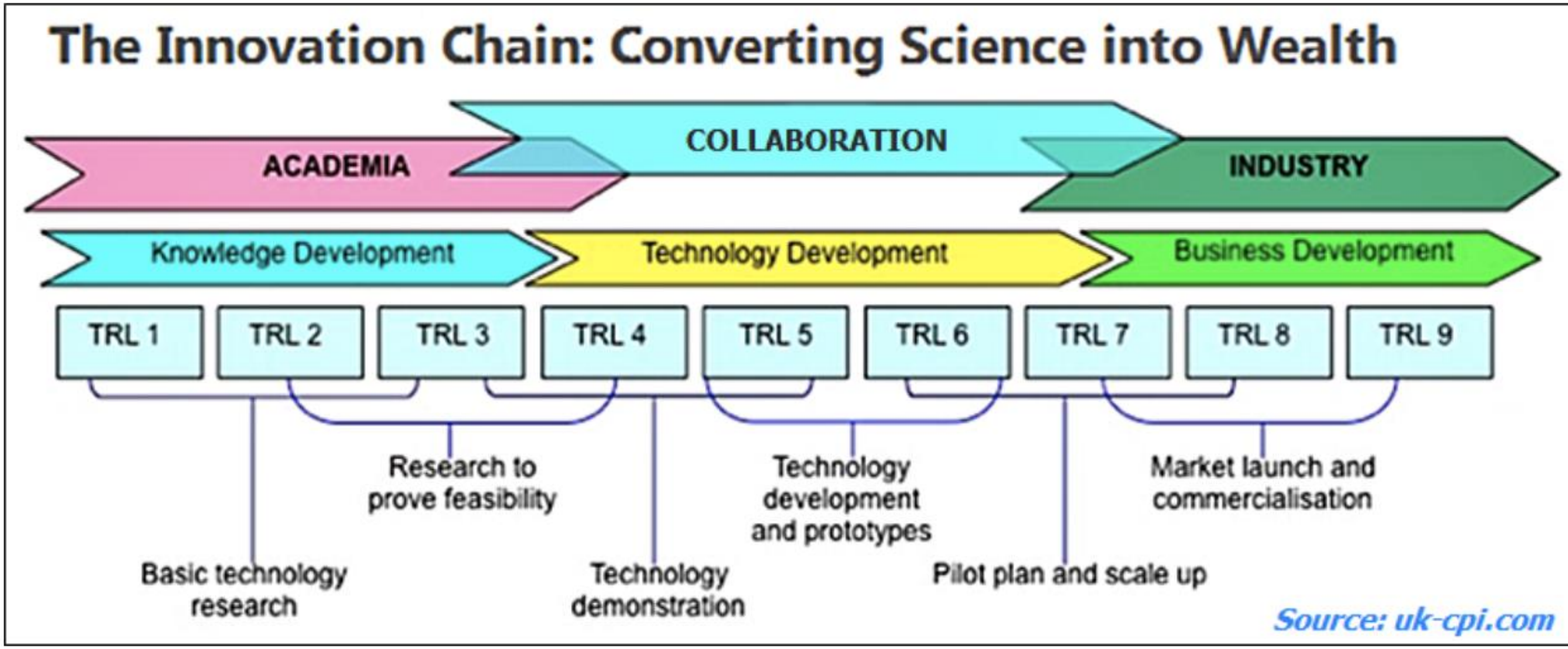
- Can I find a drug to cure cancer?
- Can I invent software to identify faces?
- Can I build a robot hand to grab things?

Applied Research

<u>Product Development</u>

- Clinical trials, manufacturing scale
- Security, retail applications
- The Amazon Picking challenge

TRL (Technology Readiness Level) Model



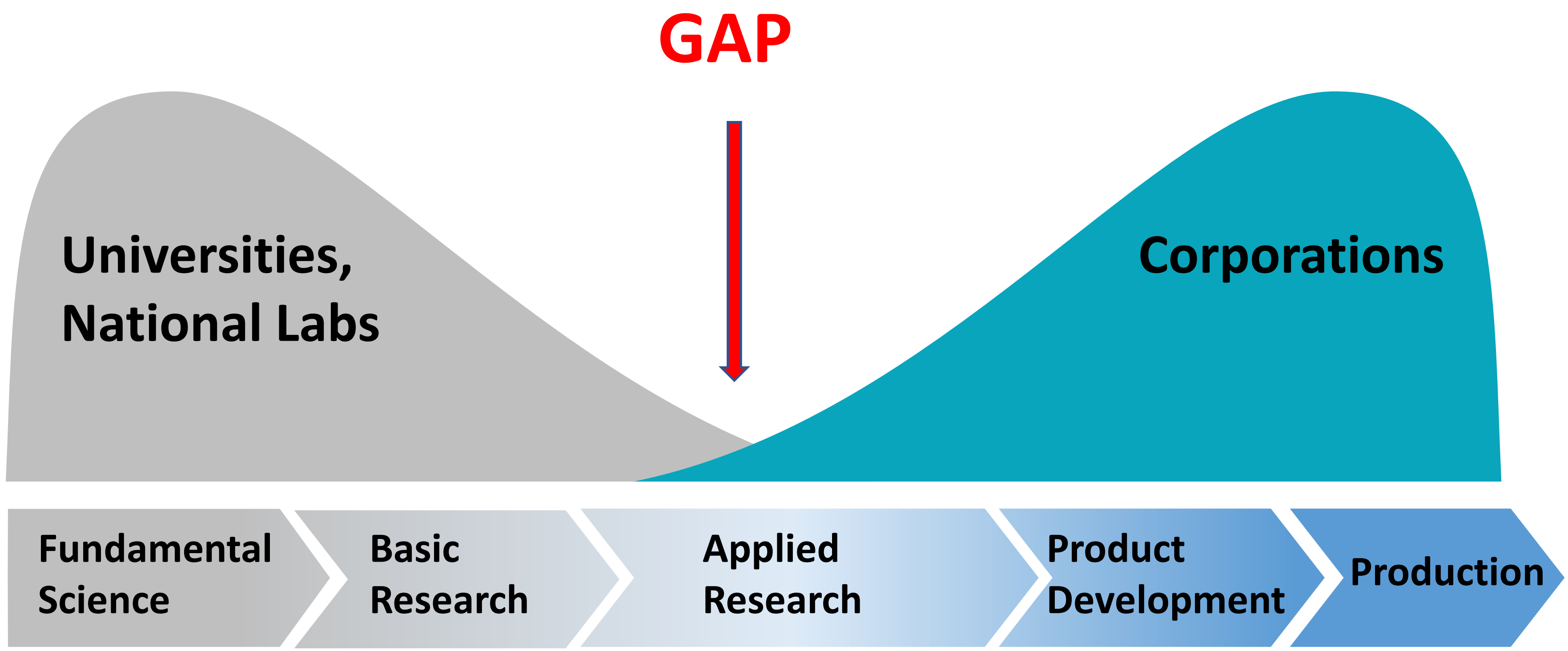
The Need for Applied Research

- Basic/Lab Research ≠ product ready for customers

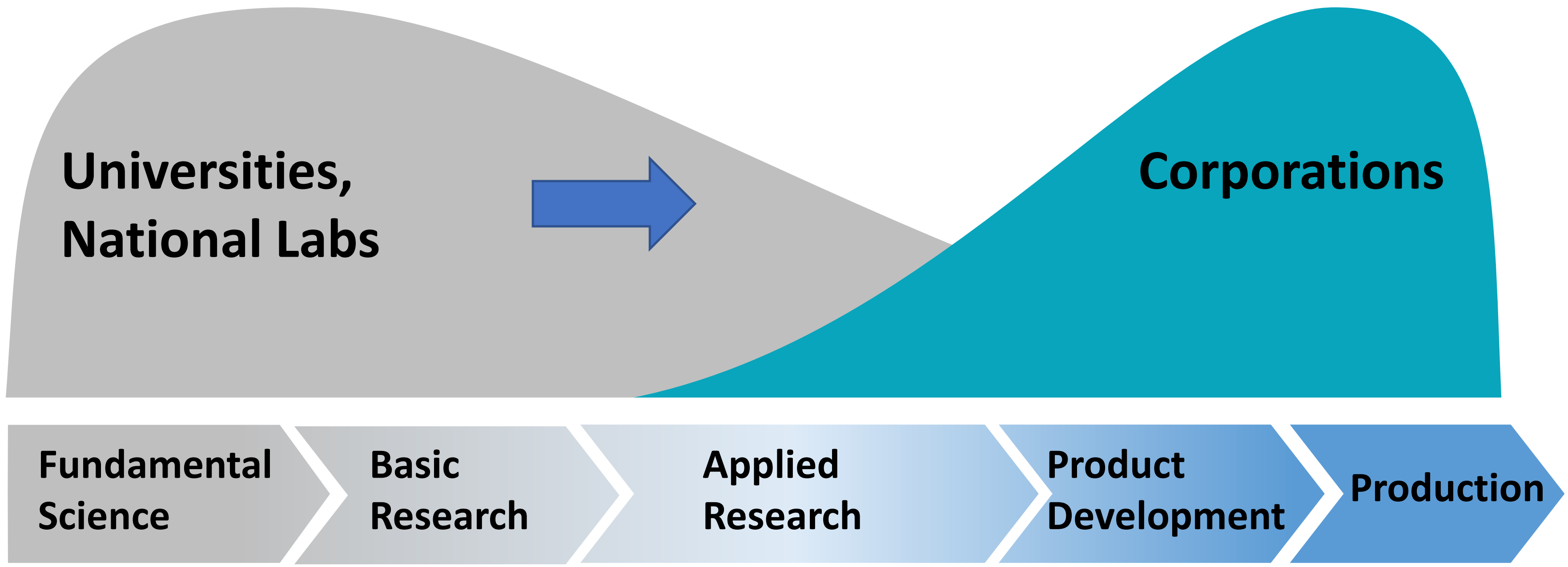
	Academic Requirement	Commercial Requirement
Certainty/proof	80% confidence	100% confidence
Scale	Lab scale	Commercial scale
Defect level	Known bugs - ok	Zero P1, P2 bugs
Documentation	Lab notes	User manuals
IP Status	Thinking about patent application	Patent application in process or approved
Staffing	Grad students	Full-time engineers

BIG DIFFERENCE!!!

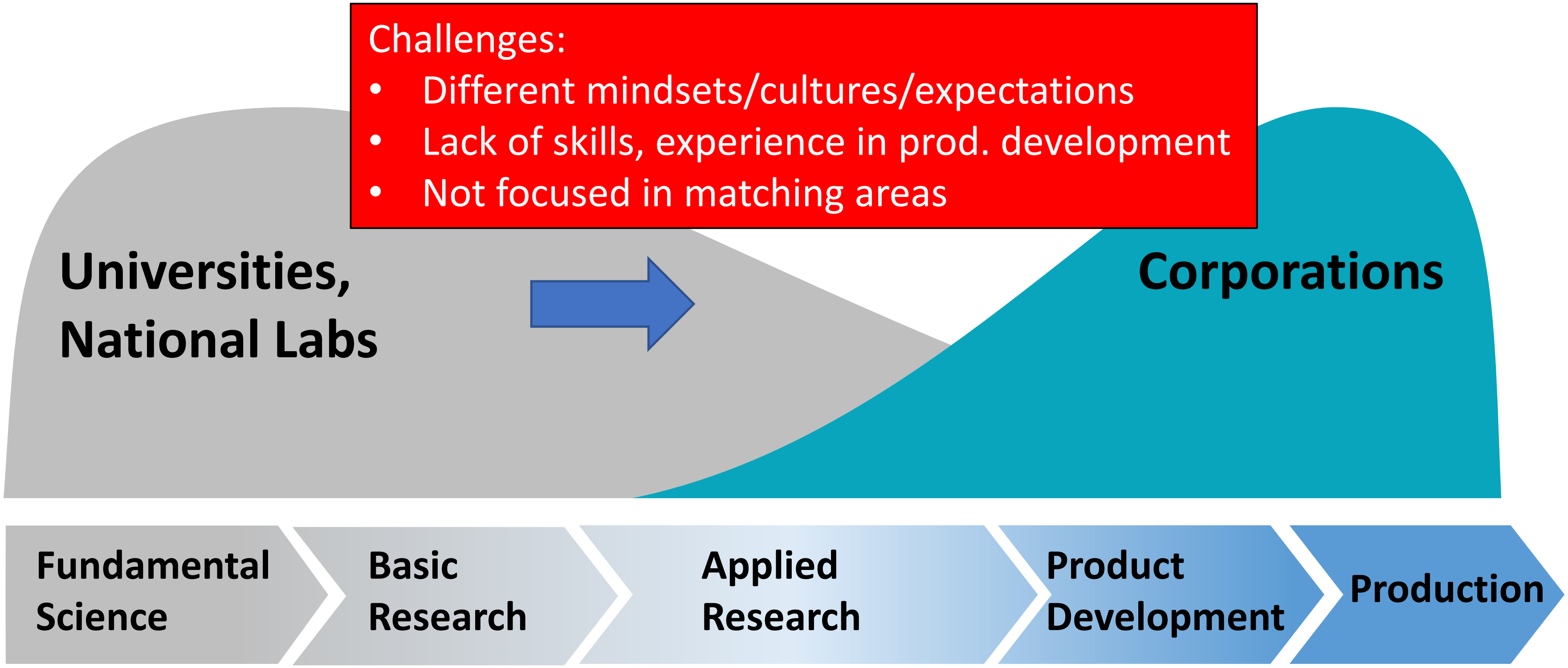
Applied Research In Estonia - today



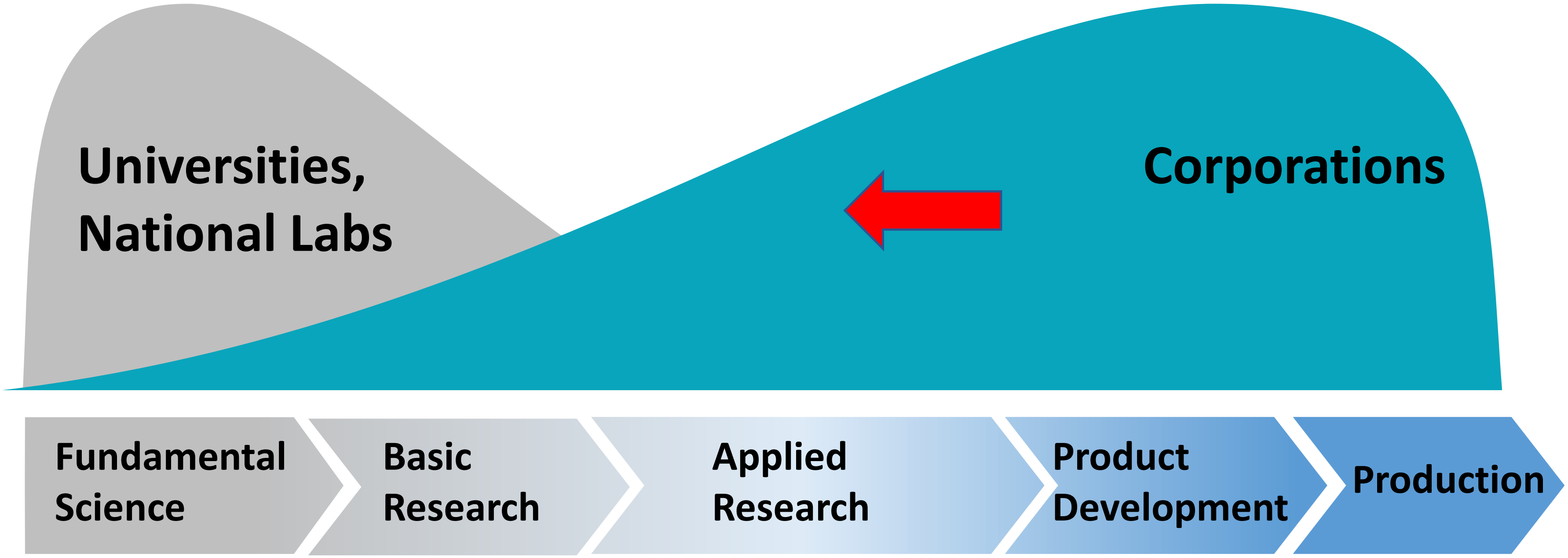
Applied Research – Change the Universities



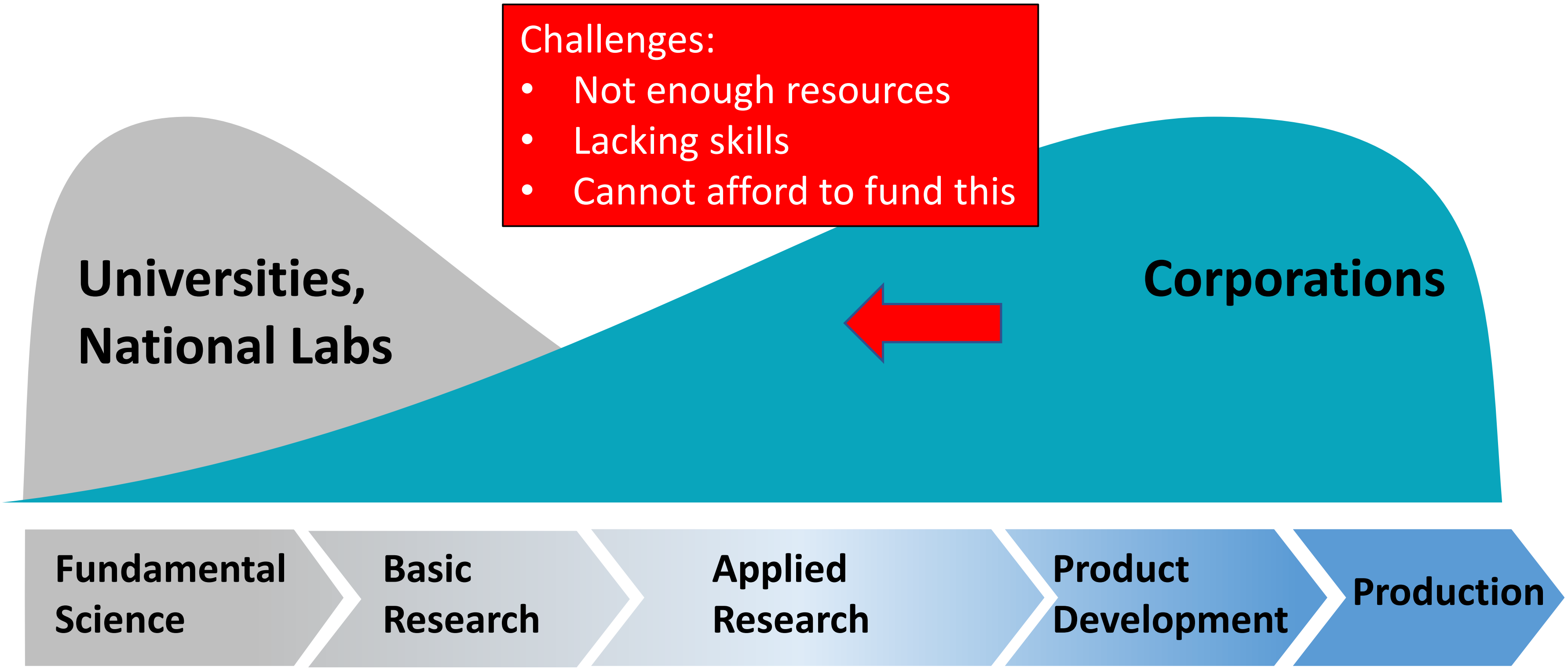
Applied Research – Change the Universities



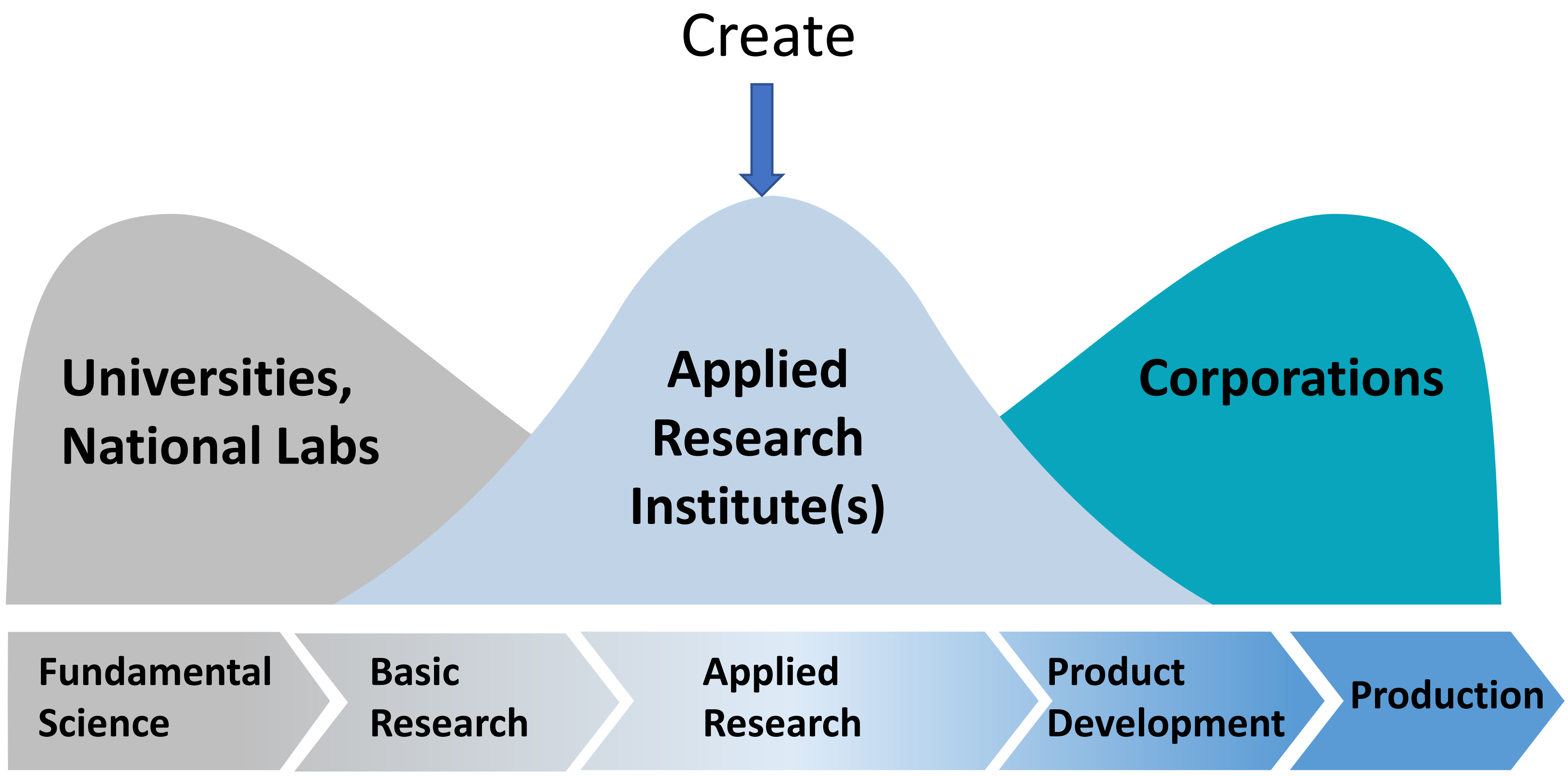
Applied Research – Encourage Companies



Applied Research – Encourage Companies



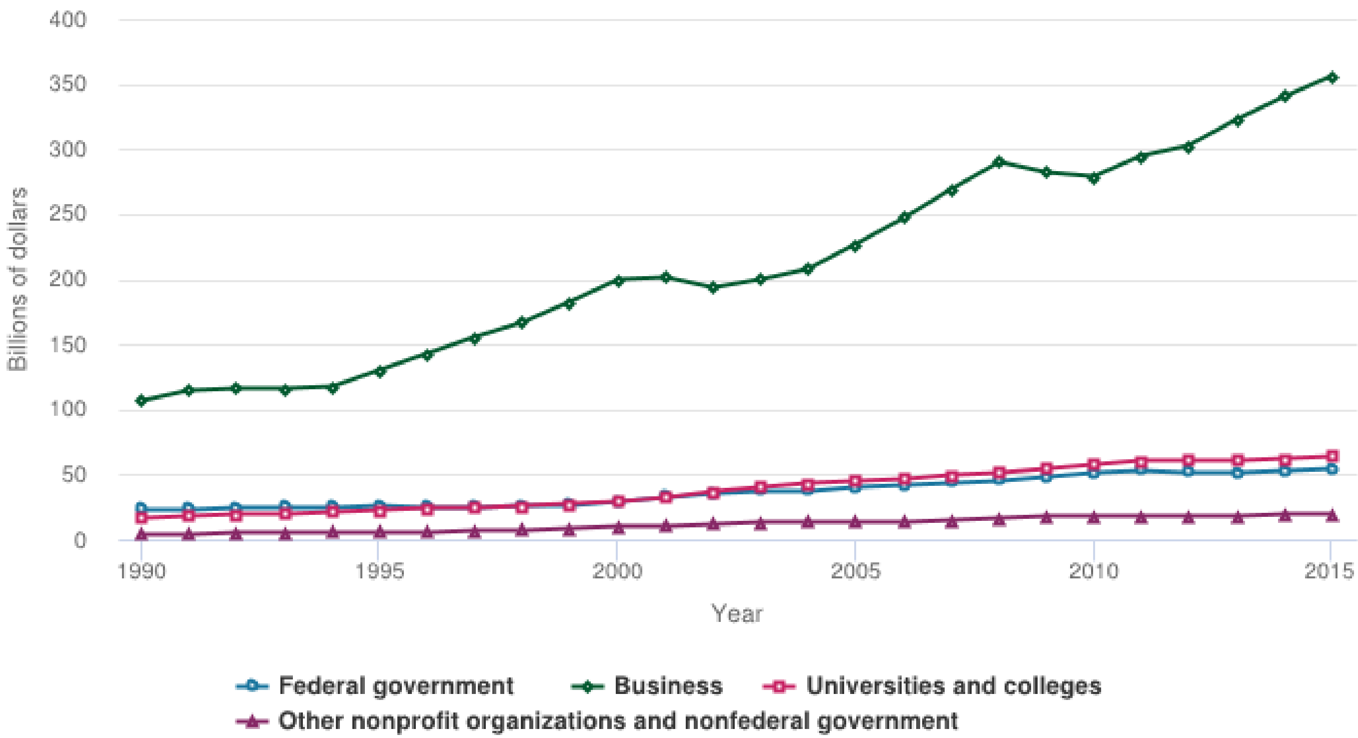
Applied Research Institute – Option 3



US R&D Execution – Who does R&D?

Figure D2-A

U.S. R&D performance, by performing sector: 1990–2015



Indicators 2018: Recent Trends in U.S. R&D Performance, Chapter 4.

US R&D Spending – by TRL groups

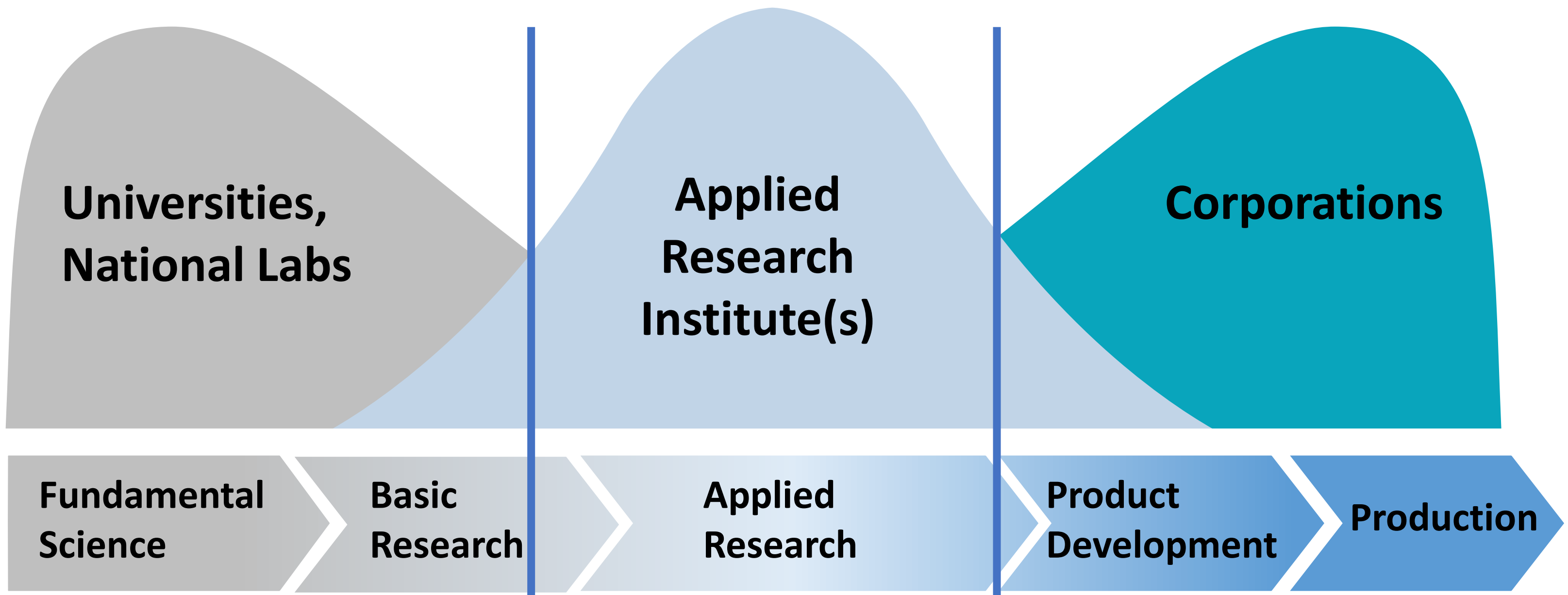
TABLE 4-4

U.S. R&D expenditures by type of work: Selected years, 1970–2015

(Billions of current and constant 2009 dollars; percent distribution)

Type of work	1970	1980	1990	2000	2010	2011	2012	2013	2014	2015[a]
Current $billions										
All R&D	26.3	63.2	152.0	267.9	406.6	426.2	433.6	454.0	475.4	495.1
Basic research	3.6	8.7	23.0	42.0	75.9	73.0	73.3	78.5	82.1	83.5
Applied research	5.8	13.7	34.9	56.5	79.3	82.1	87.1	88.3	91.9	97.2
Experimental development	16.9	40.7	94.1	169.4	251.4	271.0	273.3	287.1	301.5	314.5
Constant 2009 $billions										
All R&D	115.3	142.5	227.6	327.2	401.7	412.5	412.1	424.6	436.8	450.1
Basic research	15.8	19.7	34.5	51.3	75.0	70.7	69.7	73.4	75.4	75.9
Applied research	25.2	30.9	52.3	69.0	78.3	79.5	82.8	82.6	84.4	88.3
Experimental development	74.3	91.8	140.9	206.9	248.4	262.3	259.7	268.6	277.0	285.9
Percent distribution										
All R&D	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Basic research	13.7	13.8	15.2	15.7	18.7	17.1	16.9	17.3	17.3	16.9
Applied research	21.9	21.7	23.0	21.1	19.5	19.3	20.1	19.5	19.3	19.6
Experimental development	64.4	64.5	61.9	63.2	61.8	63.6	63.0	63.3	63.4	63.5

US R&D Spending



USA

50% by universities
25% by labs/gov't
25% by companies

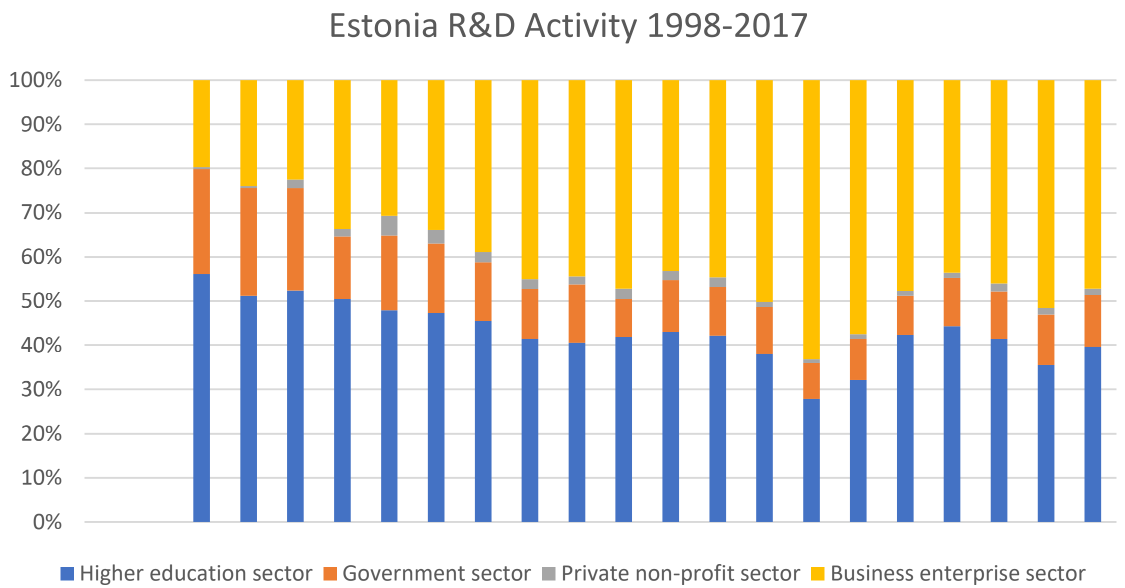
58% of R&D done by companies

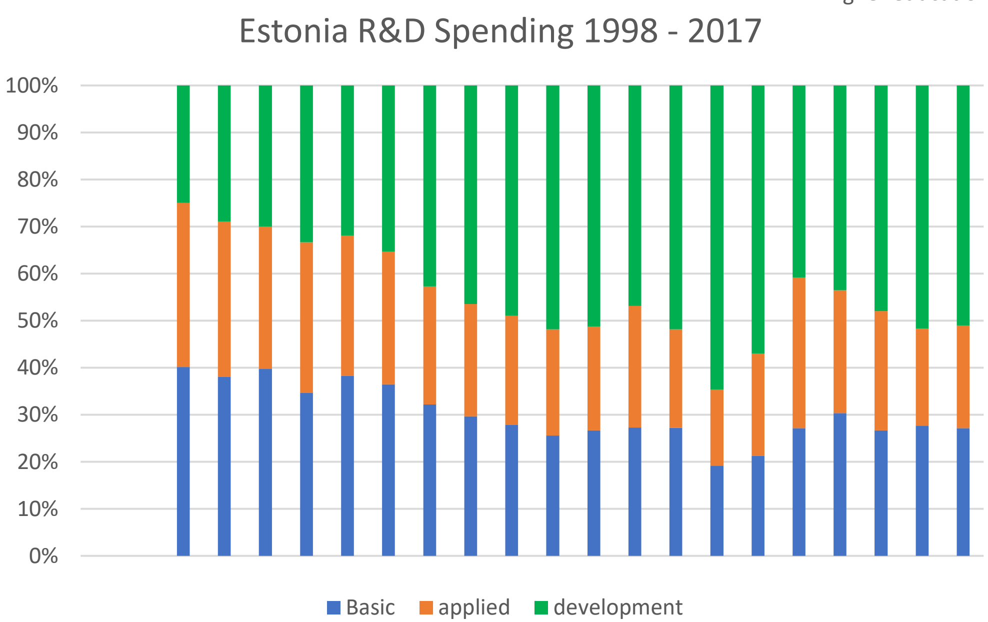
88% of R&D done by companies themselves

Source: NSF

Estonia R&D Statistics

Source: Statistics Estonia

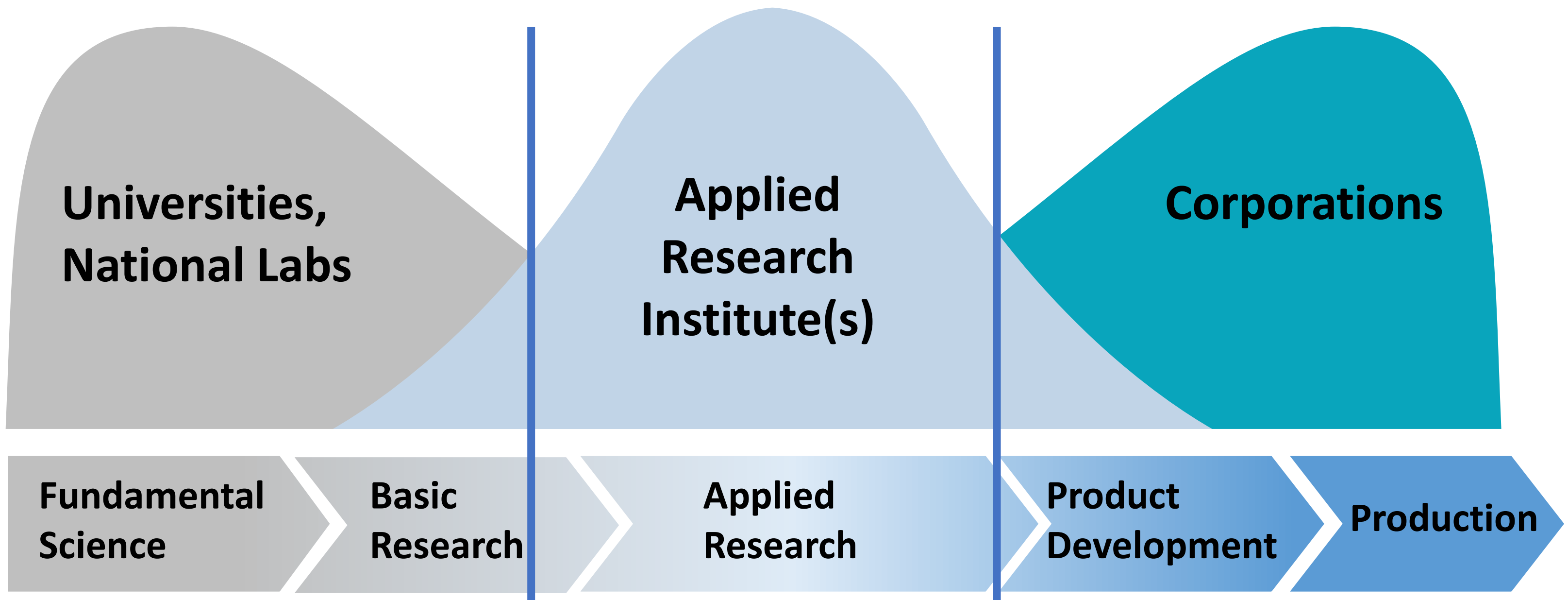




Applied Research needs to grow

Innovation Perspectives

Estonia R&D Spending



Estonia Public R&D Spending	48%	29%	22%

BREAK

What we were trying to learn

Estonian Companies \ Estonian Research	Weak	Strong
Strong	Build Research Capabilities	Strengthen, accelerate ?
Weak	Not interesting	Build New Companies

List of In-Person Meetings

- Anne Sulling—Member of the Parliament of Estonia
- Seth Lackman—CEO of Fujitsu Estonia
- Robert Kitt & team - Swedbank
- Bo Henriksson, former CEO of ABB
- Siim Espenberg and Alo Lilles—specialists in business development at Tartu City government
- Katrin Pihor, Head of Research Policy Department, Ministry of Education.
- Jaak Vilo, head of the institute of Computer Science, Tartu University
- Ene Tammsaar, CEO of Bio CC
- Mait Klaassen, Rector of the University of Life Sciences
- Ülle Jaakma, Vice Rector of Research, University of Life Sciences
- Meelis Kadaja, Director of Business Development of Icosagen
- Ulo Såre, CEO of Reach-U
- Toomas Asser, Rector of Tartu University
- Erik Puura, Vice rector for development, Tartu University
- Kristjan Vassil, Vice rector for research
- Andres Koppel, Director General of the Estonian Research Council
- Hanno Tomberg, Member of the Board of the Archimedes Foundation
- Indrek Reimand, Deputy Secretary General, Ministry of Education and Research
- Raivo Vilu, Director of Development & Aavo Sõrmus, Chairman of the Council of TFTAK (Center of Food and Fermenatation Technologies)
- Jaak Aaviksoo, Rector of Tallinn University of Technology,
- Mario Kadastik, Deputy Director of the National Institute of Chemical Physics and Biophysics.
- Kaupo Reede, Director of the Economic Development Department
- Sigrid Rajalo, Strategy Adviser to the Economic Development Department
- Oliver Väärtnõu, CEO of Cybernetica
- Karin Kivimåe, COO of Guardtime
- Sigrid Harjo, Member of the Board, Enterprise Estonia
- Triin Nõlvak, Area manager, Enterprise Estonia
- Meelis Kitsing, head of the Foresight Center and his team (Mari Rell, Johanna Vallistu)
- Kristjan Mändmaa, Dean of Design at the Academy of Arts, and his team (Martin Pärn, professor of strategical design in the Estonian Academy of Arts, Ruth Melioranski, researcher at the Estonian Academy of Arts, and Maarja Mõtus, Head of Product Design at the Estonian Academy of Arts).
- Mr. Rene Tammist, Minister of Entrepreneurship and IT
- Tiit Land, Rector of Tallinn University,
- Tarmo Soomere, President of the Estonian Academy of Sciences

List of Interviews

Wood and Forestry	**Wooden Houses**	**Food**
Estonian Cell AS	MATEK AS	Salvest AS
Lemeks AS		E-PIIM TOOTMINE AS
Peetri Puit OU		TERE
Graanulinvest	**Metal Industry**	
	Hyries	
Chemical Industry		**Electronics**
Chemi-Pharm AS		Rantelon OU
Mayeri Industries AS	**Machinery**	Skeleton Technologies OU
JOIK OU	Hekotek AS	Artec Design OU
	Equa	
Energy		
Virum Keemia Grupp AS		**Plastic Packaging**
Eesti Energia AS	**Electrical Appliances**	Estiko-Plastar
Elektrilevi	Estel	
	Harju Elekter	
Logistics	ENICS	**Construction Materials**
Cleveron		Bauroc
Textiles and Sewing	**Biotechnology**	
Baltika	Icosagen	**Start-ups**
Conectra		UBIK
		Starship Technologies
ICT Locals	**ICT Multinationals**	Plumbr
Proekspert	Fujitsu	Geneto
GuardTime	Ericsson	
Reach-U	Tieto	
Fortumo	Playtech	

Preliminary analysis/conclusions

- Everyone in Estonia agrees with the challenge
- Applied research gap exists in Estonia as elsewhere

- Common challenges:
  - Scale
  - People/skills/availability
  - Culture/aggressiveness

University of Tartu

2015 data, 2017 ratings	Agriculture & veterinary sciences	Engineering & Technology	Humanities & the Arts	Medical & Health Sciences	Natural Sciences	Social Sciences
FTE Staffing	238.2	759.6	531.6	560.9	1039.6	487.1
research	116.8	372.6	82.5	167.3	471.9	79.6
teaching	21.9	150	214	204.9	170.2	231.4
tech & Aux	99.5	237.1	235.1	216	397.6	176
Research funding						
funding total	€ 234,603	€ 4,344,191	€ 3,833,985	€ 12,845,031	€ 27,538,067	€ 4,504,974
# projects	4.33	61.53	90.68	151.79	404.91	141.74
R&D/project	€ 54,181	€ 70,603	€ 42,280	€ 84,624	€ 68,010	€ 31,783
R&D/FTE	€ 1,307	€ 8,313	€ 12,931	€ 37,094	€ 42,888	€ 14,576
Scientific Impact	very good	very good	good	very good	very good	good
Sustainability & potential of research	very good	very good	good	good	very good	good
Societal impact	very good	very good	good	good	very good	good

Tal Tech

TalTech research groups

	Research discipline	Staff in research groups: Number of research groups	*From another EU country*	Number of group members	*Incl. number of post-doctorates*	*Incl. number of doctoral studenst*	Inventions 01.01.2010 - 25.09.2018: Number of inventions	Number of patent applications	Number of patents	Number of utility models	Research and development (R&D) income 2017 (€): Total R&D income 2017	*incl. Est. Research Council funding (IUT, PUT and other)*	*incl. targeted appropriations (Ministry of Education and Research)*	*incl. R&D contracts and services*	*domestic*	interna-tional	*incl. Projects grants for R&D*	*domastic*	interna-tional	Number of ongoing projects in 2017
1.1	Mathematics	6		24		4	0	6	0	0	303,876	295,076	0	0	0	0	8,800	8,800	0	7
1.2	Computer and information sciences	10		111	1	22	1	10	1	0	1,543,022	187,500	143,000	277,067	213,577	63,490	935,455	379,198	556,257	31
1.3	Physical sciences	4		33	1	8	3	4	1	0	790,299	472,000	0	14,400	14,400	0	303,899	203,873	100,027	6
1.4	Chemical sciences	12	1	110		34	19	12	25	2	2,224,319	825,400	0	351,332	351,332	0	1,047,587	421,698	625,889	39
1.5	Earth and related environmental sciences	7		97	1	23	0	7	0	0	1,790,181	745,574	0	575,371	357,338	218,033	469,237	179,197	290,040	67
1.6	Biological sciences	10		64		16	5	10	2	0	1,085,217	851,323	0	115,638	2,300	113,338	118,256	118,256	0	18
1.7	Other natural sciences	1		20		9	2	1	2	0	147,085	85,200	0	61,885	61,885	0	0	0	0	6
2.1	Civil Engineering	7		107	1	37	1	7	0	1	1,826,968	454,004	0	425,849	387,449	38,400	947,116	709,395	237,721	50
2.2	Electrical engineering, electronic engineering, information engineering	18	1	193	5	67	26	18	36	8	6,671,387	877,098	0	1,296,189	1,132,770	163,419	4,498,100	1,154,912	3,343,188	92
2.3	Mechanical engineering	7		57		12	1	7	1	0	2,383,290	422,710	0	5,000	5,000	0	2,337,140	2,300,440	559,380	18
2.4	Chemical engineering	1		10		5	0	1	0	0	15,342	0	0	4,500	4,500	0	10,842	0	10,842	3
2.5	Materials engineering	7		87	1	37	19	7	10	0	715,909	432,280	0	155,653	80,938	74,715	127,976	127,976	0	23
2.6	Medical engineering	3		20		8	9	3	7	0	163,867	88,000	0	0	0	0	75,867	75,867	0	3
2.7	Environmental engineering	4		36		9	1	4	0	1	795,619	149,500	0	294,784	289,784	5,000	351,335	287,262	64,073	23
2.8	Environmental biotechnology																			

University of Life Sciences

	Scientific impact of research	Sustainability and potential of research	Societal importance of research	Scientific basis in the field is sufficient to conduct doctoral studies.
EMU (Estonia University of Life Sciences)				
The Estonian University of Life Sciences (EMU) (EMÜ_loodusteadused)	good	good	very good	yes
EMU (EMÜ_tehnika ja tehnoloogia). Engineering & echnology	good	good	very good	yes
EMÜ_põllumajandusteadused ja veterinaaria Agriculural science and veterinary science	good	very good	very good	yes

- Research in plant physiology particularly strong
- Some industry cooperation on precision agriculture
- But small projects - average private research effort = €3k
- No tech transfer office

“Industry Collaboration”

2.2 Elec. Eng. Institution	Period	Research area	Web of Science Documents	Category Normalized Citation Impact	Times Cited	% Docs Cited	H-Index	% Documents in Top 10%	% Industry Collaborations
Cybernetica	2015-2017	2.2	7	1.54	18	71.43	2	28.57	85.71
	2015	2.2	4	2.01	7	100.00	2	25.00	75.00
	2016	2.2	3	0.92	11	33.33	1	33.33	100.00
	2017	2.2	–	–	–	–	–	–	–
Estonian Marine Institute	2015-2017	2.2	5	2.62	1	20.00	1	20.00	0.00
	2015	2.2	1	0.00	0	0.00	0	0.00	0.00
	2016	2.2	3	0.00	0	0.00	0	0.00	0.00
	2017	2.2	1	14.45	1	100.00	1	100.00	0.00
Estonian University of Life Sciences	2015-2017	2.2	6	0.23	1	16.67	1	0.00	0.00
	2015	2.2	3	0.46	1	33.33	1	0.00	0.00
	2016	2.2	–	–	–	–	–	–	–
	2017	2.2	3	0.00	0	0.00	0	0.00	0.00
Narva College	2015-2017	2.2	1	0.24	1	100.00	1	0.00	0.00
	2015	2.2	–	–	–	–	–	–	–
	2016	2.2	1	0.24	1	100.00	1	0.00	0.00
	2017	2.2	–	–	–	–	–	–	–
National Institute of Chemical Physics & Biophysics (NICPB)	2015-2017	2.2	4	2.03	24	75.00	2	50.00	0.00
	2015	2.2	2	2.67	20	100.00	2	100.00	0.00
	2016	2.2	–	–	–	–	–	–	–
	2017	2.2	2	1.37	4	50.00	1	0.00	
Tallinn University	2015-2017	2.2	22	2.31	12	36.36	2	18.18	4.55
	2015	2.2	12	0.60	6	33.33	1	8.33	0.00
	2016	2.2	6	0.84	3	33.33	1	16.67	0.00
	2017	2.2	4	7.01	2	50.00	1	50.00	25.00
Tallinn University of Technology	2015-2017	2.2	502	1.08	854	33.86	11	10.76	
	2015	2.2	164	1.41	560	48.78	9	15.24	0.61
	2016	2.2	191	1.04	235	34.55	7	11.52	0.52
	2017	2.2	144	0.72	56	15.28	4	4.17	2.08
Tartu Observatory*	2015-2017	2.2	11	0.97	27	63.64	3	9.09	0.00
	2015	2.2	4	2.16	18	100.00	3	25.00	0.00
	2016	2.2	7	0.30	9	42.86	2	0.00	0.00
	2017	2.2	–	–	–	–	–	–	–
Tartu University Institute of Ecology & Earth Sciences	2015-2017	2.2	1	0.00	0	0.00	0	0.00	0.00
	2015	2.2	–	–	–	–	–	–	–
	2016	2.2	–	–	–	–	–	–	–
	2017	2.2	1	0.00	0	0.00	0	0.00	0.00
University of Tartu	2015-2017	2.2	136	2.50	278	50.74	8	20.59	1.47
	2015	2.2	47	2.46	191	68.09	7	27.66	2.13
	2016	2.2	45	1.46	60	46.67	4	15.56	2.22
	2017	2.2	40	4.29	24	35.00	2	20.00	0.00
University of Tartu Institute of Physics	2015-2017	2.2	18	0.52	37	38.89	4	5.56	0.00
	2015	2.2	6	1.27	29	83.33	3	16.67	0.00
	2016	2.2	7	0.26	8	28.57	2	0.00	0.00
	2017	2.2	5	0.00	0	0.00	0	0.00	0.00

University Input

- Have met with all of the universities in Estonia
- Key conclusions:
  - Good research taking place, driven by academic priorities
  - Research is largely unrelated to industry needs
  - Research not focused on applications (TRL 1-4, not 5-9)
- Universities are unlikely to be the drivers/catalysts for industry innovation, technology adoption

Company Needs (partial)

Industry Sector	Research Interests	Technical Services Needed
Wood, Forestry	plywood enhancements	wood pellet testing, characterization
	cellulose, wood chemistry	Glue-lam beam strength and safety testing/certification
	biological fermentation	fire & sound-proofing tests
	forestry robots	paper products testing
Chemistry	cosmetics development	cosmetics certification
	pharmaceutical development	clinical trials
	packaging for chemicals, detergents	robotic production lines
		biological analysis, DNA synthesis
		eco-certification
		e-commerce
Energy	oil shale refinement, processing	
	green energy alternatives	
	AI/network management	
	energy demand management	
	data analytics	
	energy storage, distributed generation	
ICT	data science/AI	product development
	radio, power technologies	product design
	battery/energy technology	business development
		product safety certifications
Food/Dairy	probiotics	factory automation
	animal feed supplements	food safety certifications
	packaging for food	applied food scientists
	food science	

Company Input

- Understand the challenge; want to grow, improve
- Diverse set of needs/requirements
- Scale is a challenge, companies are resource constrained:
  - People, skills
  - Sometimes funding
- Little university collaboration
  - Different time scales, expectations, incentives
  - Mismatch on skill requirements
- Mixed perspectives on government programs (Enterprise Estonia, Nutikas)
- Requirement/expectation for confidentiality from ECAR

Ministry of the Economy

Estonian Research and Development and Innovation Strategy 2014-2020

"Knowledge-based Estonia"

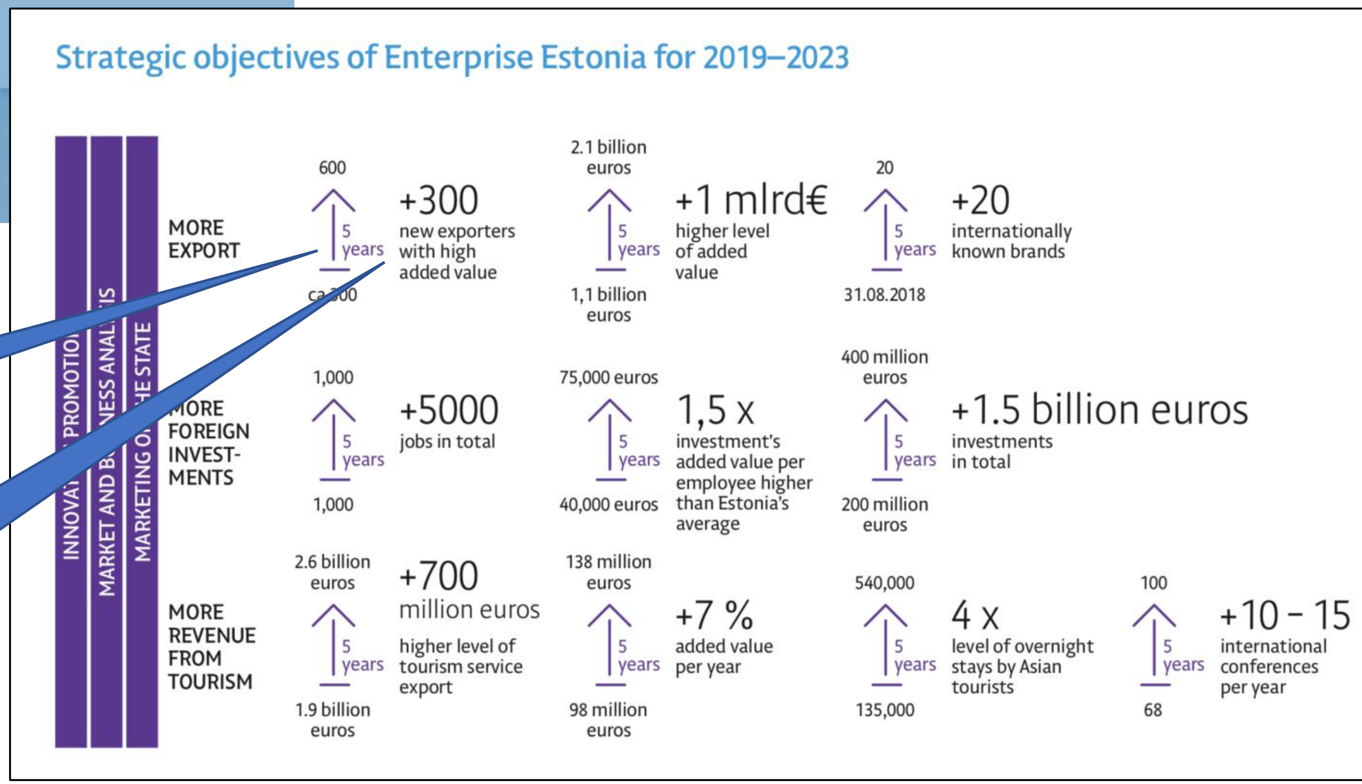
High-level requires focus

Implies/Requires Applied Research

Indicator	*Target level of the indicator*				
General aim	***2010***	***2011***	***2012***	***2020***	***EU level***
Gross domestic expenditure on R&D (GERD), % of GDP [1; 2]	1.62%	2.41 %[1]		3%	EU2011: 2.03%
inc. business enterprise sector (BERD), % of GDP [1;2]	0.81%	1.52%[1]		2%	EU2011: 1.26%
Labour productivity per person employed (EU27=100)[1;2]		68%		80%	EU2011: 100%
Position in the Innovation Union Scoreboard[3]			14(2013)	10	
Objective I: Research in Estonia is of a high level and diverse					
Number of PhDs awarded in an academic year [6]	175	250	190	300	
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country [3;7]	7.5% (2008)			11%	EU2008: 10.9%
Number of scientific publications per million population[1;8]	1,125	1,174	1,191	1,600	EU2012: 1,310
Objective II: Research and development functions in the interests of the Estonian society and economy					
Share of public sector research and development expenditures financed by the private sector[1; 2]	3.9%	3.1%		7%	EU2010: 7.01%
Government budget appropriations or outlays on R&D (GBAORD) by socio-economic objectives other than GUF[1; 2]		~ 30%		40%	EU2008-2010: 43.1-44.6%
Objective III: RD makes the structure of the economy more knowledge-intensive					
Exports of high technology products as a share of total exports[1;2]	10.4%	14.9%		15%	EU2011: 15.4%
Employment in high-tech and medium high-tech manufacturing and in knowledge-intensive services (KIS) as % of total employment[1;2]	6.0%	6.9%		9%	EU2011: 8.3%
Objective IV: Estonia is active and visible in international RDI cooperation					
The success rate of Estonia in EU research and development framework programme Horizon 2020: funding received per capita, % of EU average, where EU average = 100[1; 9]			87%	100%	EU2013: 100%
Share of national public funding to transnationally coordinated research in total GBAORD[1]	1.31%			3%	EU2010: 3.8%

Enterprise Estonia

No indicator/objective for helping start-ups !



2X = Ambitious goal

Implies Applied Research

How to Allocate Your R&D funding?

Spread thin – across many areas/ideas?

Focused on a few areas/ideas?

Existing TAKs – not succeeding

Competence Centre on Health Technologies

TFTAK CENTER OF FOOD AND FERMENTATION TECHNOLOGIES

eliko

BioCC

STACC

IMECC Innovative Manufacturing Engineering Systems Competence Centre

<u>Multiple Issues:</u>

- Lack of critical mass
- Financing rules, ownership model
- Inability to evolve/change model once established
- Focus on "outsmarting the system", taking advantage

Take-aways from Interviews

- Companies want/need applied research
  - Diverse set of requirements
- But no good source for applied research currently
  - Mismatch with Estonian universities
  - TAKs not succeeding

National Applied Research Labs in EU

EU Country	National Applied Research Lab(s)		EU Country	National Applied Research Lab(s)
Austria	AIT		Italy	IIT
Belgium	imec, VITO		Latvia	x
Bulgaria	x		Lithuania	x
Croatia	ICENT		Luxembourg	LIST
Cyprus	EUC		Malta	x
Czechia	x		Netherlands	TNO
Denmark	DTI, GTS		Poland	NCBR
Estonia	x		Portugal	x
Finland	VTT		Romania	x
France	INRIA, CNRS, others		Slovakia	x
Germany	Fraunhofer		Slovenia	IJS
Greece	CERTH, FORTH, etc.		Spain	Tecnalia
Hungary	x		Sweden	RISE
Ireland	x		UK	Catapult Centers, etc.

VTT - Finland

“Research, Development, and Innovation Partner”

Key performance indicators 2017

Net turnover and other operating income*
258 M€

Invention disclosures received
237
45 priority patent applications**

Patent families**
364

Patents or patent applications*
1,324
751 patents granted, 573 pending patent applications**

Publications
1,345
In VTT’s own publication series 61**

International scientific articles**
610

Personnel 31.12.2017*
2,368

Doctors and licentiates*
27%

University-level degree*
80%

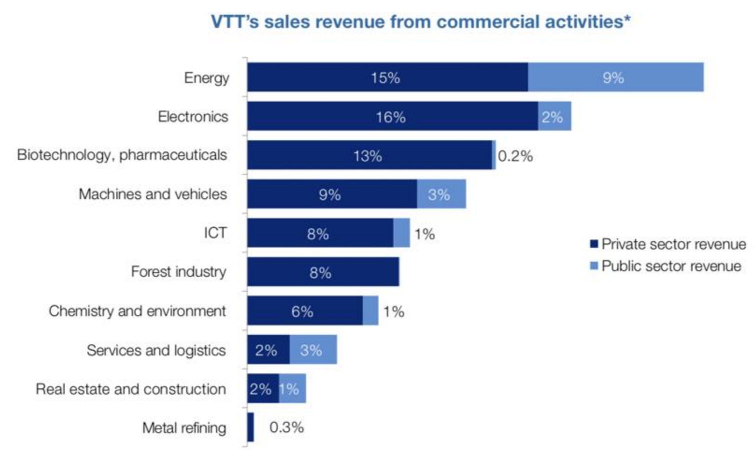
*VTT Group **Parent company

Customers*
1,530

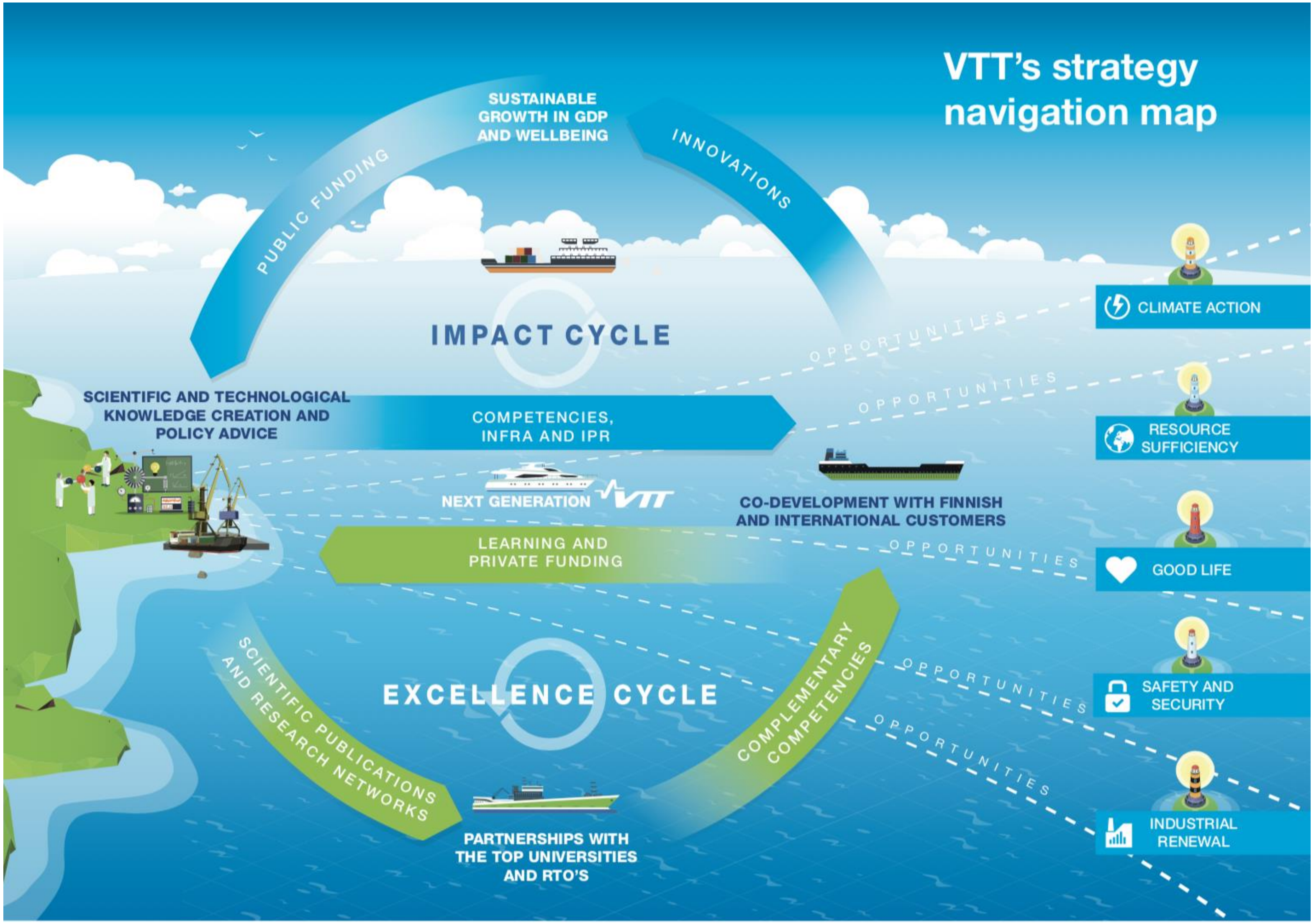
Domestic companies
915

Foreign companies
390

Public organisations in Finland and abroad
225



VTT – Finland (2)



GTS - Denmark

Denmark GTS = "Approved Technical Service Provider"

Provides both R&D (25%) and Services (75%) to large enterprises and SMBs/SMEs in Denmark & other countries

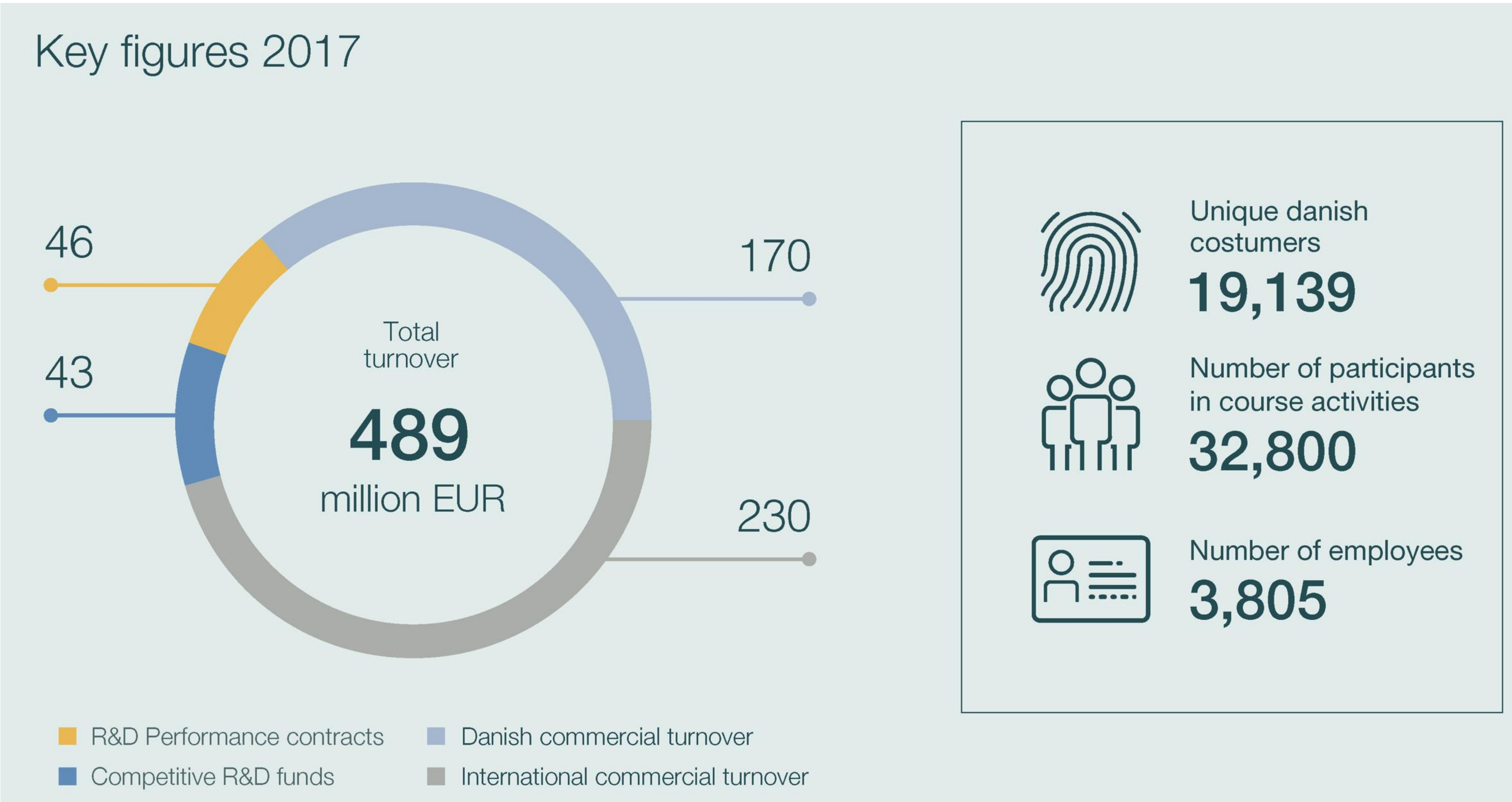
Variety of Services:

- Courses, seminars and other events
- Consultancy
- Research and business development
- Inspection and control
- Measuring technique and calibration
- Certification, testing and simulation

Seven Institutes:

- Alexandra Institute – IT (Info Tech)
- Bioneer – Biotech & Pharma
- DBI – Fire & Security (& Buildings)
- DFM – Metrology (Measurement and Quality)
- DHI – Water & Environment
- DTI – Systems Integration, Solutions
- Force Technology – Energy & Infrastructure

GTS – Technical Services Focus



Earth & Space

Sensing & Devices

Health & Biomedical Sciences

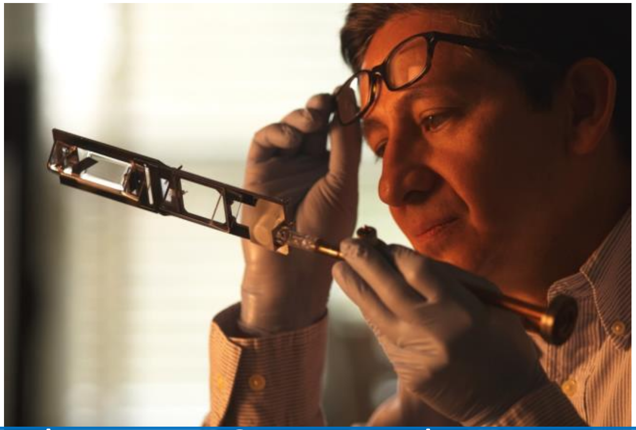
SRI International

$500m revenue/yr
~ 1000 research projects/yr
~ 2000 employees
5-10 start-ups/yr

Robotics & Automation

Information & Computing

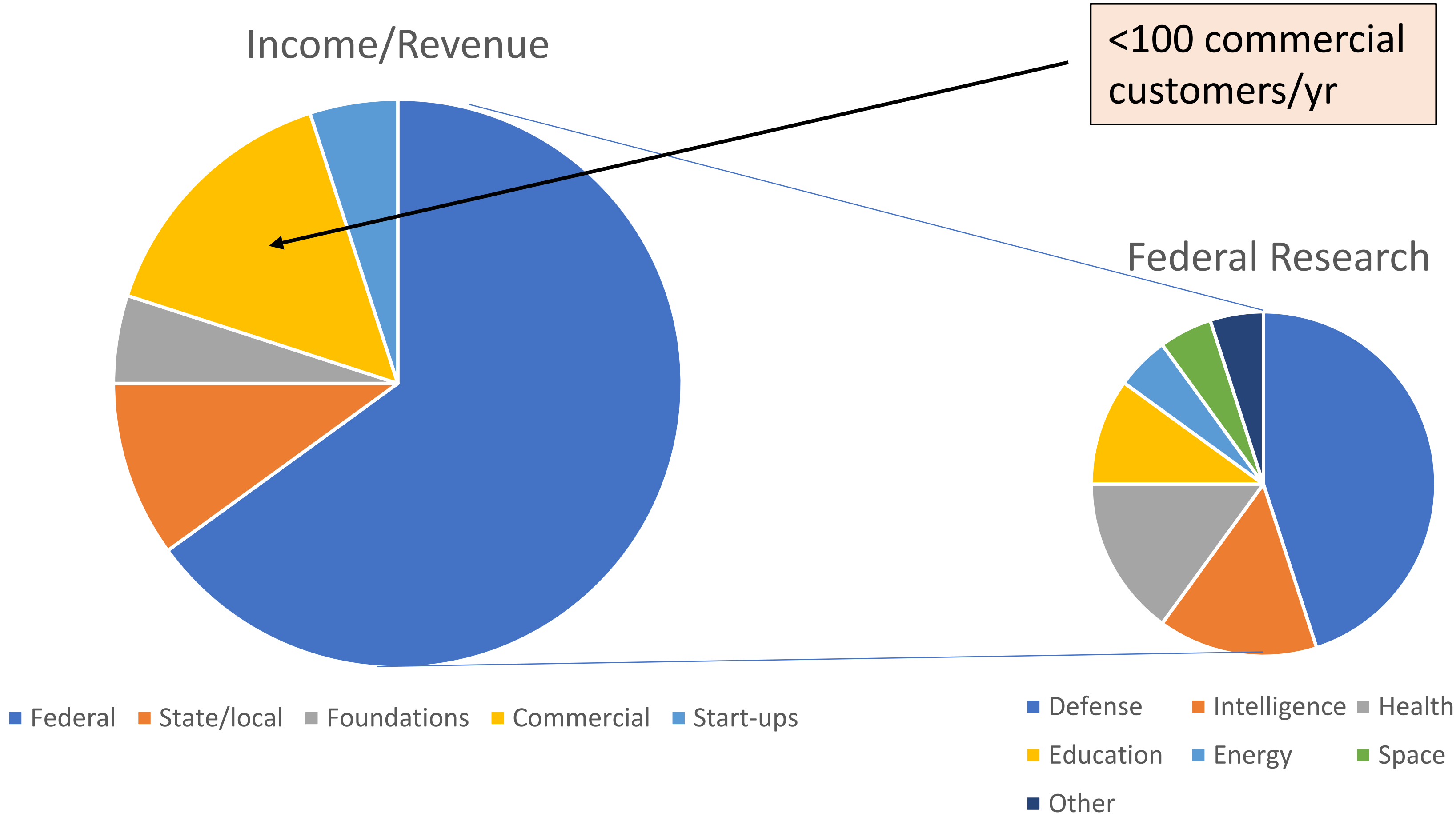
Innovation & Economic Dev.



Chemistry & Materials

Education & Learning

SRI International

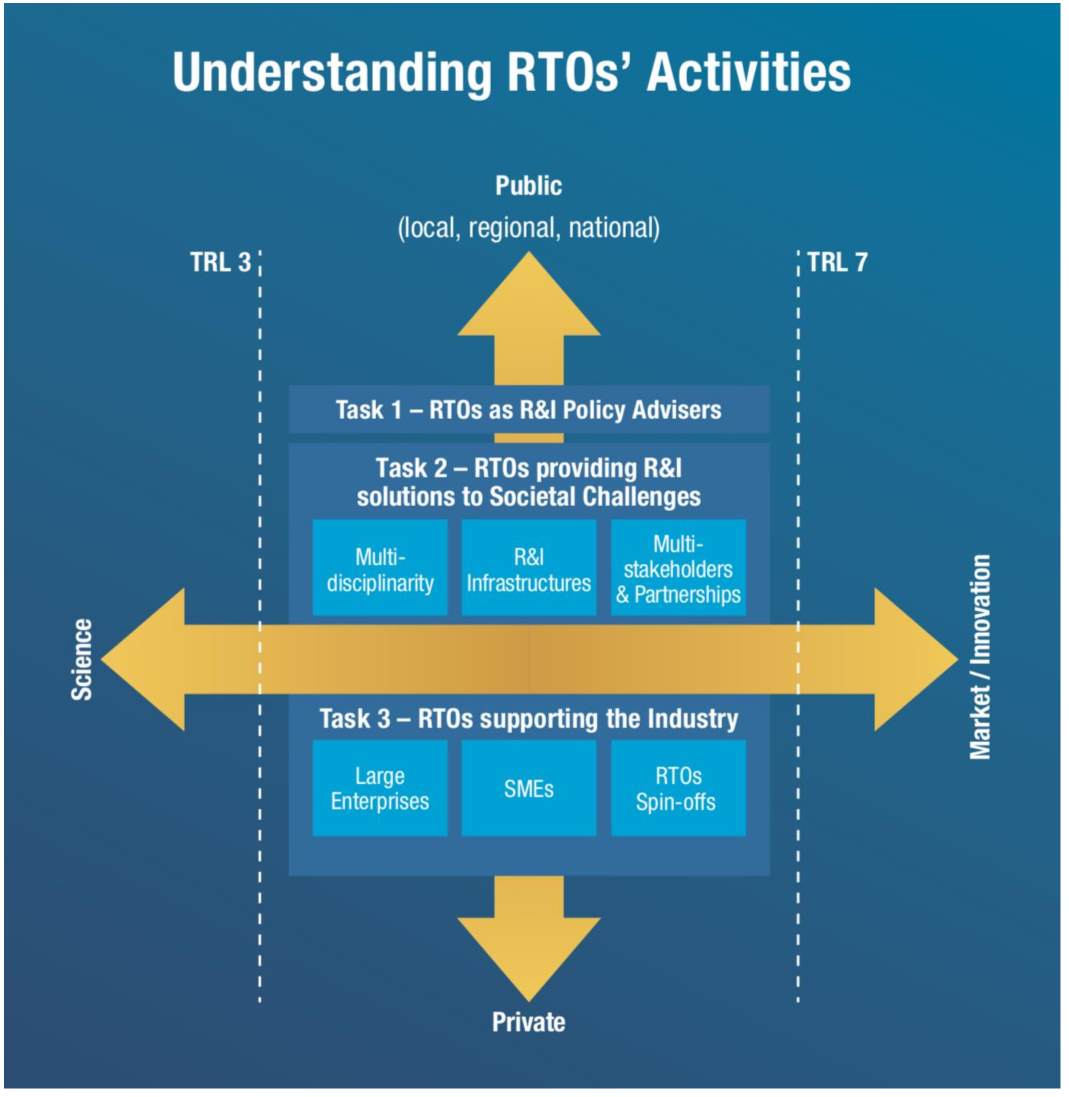


"Pass-through" research ranges from 10 to 50% depending on research area

Different Applied Research Models

	GTS	VTT	SRI
Turnover	489 M€	258 M€	~500 M$
# Employees	3805	2368	~1800
# Commercial Customers/yr	19,000+	1530	<100

EARTO.EU



Understanding RTOs' Activities
Public
(local, regional, national)
TRL 3
TRL 7
Task 1 – RTOs as R&I Policy Advisers
Task 2 – RTOs providing R&I solutions to Societal Challenges
Multi-disciplinarity
R&I Infrastructures
Multi-stakeholders & Partnerships
Science
Market / Innovation
Task 3 – RTOs supporting the Industry
Large Enterprises
SMEs
RTOs Spin-offs
Private

Economic Footprint of 9 European RTOs in 2015-2016

	EMPLOYMENT (HC)	TURNOVER (B€)	VALUE ADDED (B€)
Direct	54,191	7.193	3.503
Indirect	60,656	7.363	3.361
Induced	10,385	1.223	0.563
Total core	125,231	15.779	7.427
Fiscal return core (B€)	1.834	0.261	0.541

= 2.6 BILLION EURO FISCAL RETURN CORE ACTIVITIES

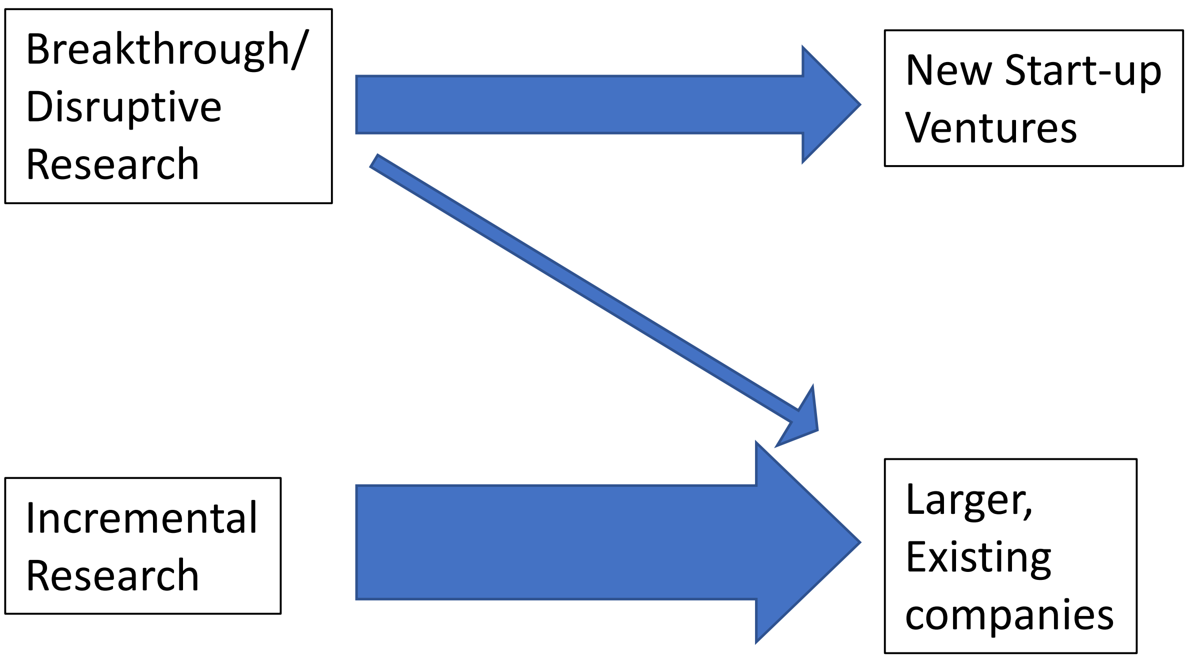
	EMPLOYMENT (HC)	TURNOVER (B€)	VALUE ADDED (B€)
Contract research	139,767	17.610	8.289
Spin-off activities	18,800	2.369	1.115
Total	283,798	35.758	16.831

= 6.7 BILLION EURO FISCAL RETURN TOTAL CORE ACTIVITIES, CONTRACT RESEARCH, AND SPIN-OFF ACTIVITIES

<u>9 RTOs in Study:</u>

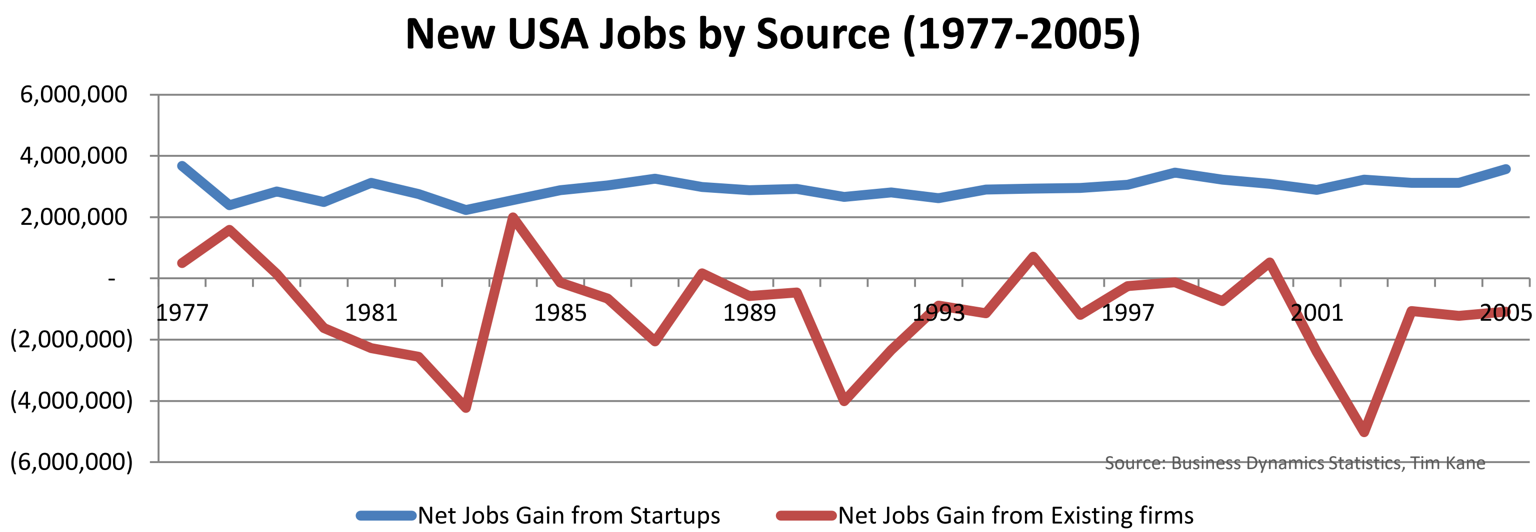
AIT – Austria
CEA – France
DTI – Denmark
Fraunhofer – Germany
IMEC – Belgium
SINTEF – Norway
Tecnalia – Spain
TNO – Netherlands
VTT - Finland

Transitioning Research to Industry



Research has to get to the market if it's going to make a difference!

Start-ups, Entrepreneurs Create Jobs



Net Jobs Gained by Source 1977-2005	
From Startups	+ 85,674,601
From Existing Firms	- 30,423,864

Big Companies Need to do R&D Also

Harvard Business Review

RESEARCH & DEVELOPMENT

There's No Good Alternative to Investing in R&D

by Anne Marie Knott

APRIL 17, 2018 **UPDATED** APRIL 19, 2018

GROWTH STRATEGY

When Large Companies Are Better at Entrepreneurship than Startups

by Chris Zook

DECEMBER 27, 2016

Estonian Company Distribution - 2016

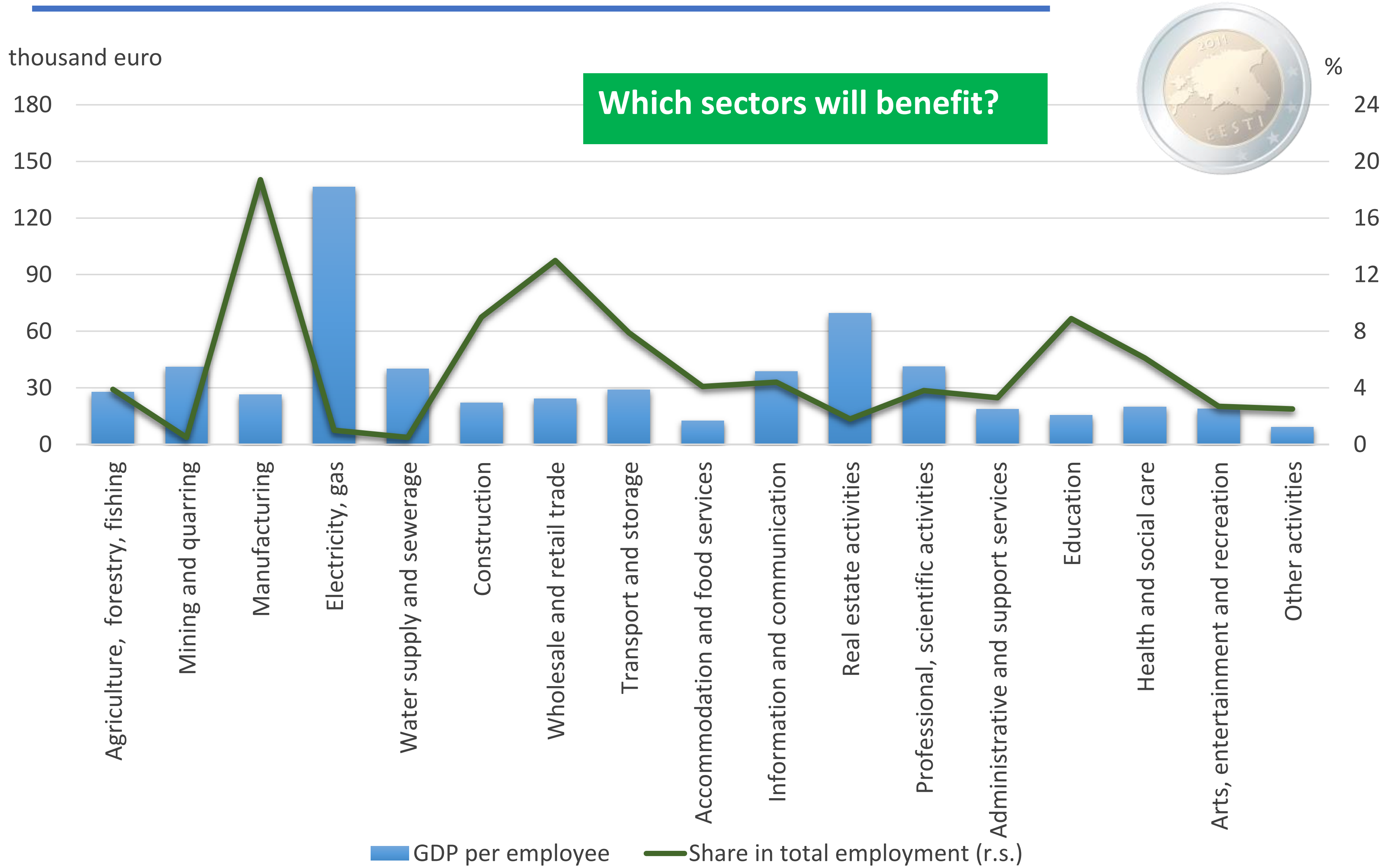
Class size	Number of enterprises			Number of persons employed			Value added		
	Estonia		*EU-28*	Estonia		*EU-28*	Estonia		*EU-28*
	Number	**Share**	***Share***	**Number**	**Share**	***Share***	**Billion €**	**Share**	***Share***
Micro	62 493	90.5 %	*93.0 %*	127 177	30.4 %	*29.8 %*	2.8	26.2 %	*20.9 %*
Small	5 315	7.7 %	*5.8 %*	101 932	24.4 %	*20.0 %*	2.5	23.3 %	*17.8 %*
Medium-sized	1 047	1.5 %	*0.9 %*	97 155	23.2 %	*16.7 %*	2.8	26.2 %	*18.2 %*
SMEs	**68 855**	**99.8 %**	***99.8 %***	**326 264**	**78.0 %**	***66.6 %***	**8.2**	**75.7 %**	***56.8 %***
Large	172	0.2 %	*0.2 %*	91 918	22.0 %	*33.4 %*	2.6	24.3 %	*43.2 %*
Total	**69 027**	**100.0 %**	***100.0 %***	**418 182**	**100.0 %**	***100.0 %***	**10.8**	**100.0 %**	***100.0 %***

These are estimates for 2016 produced by DIW Econ, based on 2008-2014 figures from the Structural Business Statistics Database (Eurostat). The data cover the 'non-financial business economy', which includes industry, construction, trade, and services (NACE Rev. 2 sections B to J, L, M and N), but not enterprises in agriculture, forestry and fisheries and the largely non-market service sectors such as education and health. The following size-class definitions are applied: micro firms (0-9 persons employed), small firms (10-49 persons employed), medium-sized firms (50-249 persons employed), and large firms (250+ persons employed). The advantage of using Eurostat data is that the statistics are harmonised and comparable across countries. The disadvantage is that for some countries the data may be different from those published by national authorities.

Source: European Commission
2017 SBA Fact Sheet

Focus for ECAR ?

GDP/Employee and Employment, 2016



Source: Statistical Office of Estonia

Alternative Scenarios for Estonia

- Don’t change anything
  - But the current system is not succeeding
- Funding Pool dedicated to Applied Research
  - ETAG equivalent for TRLs 4-9
  - Doesn’t solve the problem of who will do the work
- ECAR (Estonian Center for Applied Research)
  - Dedicated resources, appropriate skills to do applied research
  - Where to focus?
  - How to fund?
- Other ideas ?

Discussion

Do you agree?

- More Applied Research is needed in Estonia
- An Applied Research Institute is the best way to make this happen

What should it be trying to do?

- Assist existing Estonian companies
- Provide disruptive technologies to start-ups
- Other?

Alternative Scenarios for ECAR

- Advanced Applied Research
  - Pick a megatrend – invest for the long haul
- Technical Services
  - Provide technical assistance to existing companies
- Expand/build on ICT, Security Successes
  - encourage more start-ups
- Other ideas ?

Key Challenge for ECAR = Scale

- Amount of basic research in universities that can be transitioned to industry
- Amount of funding available to support ECAR
- Number, size of companies to take advantage of ECAR research
- Amount of VC funding available, and where it is focused
- Amount of funding being spent by other countries/ research labs

Scale Challenges

Hypothetical Mid-size Estonian Company

- 100 people
- €50m revenue
- 5% on R&D
  - €2.5M R&D spending
  - 20 people

Example Applied Research Project

- 5 people
- 6 months
- €250k cost

Hard to justify spending 10% of R&D budget on uncertain applied research

Without government support/subsidy – this will not happen

US Academic R&D – by Focus Area

TABLE 5-5

Federal funding of academic S&E R&D, by agency and field: FY 2016

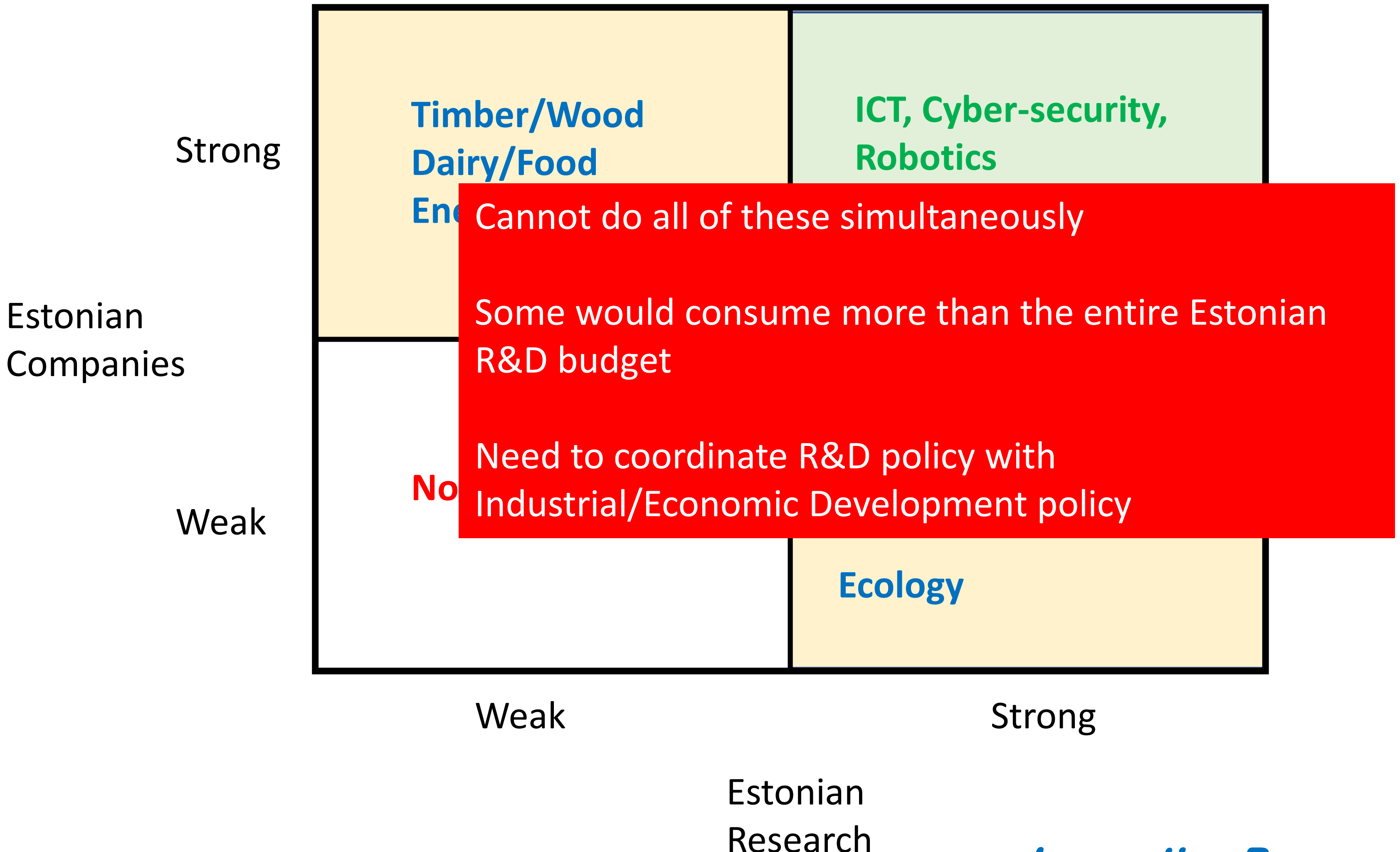
(Percent)

Field		All federal R&D expenditures	DOD	DOE	HHS	NASA	NSF	USDA	Other[a]
All R&D fields		38,793,542	13.7	4.6	53.3	3.8	13.2	3.1	8.3
Computer sciences		1,442,771	41.9	4.0	5.6	1.1	40.9	0.2	6.3
Geosciences		1,992,990	9.5	5.3	3.2	17.7	35.4	1.6	27.3
Life sciences	56%	21,798,334	4.4	0.7	83.2	0.4	3.3	4.5	3.4
Mathematical sciences		444,419	27.1	2.6	10.5	0.7	51.7	1.1	6.3
Physical sciences		3,286,816	16.0	21.3	15.8	14.3	29.8	0.2	2.6
Psychology		761,433	9.2	0.1	65.7	2.9	9.3	0.9	12.0
Social sciences		898,576	8.6	1.2	36.0	0.9	16.2	5.6	31.7
Sciences nec		465,015	23.0	3.7	23.5	1.4	28.0	2.6	17.8
Engineering	17%	6,583,476	39.6	10.6	10.0	7.8	19.3	1.0	11.7
Non-S&E		1,119,712	5.1	0.6	19.6	0.8	23.5	3.7	46.7

Potential Focus Areas – to be explored further

Estonian Companies \ Estonian Research	Weak	Strong
Strong	**Timber/Wood** **Dairy/Food** **Energy**	**ICT, Cyber-security, Robotics**
Weak	**Not interesting**	**Gene databank, personalized medicine** **Ecology**

Potential Focus Areas – to be explored further



Recommendation = Pick One

- Path One – focus on helping existing Estonian companies (food/dairy, wood/timber, manufacturing)
  - Partner with VTT
- Path Two – focus on creating more start-ups in the ICT/Robotics space
  - Build on existing successes
- Path Three – long term bet on a megatrend, in conjunction with Estonian government, universities and EU
  - "Invent the Future"

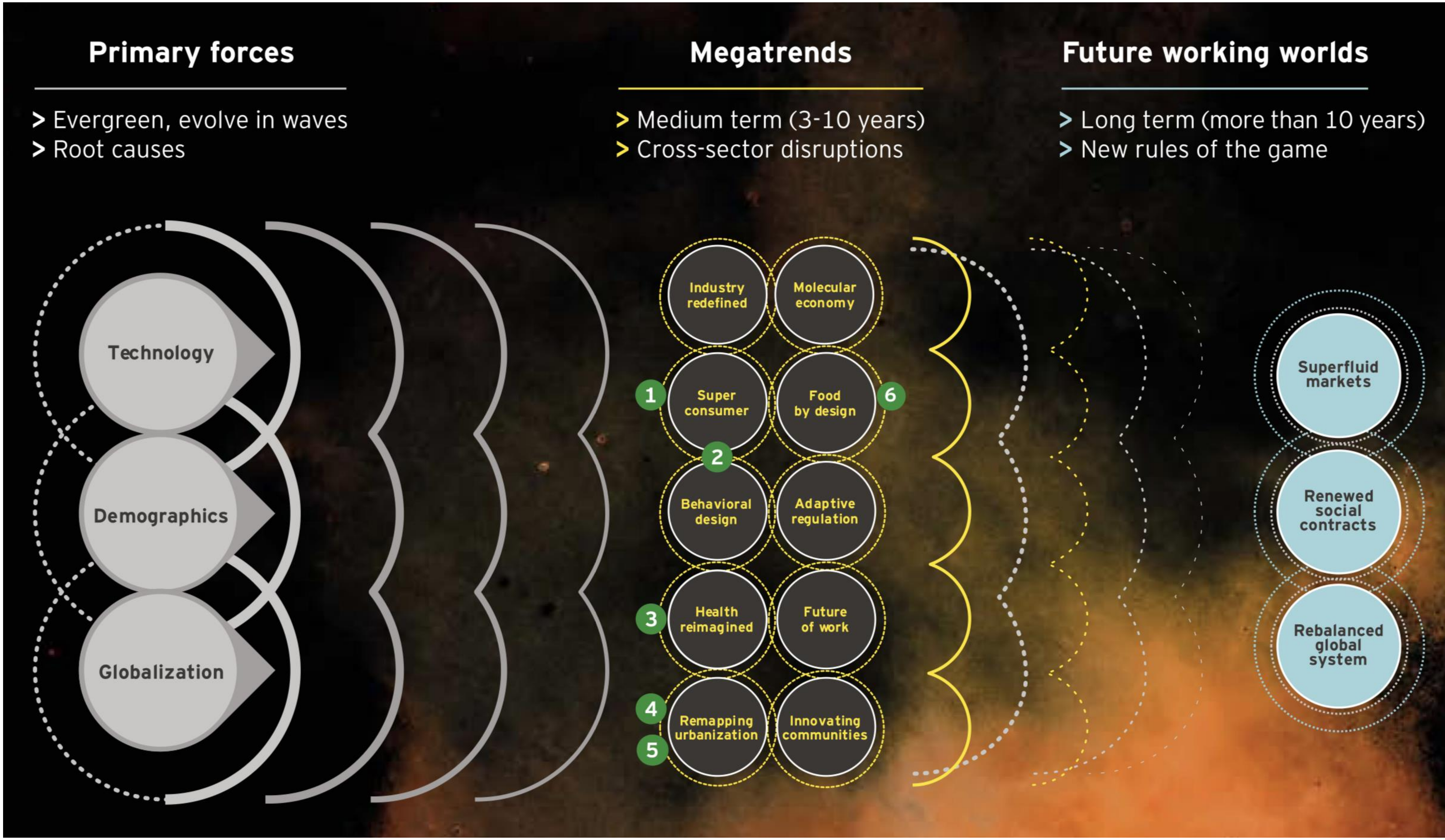
Potential VTT Partnership

- VTT is open to a potential partnership with Estonia/ECAR.
- VTT is willing to consider working together, transferring people, investing jointly in infrastructure, and being joint equity owners in a sector.
- VTT would want to identify research areas of common interest—i.e. where our focus areas for research match.
- This discussion should be continued.

More New Start-Ups in ICT, Robotics

- Build on top of success, reputation in these areas
  - Skype, E-Government, Cybernetica, GuardTime, Cleveron, Starship, etc…
- Existing VC funding avenues
- Well understood growth paths
- Identified needs:
  - AI, data science
  - Databases/Hadoop
  - Application specific knowledge

EY- Megatrends



Projected EU Funding – post 2020

Potential Mission areas and Specific Missions

Mission area	Potential examples of concrete missions
Digitisation	Quantum[3]: Build the first universal quantum computer in Europe by xxx to enable breakthroughs in artificial intelligence.
Health	Beating cancer: Cure paediatric cancer by 20xx.
Clean Europe	Healthy Oceans: Eliminating plastic waste in rivers and seas by 20xx. Clean cities: the first xx carbon-neutral cities with clean air by 20xx
Food/ Agriculture	Sustainable land: Restoring soil health by 20xx.

Potential areas for institutional partnerships[5]

1. Health innovation, for the rapid development, deployment and safe use of medical treatments, devices and technologies enhanced by digital technologies.
2. Global health, including links to national health research systems and philanthropic funding.
3. Key digital technologies, including novel technologies such as AI and linking to downstream sectors.
4. Metrology, to develop new tools for the speed, accuracy and cost of measurement.
5. Air traffic management, including new tools and technologies for flexible use of airspace (including for novel avionics, drones).
6. Aviation, to reduce CO2 emissions and noise, including through electric or other alternative propulsion systems.
7. Rail, including transformative change in rail through automation and digitisation.
8. Bio-based solutions, including CO2 uptake technologies for food and energy; biomass; and maritime resources.
9. Fuel cells and hydrogen energy storage technologies.
10. Connected, autonomous mobility (as identified in the Third Mobility Package)

Estonian Government Policy

- ECAR (Mission/Vision/Funding/Programs) needs to be coordinated with:
  - Ministry of Education & Research
  - Ministry of Economic Affairs & Communications
  - Ministry of Finance
  - Estonian Research Council

- Need policy coordination on many issues:
  - Research funding
  - Industry emphasis
  - Company formation/growth

Staffing Challenge

- Initial staff:
  - Estonian universities
  - TAKs
  - Re-patriated Estonian scientists/engineers
  - Estonian companies
  - VTT staff ?
  - International research community

- Key management metric = attraction of int'l staff to Estonia

ECAR - Cooperation with Universities

Potential areas for collaboration:

- EU grant application process
- International staff recruiting
- IP offices
- Tech Transfer/Licensing functions
- Industry Councils/Research Coordination
- Career Path Options

Potential Impact:

- Greater Research Funding
- More Research put into practical use
- Additional license fees
- More Staffing Options

Discussion – Which Path for ECAR?

- Existing companies/VTT
- Start-ups/ICT/Robotics
- Megatrend/Long-term

Cannot be decided in isolation

Must be coordinated with:
- Education ministry, research funding
- Economic ministry, industrial policy
- Finance ministry, EU priorities

Other Innovation Ecosystem Concerns

- Innovation Ecosystem Management/Coordination
- Immigration
- Risk Capital
- Capital Markets/Exit Opportunities
- Government R&D Spending Level
- Company R&D Spending Levels
- R&D Reporting by companies
- ETAG R&D funding allocation methods
- STEM teacher shortage
- STEM education in secondary schools
- Compensation Levels in Universities

The Nature of Work is Changing

The New York Times 5 Feb 2019

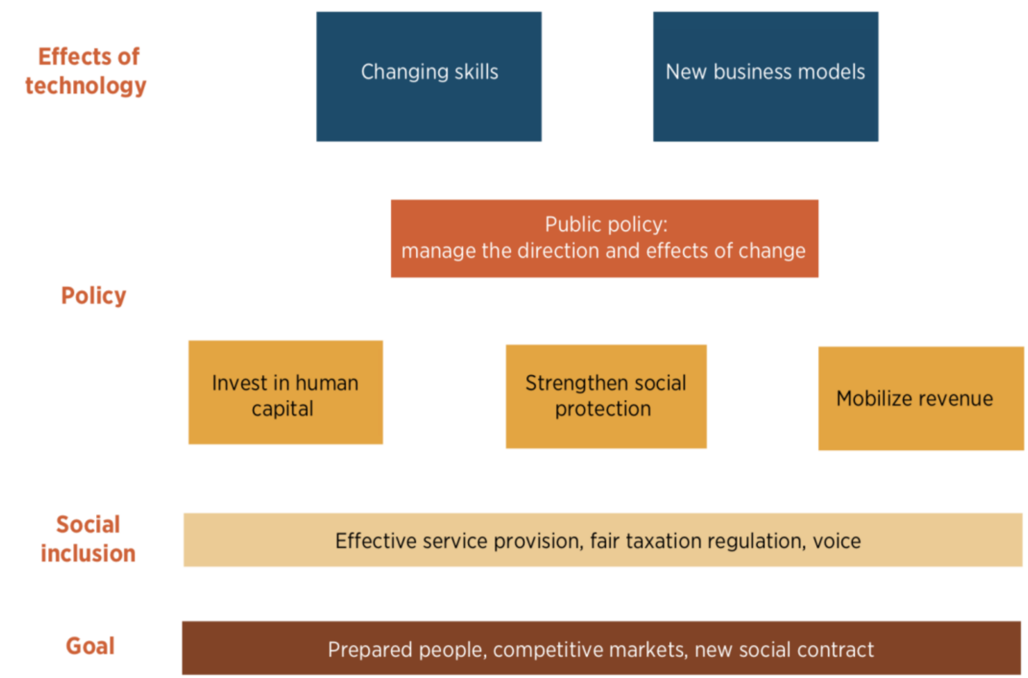
Tech Is Splitting the U.S. Work Force in Two

A small group of well-educated professionals enjoys rising wages, while most workers toil in low-wage jobs with few chances to advance.

THE
CHANGING NATURE OF WORK

The WorldBank Group
2019

FIGURE O.3 Responding to the changing nature of work



Source: WDR 2019 team.

Open Discussion

Next Steps

- VTT workshops to define focus areas with highest impact on Estonian economy
  - And develop a pilot action roadmap
- Continued discussion of potential VTT Partnership
- More in-depth assessment of company needs/ requirements by industry sector
- More discussion with Government ministries on industrial/economic development policy

How to allocate increase in R&D funding?

Product Development – 25% → Encourage company activity

Applied Research – 50% → Start-up ECAR

Basic Research – 25% → Allocate incremental funds to specific areas identified by industry

Concluding Thoughts

- Estonia wants to become an innovation-driven economy
- Innovation requires applied research
- Applied research is different from basic research
- ECAR can help catalyze applied research activities in Estonia
- But it will only be truly effective if ECAR is married to changes in basic research funding, industrial policy, and company behavior/incentives.

Thank you!

Aitäh!

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