Europe 5G Readiness Index

Assessing Europe's readiness to deploy and adopt 5G

incites Consulting S.A.

Introduction

One year after the introduction of our 5G Readiness Index, the ICT world keeps pushing towards the common goal of 5G deployment. Time and effort are tirelessly being put into the technological advancement that has been touted as the next big step for the telecommunications world. The potential is said to be limited only by the boundaries of our imagination, but to reach untapped capabilities there needs to be actual development before all else. For some, the 5G era looks closer than ever as commercial 5G networks are already being deployed in well-developed and mature markets. But for others, there still exist some serious obstacles before being able to hop onto the bandwagon and start reaping the multi-faceted benefits that the next day can bring.

Once again, in year 2020, we will be taking a close look into what we believe to be some of the most important factors and evaluate each European country's readiness to deploy and adopt 5G networks. To achieve such a goal, the Europe 5G Readiness Index is being updated, taking into consideration a full year of developments in the 5G race. For those unfamiliar with the index, an overall readiness score is presented for each country which comprises 6 factor categories with 35 criteria in total within those categories. Index scores can be used to draw comparisons at all levels (overall score, factor category score, criterion score) on a like-for-like basis.

The divide between Western and Eastern Europe still exists, while Northern European countries in particular look very well equipped for the challenges lying ahead. The ability to promote innovation accompanied by stable regulation and policymaking appear to be strong points that characterize most mature European markets. Nonetheless, most countries can take advantage of their strengths, alleviate their weaknesses and look to adjust and take the necessary steps to prevent lagging and missing out on the technological wave that is expected to take the world by storm.

More details regarding the methodology and assumptions used to construct the Index can be found in the Europe 5G Readiness Index: Methodology document. For press inquiries, email info@incites.com.

01 Index Results

Table 1

5G Readiness Index – Unequal weights

Total Rank	Country Name	Total Score	Infrastructure and Technology		Regulation and Policy		Innovation Landscape		Human Capital		Country Profile		Demand	
			Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
1	Finland	70.95	67.44	4	75.62	1	64.24	3	76.04	1	85.06	1	62.23	5
2	Switzerland	69.00	65.16	6	74.62	2	64.17	4	69.74	2	81.12	8	61.77	6
3	Germany	66.68	69.99	3	68.95	6	63.83	5	64.79	10	82.35	4	51.82	19
4	Denmark	65.93	51.18	21	69.49	5	65.52	2	65.00	8	79.93	12	71.23	1
5	Sweden	65.91	56.58	13	66.64	9	68.00	1	65.15	7	83.02	3	63.39	4
6	United Kingdom	65.26	66.09	5	66.74	8	55.53	11	60.54	13	81.90	6	61.42	7
7	Netherlands	65.24	52.48	19	73.13	4	59.75	6	68.71	3	84.77	2	60.28	8
8	Norway	64.08	62.53	7	67.03	7	56.21	9	66.70	4	80.92	9	55.50	13
9	Luxembourg	62.97	54.15	17	73.74	3	54.23	12	55.18	22	81.80	7	58.92	10
10	Austria	62.61	59.09	9	62.49	13	56.57	8	65.58	6	80.05	11	58.28	12
11	Iceland	61.00	44.44	27	65.38	10	55.98	10	64.34	11	77.07	15	67.57	2
12	Estonia	60.46	57.32	11	63.24	12	46.33	17	58.73	15	82.02	5	58.64	11
13	France	59.38	56.97	12	60.18	14	52.99	13	59.98	14	80.20	10	51.74	20
14	Ireland	59.06	54.89	14	60.12	15	51.28	14	64.92	9	75.57	18	54.56	15
15	Spain	58.63	73.58	1	49.23	20	40.31	20	58.11	16	79.63	14	52.49	18
16	Portugal	55.76	57.32	10	48.53	21	46.35	16	57.24	17	79.67	13	53.17	16
17	Belgium	55.71	42.83	28	56.77	16	56.71	7	64.00	12	73.37	20	52.66	17
18	Latvia	55.07	59.34	8	46.46	22	37.29	25	53.81	23	73.37	21	63.54	3
19	Lithuania	54.92	49.43	24	52.29	19	43.64	19	55.65	20	76.25	16	59.37	9
20	Italy	53.01	71.60	2	35.83	33	36.75	26	52.32	27	76.05	17	49.05	21
21	Slovenia	51.32	50.29	23	46.19	23	45.21	18	55.35	21	73.04	22	46.63	25
22	Russia	49.90	50.79	22	44.15	24	36.58	27	53.28	24	74.22	19	48.28	22
23	Czech Republic	49.83	51.81	20	41.37	31	47.11	15	52.71	25	67.21	33	46.42	26
24	Azerbaijan	49.52	32.92	32	63.73	11	40.02	21	52.48	26	71.95	27	43.02	32
25	Poland	49.21	54.47	15	34.86	35	36.11	28	50.34	28	72.39	23	54.91	14
26	Hungary	48.90	54.44	16	41.44	30	38.30	23	44.54	32	71.13	28	47.05	24
27	Romania	47.18	53.54	18	41.80	29	32.11	30	43.99	33	70.18	30	44.25	28
28	Slovakia	46.27	47.83	25	35.13	34	38.60	22	43.90	34	72.26	25	47.97	23
29	Cyprus	46.24	36.64	31	53.54	18	30.76	32	56.28	19	72.26	24	38.14	36
30	Greece	45.76	44.91	26	34.59	36	31.44	31	65.96	5	70.78	29	44.04	31
31	Bulgaria	45.27	37.94	29	42.82	27	37.50	24	47.37	30	71.99	26	44.21	29
32	Georgia	42.36	27.60	37	55.87	17	28.48	35	39.67	36	63.46	36	42.34	33
33	Serbia	42.17	31.41	33	43.86	25	34.92	29	48.45	29	68.88	31	37.38	37
34	Albania	41.23	29.67	36	43.72	26	28.14	36	47.36	31	64.29	35	44.12	30
35	Croatia	39.97	37.81	30	28.55	38	28.72	34	42.15	35	68.22	32	45.66	27
36	Moldova	39.07	30.76	35	39.65	32	25.68	38	38.80	37	64.95	34	42.17	34
37	Ukraine	37.98	22.87	38	41.89	28	30.04	33	57.09	18	61.83	38	31.26	39
38	North Macedonia	35.93	30.80	34	34.54	37	26.24	37	27.35	39	62.44	37	38.57	35
39	Bosnia and Herzegovina	28.38	19.62	39	19.91	39	23.58	39	33.34	38	54.07	39	33.45	38

02 Highlights by Geography

2.1 Western Europe

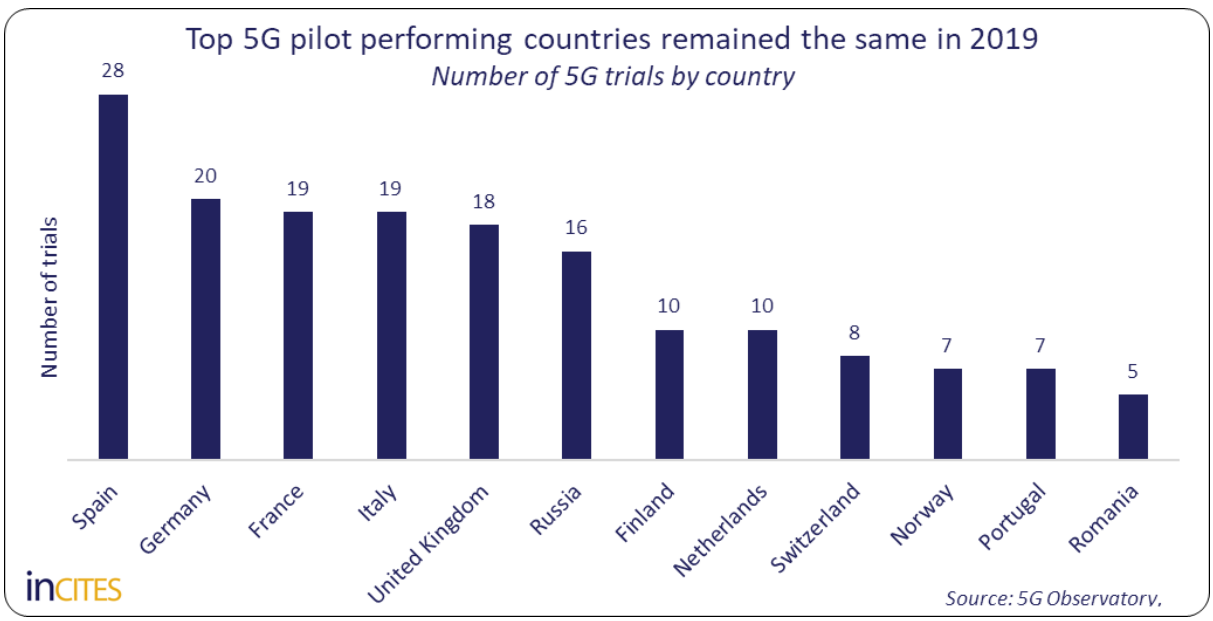
During 2019, Western European countries retained their strong focus on 5G networks as trials are still being conducted while concentrated effort is being placed into the development of commercial 5G networks. However, there are more steps to take in order to create the conditions needed to successfully adopt this new technology and exploit its vast capabilities.

As observed in the final rankings, there can be substantial disparity between 5G pilots and overall score as the Index is looking to evaluate a country's ability to create a sustainable ecosystem that will allow the full 5G potential to surface.

New technologies require governmental, regulatory and business forces to be aligned in order to create a productive environment and lack thereof can become a severe hindrance. This is the case for Spain, France and Italy, for example, who are leading the pack in terms of 5G pilots but are lagging behind in overall rank due to shortcomings in other impactful sectors.

Table 2 Overall & 5G pilots ranking of top-6 countries

Country name	Overall Rank	5G pilots rank
Finland	1	7
Switzerland	2	22
Germany	3	8
Denmark	4	8
Sweden	5	16
UK	6	12

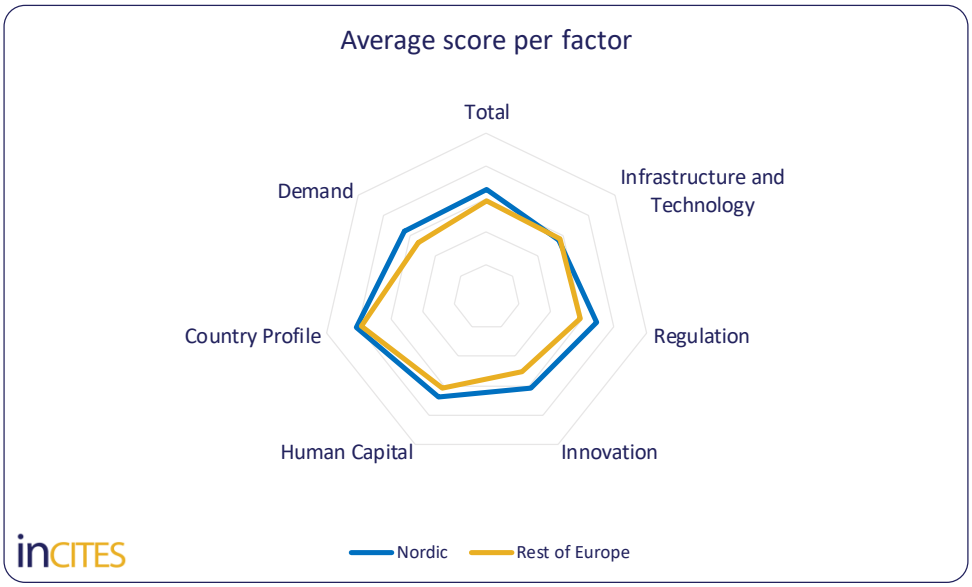


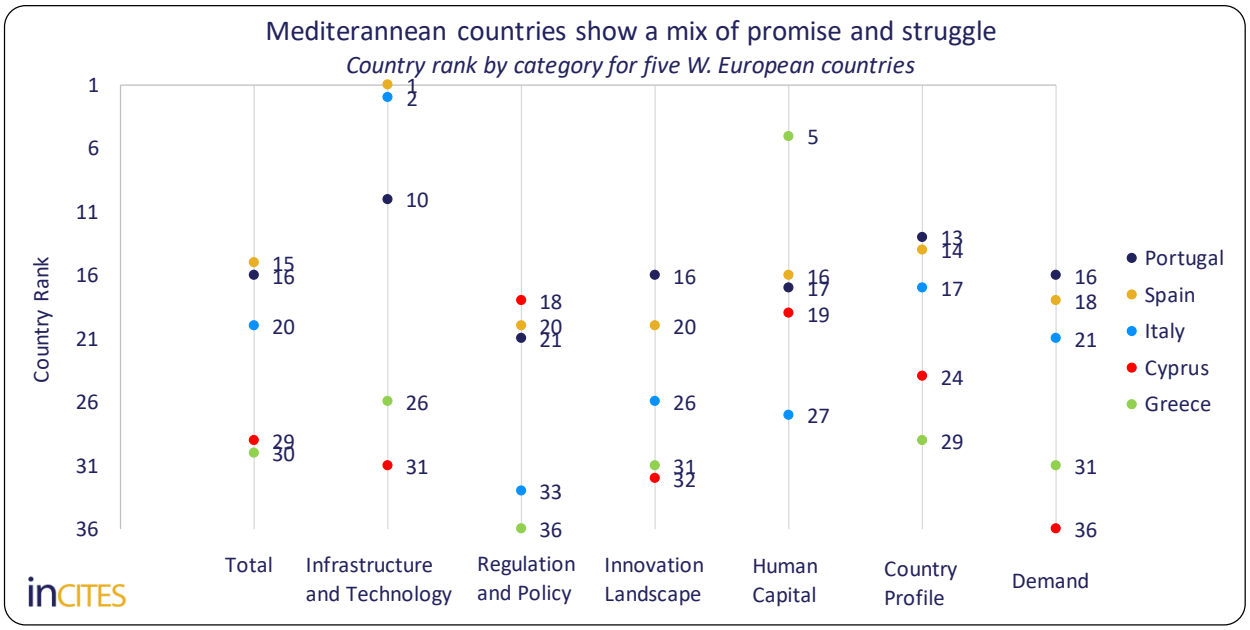
Overall, Western Europe is dominating the *Europe 5G Readiness Index* capturing 17 spots in the top-20, a result of its consistent performance across all factors. On average, W. Europe's performance ranks better the Eastern European average in every category.

Big part of said consistency is the performance of the Nordic countries that take up 3 spots in the top 5 and all rank into the top 10 with the close exception of Iceland in the 11th place. They rank on average noticeably better than the rest of the Europe, trailing only in the *Infrastructure and Technology* factor.

Other than that, they excel and rank at least in the 70th percentile in factors dealing with regulation, policymaking, innovation and human capital. The North looks primed for the successful integration of 5G in the societal and business framework.

As top performers build on their well-rounded performance, it becomes more difficult for others to catch up. Southern European countries faces such difficulties as they display volatility across factors. Performing well on some factors and poorly on others.





Notably, Italians and Iberians are ranking in the top 10 in *Infrastructure and Technology* but really average on *Regulation and Policy*. Regardless, they show promising signs and can surely move to the right direction should they adopt a right mixture of policymaking and incentives.

On the other hand, Greece and Cyprus seem to have serious issues, performing poorly in most cases with a few exceptions. Overall, they both rank way below the other W. European countries.

Benelux is another subset of interest within the Western Europe group showing some disparity. Both Netherlands and Luxembourg rank in the top 10 (7th and 10th) but Belgium falls off in the 17th position.

Netherlands is a top tier performer, consistently placing in the top 10 with the exception of *Infrastructure and Technology* (20th), mainly due to the lack of commercial 5G networks and fiber deployment. Luxembourg's strength lies in its 3rd place in *Regulation and Policy*, achieving great result in ensuring a stable, efficient and adaptable environment for the ICT sector to prosper.

Belgium performs well in the *Innovation Landscape* (7th) and *Human Capital* (12th) category, especially when education and R&D is involved, but has difficulties in the infrastructure department ranking 37th in fiber coverage and 28th overall.

Interesting Data Points

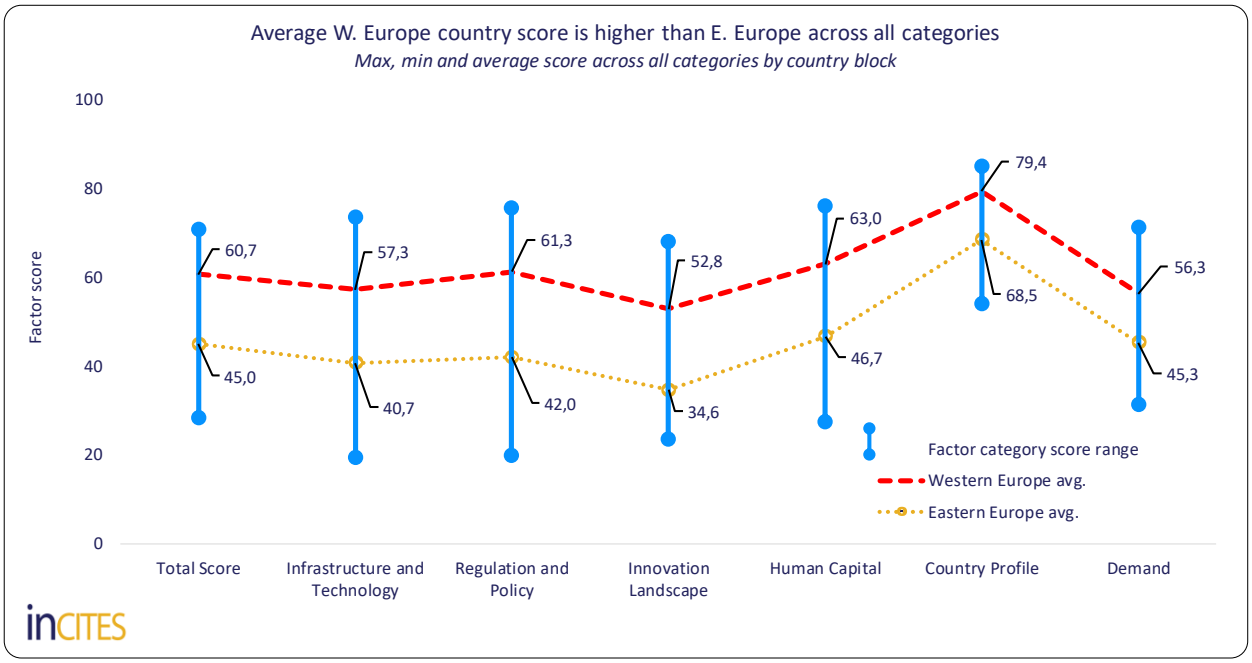
- Finland is a top 5 performer in all categories and takes the 1st place in *Regulation and Policy*, *Human Capital and Country Profile*. Having completed relevant spectrum auctions and already boasting commercial deployment, Finland is primed for a leading role in the 5G era.
- The average South European country would rank 21st overall but excluding Greece and Cyprus from the mix, the rest of the bunch would average 16th. Interestingly, the difference comes mainly from the *Infrastructure and Technology* factor, as the divide is quite small in other categories.
- Spain ranks 1st in *Infrastructure and Technology* but produces mediocre results in the other categories, resulting in its overall 15th place.
- A correlation analysis between all examined criteria and the countries' land area (km^2) was conducted to identify whether country size has any role to play in a country's 5G readiness. No significant correlation was identified to exist between country size and any one criterion.

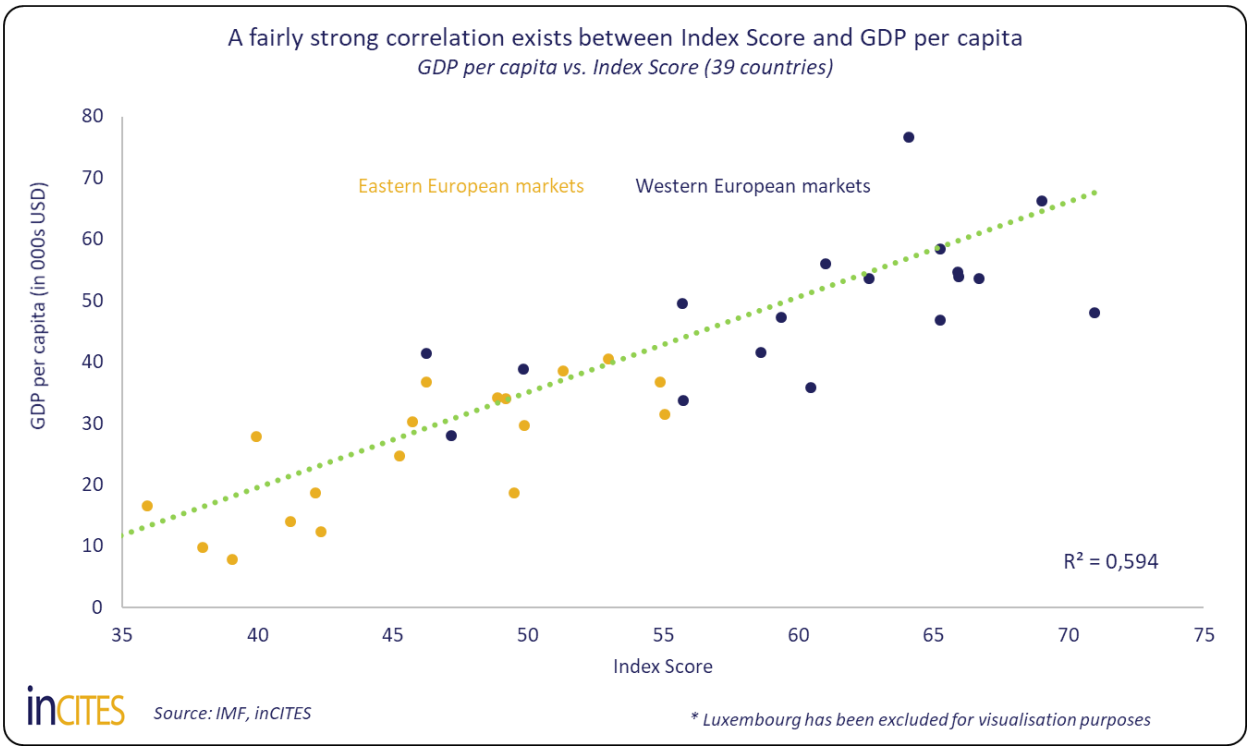
2.2 Eastern Europe

Eastern European countries do not appear as ready as the Western ones. The highest ranked is the outlier and 12th placed Estonia. The average E. European country would rank 32nd with an overall score of 45.16 points.

There is a substantial score difference when compared to W. Europe in all categories. The overall score gap cannot easily be attributed to a specific factor as there is a divide that characterizes all factors. Such a divide would be the outcome of a multitude of societal, economic and political reasons.

But the greatest disparity comes in *Regulation and Policy* and *Innovation Landscape,* two factors that negatively affect Eastern countries and come up regularly as focal points in establishing 5G networks.





This can be also observed in the Balkan region where E. European countries occupy 6 bottom 10 spots. Eastern countries seem less able to provide stability and adaptability while being perceived as more corrupt than their Western counterparts in addition to falling behind in the R&D department.

An underlying explanatory parameter behind the described differences can be the national levels of wealth. A fairly strong correlation can be observed between final *Index* score and GDP per capita (R = 0.77) supporting the intuition. Although, this conclusion is not relied upon to understand further relations between countries.

Interesting Data Points

- The Baltics countries are the clear frontrunners in the E. Europe subregion with no other countries earning a top 10 spot in any of the categories
- Slovenia is the next best in the 21st place overall with balanced scores across all categories ranging from 18th to 25th.
- Eastern European countries place 31st on average as their total score deeps low, especially at the tail end of the distribution.
- The highest-ranking Balkan country is Romania (27th) mostly due to an outstanding 18th place in the *Infrastructure and Technology* category (subregion would place 29th on average). *Fiber coverage* and *5G commercial deployment* activity act as a difference maker for Romania, a dynamic telecom market with high potential.

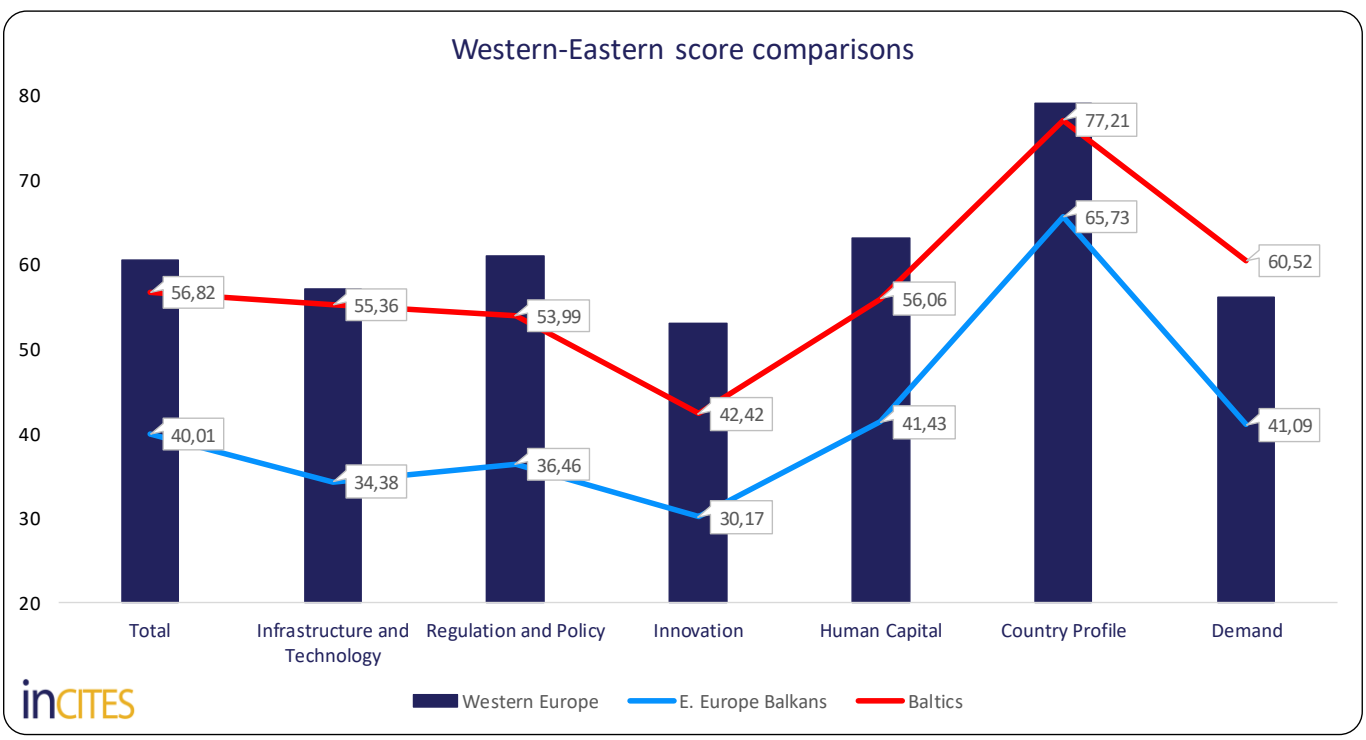
2.3 Baltics

The Baltics are closer to the Western Europe considering their 5G readiness as Estonia, Latvia and Lithuania stand in the 12th, 18th and 19th position, respectively.

Estonia is scoring very well in *Country Profile* (5th) and generally in subfactors describing the ability to nurture the right environment for businesses to thrive. Latvia's position is driven by its 8th place in *Infrastructure and Technology* (result of the exceptional 1st overall place in *fiber coverage* achieving a whopping 87.8%) as well as the 3rd place in *Demand* (ranking 2nd overall in *4G penetration*).

Lithuania is also performing well in the *Demand* category (9th) mainly due to its position as the 4th ranked country in NGA penetration.

Countries that have traditionally been pioneers in technology development and adoption lead the 5G race in Europe. Due to their geographic proximity with Nordic countries, Baltic countries are cooperating heavily with them in order to facilitate the swift and smooth transition to 5G networks.



2.4 Clustering Analysis

Clustering analysis was performed to identify whether the analysed markets can be grouped into clusters with similar characteristics with geographical correlation being atop of the hypotheses list. The analysis revealed three main country groups, with unequal distribution between them. More specifically, the first cluster includes 15 countries, the second 13 countries and the third 11 countries.

Interesting Data Points

- The first cluster includes the top-14 countries as per the Index ranking with the addition of 17th Belgium. All the countries in the first cluster belong to W. Europe and they are located in the north-west part of Europe, apart from Estonia.
- The average GDP per capita for the three clusters is $59.5k, $34.9k and $17.7k, respectively and 14 out of 15 countries within the first cluster are also the top-14 countries by GDP per capita in W. Europe. This highlights a relationship between ranking and economic status.
- The second cluster comprises 13 countries, 4 from W. Europe and 9 from E. Europe, while all countries except Russia are part of the EU. This cluster includes middle of the pack countries with tendencies that go both upwards and downwards. Spain and Greece, the outer limits, rank 15th and 30th respectively.
- The third cluster numbers 11 countries, including 10 from E. Europe and Cyprus which fits better in the 3rd cluster due to low *Demand* and *Infrastructure* scores. This cluster includes countries that consistently rank in the middle or lower in most categories.

Table 3

Overall ranking, cluster region and GDP

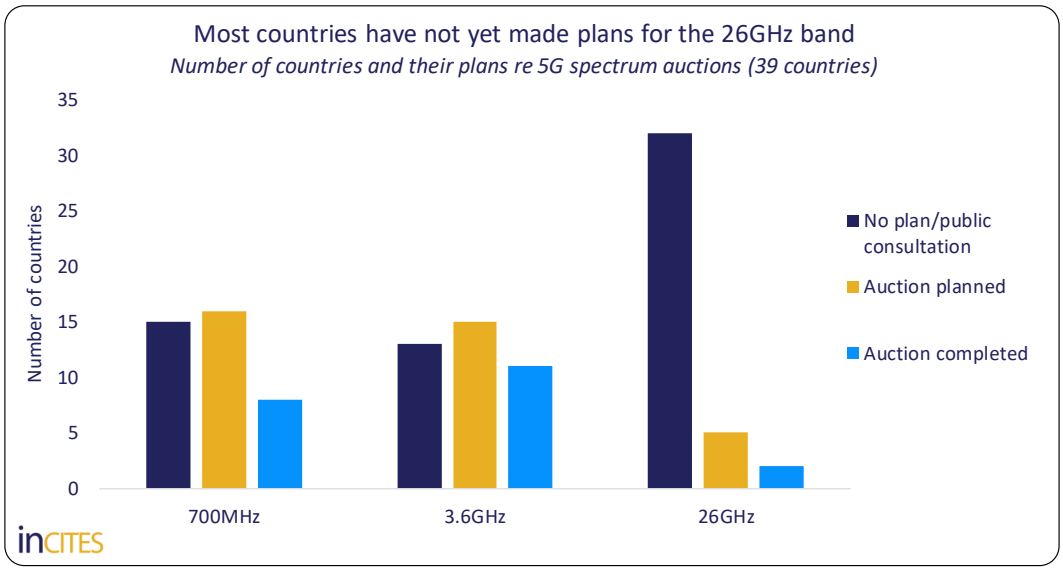
Country name	Cluster	Country Rank	Region	GDP per capita
Finland	1	1	Western Europe	47.975
Switzerland	1	2	Western Europe	66.196
Germany	1	3	Western Europe	53.567
Denmark	1	4	Western Europe	53.882
Sweden	1	5	Western Europe	54.628
United Kingdom	1	6	Western Europe	46.827
Netherlands	1	7	Western Europe	58.341
Norway	1	8	Western Europe	76.684
Luxembourg	1	9	Western Europe	108.951
Austria	1	10	Western Europe	53.558
Iceland	1	11	Western Europe	56.066
Estonia	1	12	Eastern Europe	35.853
France	1	13	Western Europe	47.223
Ireland	1	14	Western Europe	83.399
Belgium	1	17	Western Europe	49.529
Spain	2	15	Western Europe	41.592
Portugal	2	16	Western Europe	33.665
Latvia	2	18	Eastern Europe	31.402
Lithuania	2	19	Eastern Europe	36.701
Italy	2	20	Western Europe	40.470
Slovenia	2	21	Eastern Europe	29.642
Russia	2	22	Eastern Europe	38.462
Czech Republic	2	23	Eastern Europe	38.834
Poland	2	25	Eastern Europe	33.891
Hungary	2	26	Eastern Europe	34.046
Romania	2	27	Eastern Europe	27.998
Slovakia	2	28	Eastern Europe	36.640
Greece	2	30	Western Europe	30.252
Azerbaijan	3	24	Eastern Europe	18.616
Cyprus	3	29	Western Europe	41.407
Bulgaria	3	31	Eastern Europe	24.595
Georgia	3	32	Eastern Europe	12.227
Serbia	3	33	Eastern Europe	18.564
Albania	3	34	Eastern Europe	13.991
Croatia	3	35	Eastern Europe	27.729
Moldova	3	36	Eastern Europe	9.775
Ukraine	3	37	Eastern Europe	7.703
North Macedonia	3	38	Eastern Europe	16.486
Bosnia and Herzegovina	3	39	Eastern Europe	14.220

03 Highlights by Factor Category

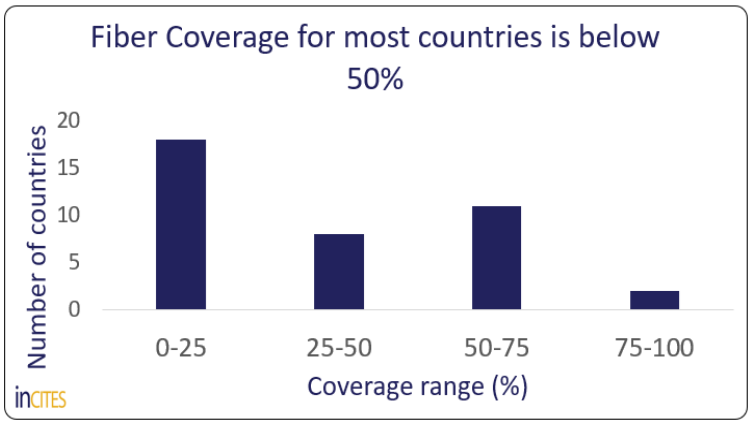
3.1 Infrastructure and Technology

This category includes factors that relate to existing fixed and mobile infrastructure that will be used in 5G networks as well as preparatory steps towards deploying the new technology, such as spectrum auctions, 5G trials and deployment of commercial 5G networks. In the early years of 5G, operators are expected to deploy Non-Standalone (NSA) 5G networks, which will rely heavily on existing 4G infrastructure to operate.

In a next stage, they will upgrade their network according to Standalone (SA) 5G standards, which will be relying solely on 5G infrastructure. Fiber will play a key role in the development of 5G networks both on the core side, but most importantly in backhauling for small cells. The large amount of data expected to be transferred through small cells, requires very high capacity backhauling, which cannot be supported by technologies based on copper.



5G in the low and mid bands will enable a host of innovative services in the early years, while mmWave band deployments are expected to happen later.



Overall, the least variability between the countries across all criteria was observed in the *4G availability* criterion, which likely implies that as technology matures, it is easier for laggard countries to close the gap with the pioneer countries. This is likely due to equipment commoditisation and the diminishing increase saturated markets are able to achieve. The largest variability is seen in the *5G spectrum auctions* and *fiber coverage* criteria. Several countries have not allocated the appropriate spectrum resources and even though 5G networks are being deployed, almost half of the countries fail to achieve fiber coverage greater than 25%.

Interesting Data Points

- Western European markets dominate the top 10 in this category with 9 appearances interrupted only by Latvia in the 8th spot. They average a score of 57.26 versus 41.53 for Eastern European markets.
- Spain followed by Italy placing 1st and 2nd mirroring their ranking in the *5G pilots* criterion.
- Bosnia and Herzegovina occupies the last position as it lacks any critical for 5G infrastructure and only recently saw its first commercial 4G implementations (2Q 2019).
- Denmark has a lot of difficulties in this category coming in 21st despite its overall 4th ranking, failing to kickstart its 5G networks. The lack of commercial 5G along with a low number of trials are the biggest obstacles the country is facing. Similar issues exist for the Netherlands too, ranking 19th in this category out of the 7th overall spot with the added issue of lacking fiber coverage.

3.2 Regulation and Policy

This category includes factors that relate to the regulatory and policy frameworks that will be key to facilitate the smooth and swift deployment of 5G networks. 5G is going to use two new frequency bands, 3.6 GHz and 26 GHz, which will be essential to achieve the higher data rates it promises. This will only be possible by deploying a larger number of small cells, due to the shorter transmission range that higher frequencies can achieve. With 5G it is expected that the deployment of a large number of macro and small cell antennas will be required to accommodate the increasing demand for capacity. Past regulatory practice was generally based on the requirements of physically larger high-power macrocells, which might not be appropriate in the case of networks that use smaller cells. Enabling the deployment of small cell networks requires streamlined federal, state and local permitting, rights-of-way, application submission timelines, application fees, application review timelines and appeals processes to make it economically feasible for operators to deploy 5G across communities.

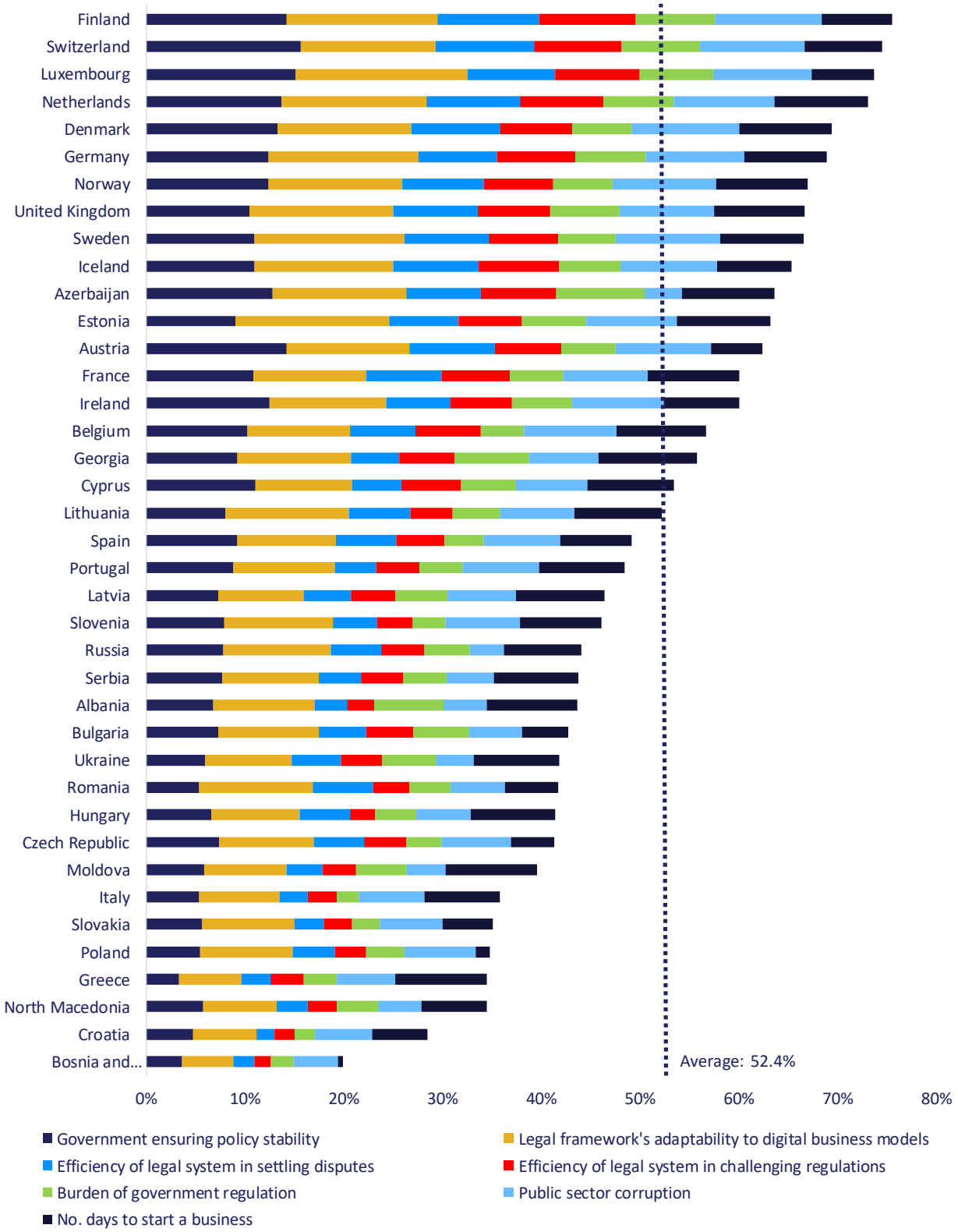
The greatest variability in the scores between the different criteria is observed in the *no. of days to start a business* criterion. The intuition behind this criterion is to capture a metric that would represent the ease of setting up a business as 5G will enable new and disruptive business models that will overhaul the entire telecoms value chain. Thus, it is important for new start-ups that develop new 5G services and applications to easily set up shop, fostering innovation and helping create an ecosystem around 5G. The creation of an ecosystem is important as 5G will redefine the existing bilateral relationships, with new players entering the market and present players seeing their roles change. Hence, it is likely that in countries burdened by red tape, 5G development and adoption will be hindered, at least in the early stage. Correlation analysis between the *no. of days to start a business* criterion and each of the criteria in the *Innovation Environment* category shows little correlation between the two.

Interesting Data Points

- Western European countries score an average of 61.19 in this category, while the Eastern European average stands at 43.07 and the overall average at 51.90. The highest ranked E. European country in the category is Azerbaijan at the 11th position.
- Italy and Greece have the two lowest positions in this category amongst all Western European markets scoring very low on multiple criteria. This is Italy's lower performing category.
- Azerbaijan and Georgia are peaking in this category ranking 11th and 17th respectively, substantially better than their overall position (24th and 32nd).
- Luxembourg ranks between 1st and 7th in 6 out of the 7 criteria, though it ranks in the 31st position in the *no. of days to start a business* criterion, which brings it overall in the 3rd position in this category. Luxembourg ranks 1st in the *Legal framework's adaptability to digital business models* and is at least in the 80th percentile in all government relevant criteria which further highlights its capability to make the necessary regulatory interventions needed for 5G to flourish in the country.

Regulation and Policy is dominated by W. Europe despite interesting outliers

Regulation and Policy score by criterion (39 countries)



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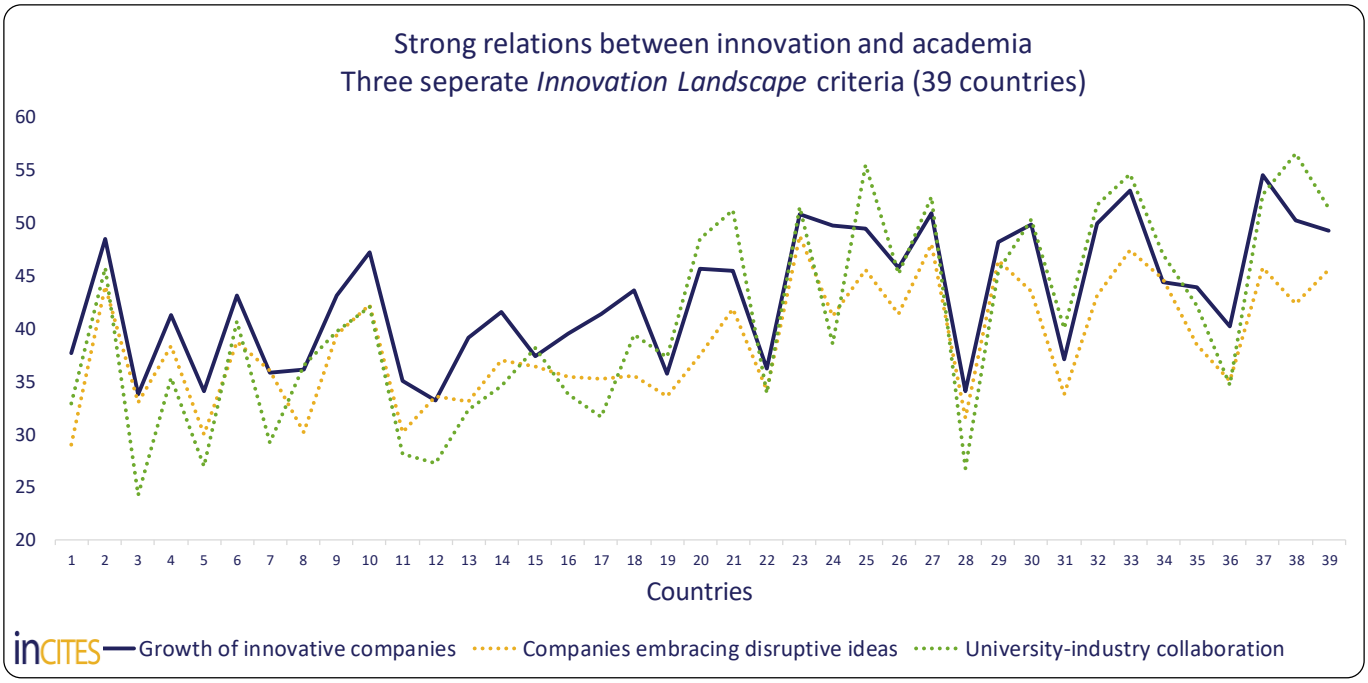
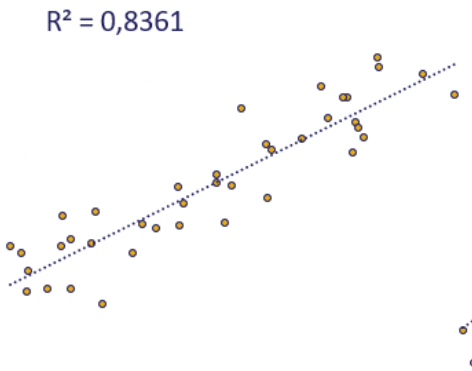
3.3 Innovation Landscape

This category includes factors that relate to potential contributors to the development of the new technology from a research and financial perspective. 5G is all about innovation. Innovation in the provided services and business models as well as the way the network is set up to provide seamless connectivity to tens or hundreds of thousands of devices. Hence, a skilled research community coupled with strong financial backing for R&D could create sustainable competitive advantages for an economy. The figure below highlights the importance of a strong relationship between academia and the market in fostering innovation.





Growth of innovative companies
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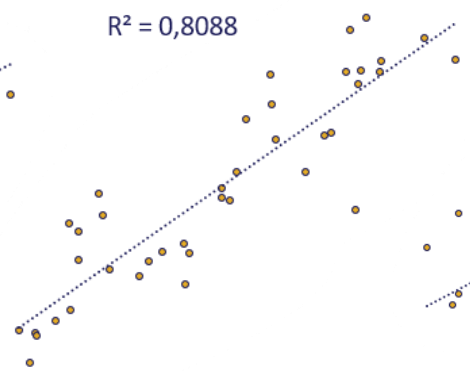
Companies embracing disruptive ideas



Growth of innovative companies
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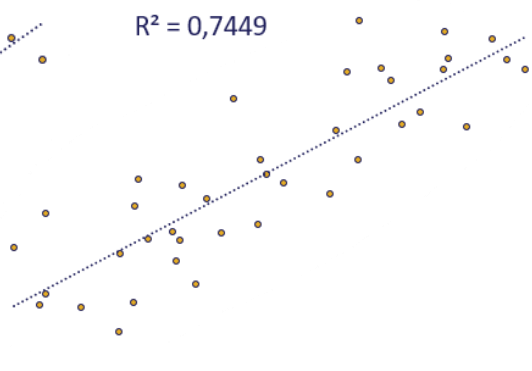
University-industry collaboration



University-industry collaboration
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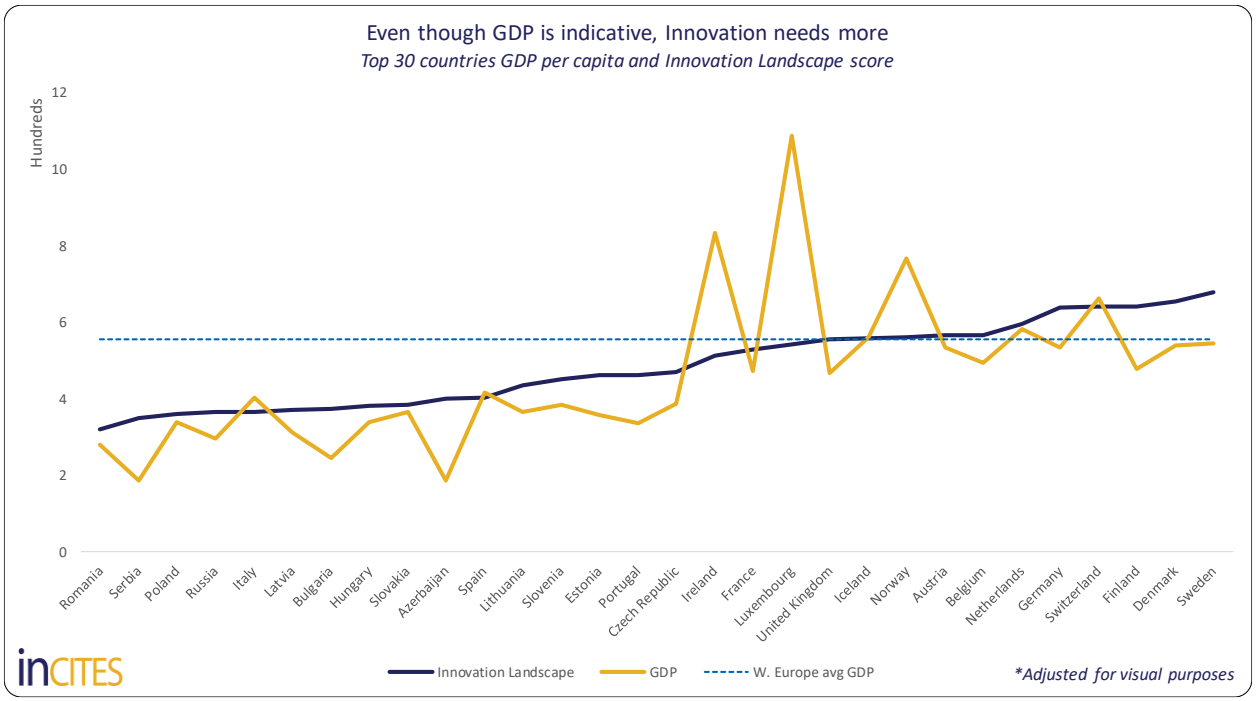
Companies embracing disruptive ideas

Western Europe in this category is once again outperforming the rest of the European countries, averaging 53.19 to the East's 35.23 taking up the first 14 positions. The first Eastern European appearance comes with the Czech Republic.

Even tough countries with a higher GDP per capita are more likely to be found at the top of the *Innovation Landscape* list, more is needed to excel in this category. Six out of the top 10 countries have a GDP per capita that is lower than the Western European average

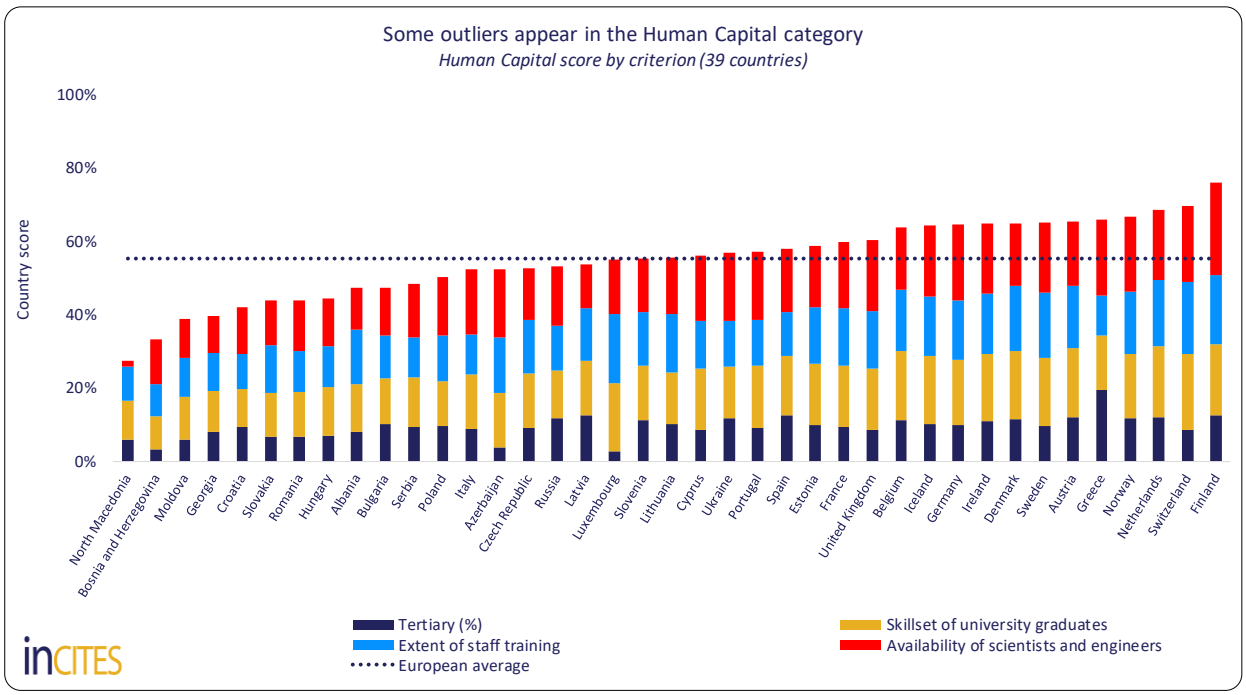


Interesting Data Points

- This category is dominated by W. European countries. The first E. European country, the Czech Republic, ranks only in the 15th position. The average W. European country would rank 13th while the average Eastern one would rank 29th.
- Belgium out of the 16th overall place, catches the 7th best score in this category driven by their expenditure in R&D which also ranks 7th in Europe.
- Nordic countries perform better than all subregions examined achieving 61.99 and 6th place, on average. Sweden, Denmark and Finland are the top three countries while Norway and Iceland come 9th and 10th.
- Azerbaijan (21st) ranks in the top 15 in 5 out of 7 criteria in this category. Ranking second to last in *Researcher in R&D* and *R&D expenditure*, hinders its otherwise very good performance.

3.4 Human Capital

This category includes factors that relate to quality of the education system and training initiatives that could be useful in deploying and adopting new technologies. 5G is a new technology which finely orchestrates existing technologies to achieve the advanced properties it promises. As such, qualified personnel and solid engineering expertise will help in the swift development of 5G networks, the creation of new more exciting applications and use cases that take advantage of the characteristics of 5G. Consequently, a tech-savvy Human Capital supported by training initiatives could also stimulate the adoption of the new technology. The greatest variability among the countries exists in the *availability of scientists and engineers* criterion and, despite what could be expected, there is only moderate correlation between this criterion and *GDP per capita* (R^2=0.5). Though, there is fairly strong correlation (R^2=0.75) with the *skillset of university graduates* criterion, suggesting that availability is mostly influenced by strong educational foundations.



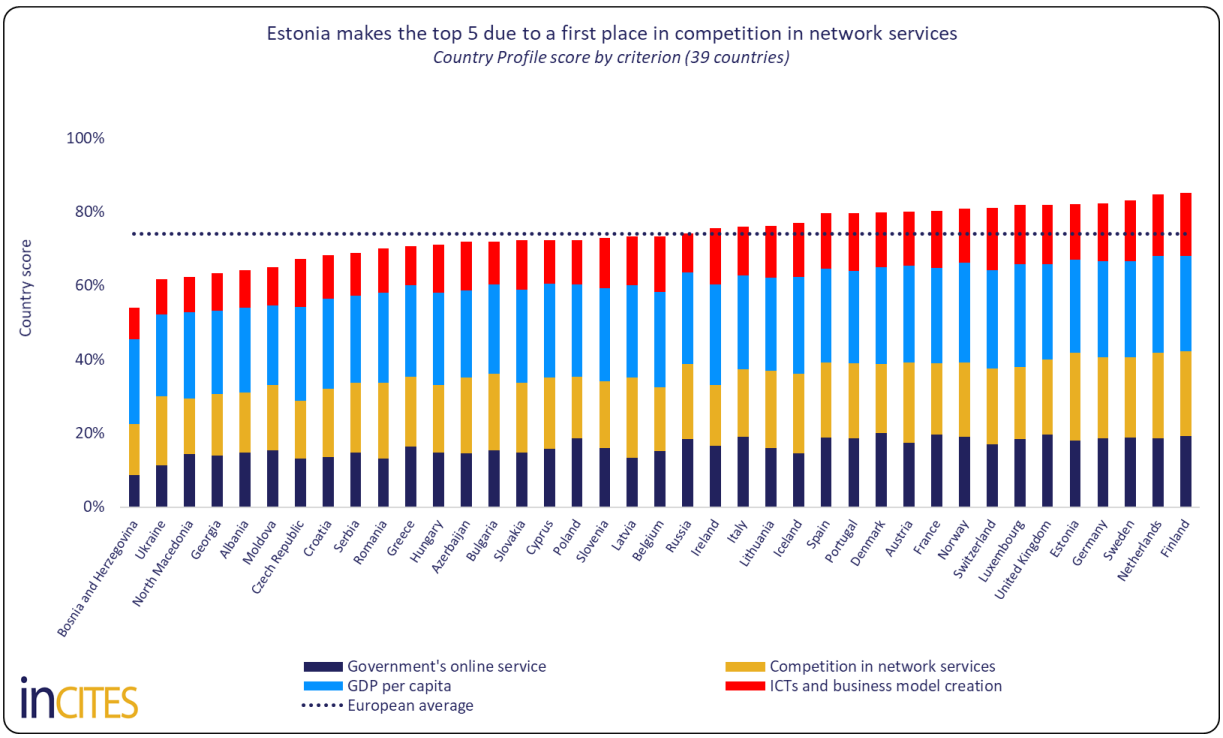
Interesting Data Points

- The average score for W. European countries is 63.19 and 47.32 for E. European. The average score of all countries in 55.05.
- Greece ranks 5th in this category, its highest rank in all categories, due to its high scores in the *tertiary enrollment* (1st) and *availability of scientists and engineers* (2nd) criteria.
- Luxembourg ranks 22nd in this category, its lowest rank across all categories, due to its last ranking in the *tertiary enrollment* criterion.
- Finland has one of the most efficient educational systems in the world, hence its rank in this category (1st). Finnish universities are also famous for their R&D activities, something that will prove very useful in the 5G era.
- Switzerland ranks 2nd in this category despite its 29th place in *tertiary enrollment* as it also ranks 1st in two other criteria in the category.

3.5 Country Profile

This category includes factors that relate to the existing economic state of a country, ICT industry competition and the government's support and use of new technologies. Deploying 5G does not come cheap. Hence, in many cases, state support will be required for the development of 5G pilots in some countries. State support might be financial, procedural, regulatory or legislative. Countries with higher *GDP per capita* are also more likely to deploy and adopt 5G faster due to the increasing purchasing power of their citizens. What is also key, the presence of ICTs and new business models within a country's economic ecosystem, increasing the chances it will invest in new technologies.

The lowest variability between the countries across the criteria exists for the *Competition in network services* criterion. This implies that market competition is high enough to drive existing operators to invest in new technologies and gain competitive advantage over their peers. The greatest variability exists in the *ICTs and business model creation* criterion which varies greatly between Western and Eastern European countries, likely due to the cohesive framework that the EU has as compared to E. European countries.



Interesting Data Points

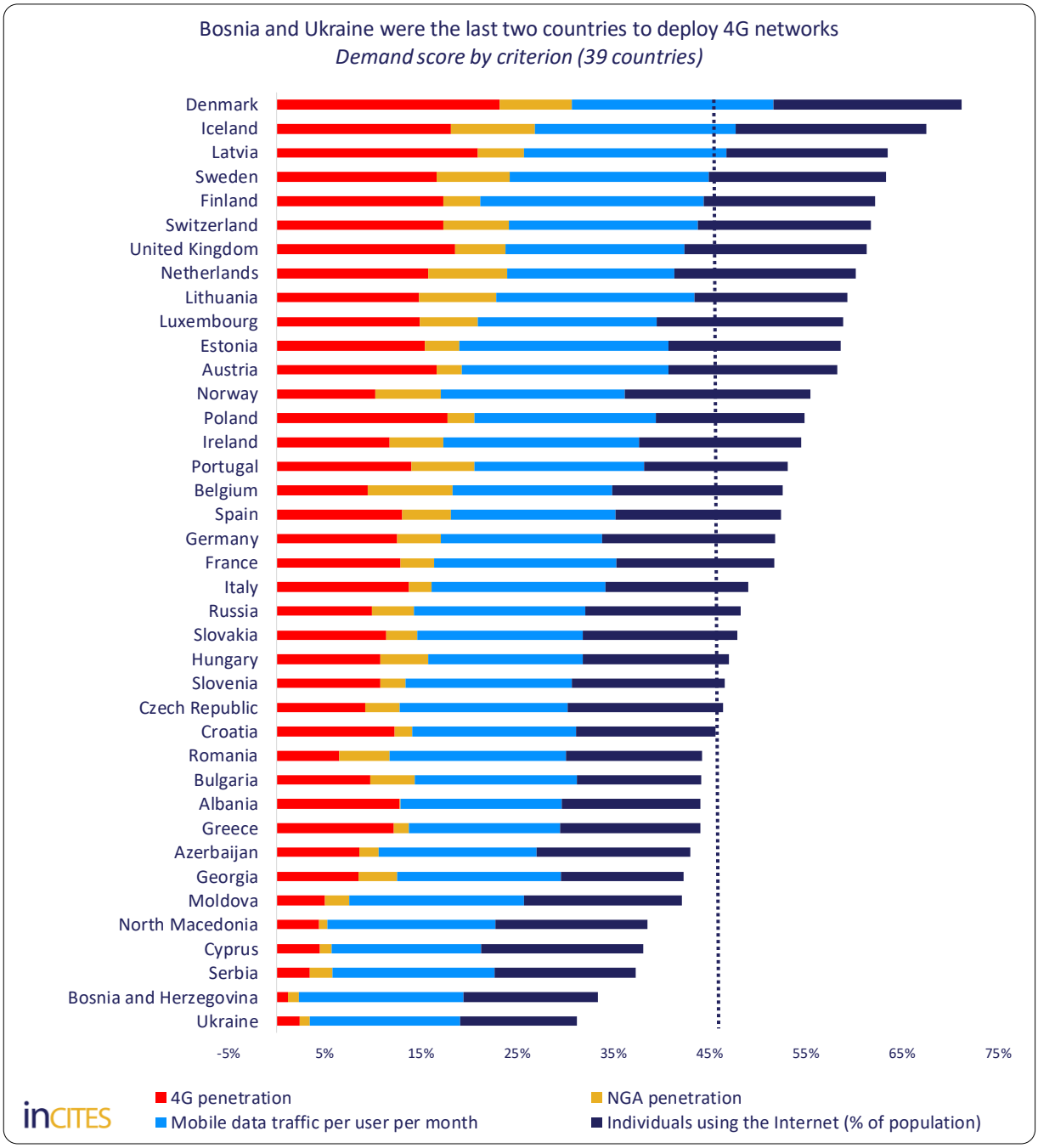
- The *Country Profile* category has the lowest score difference between Western and Eastern European countries of all categories. The average W. European country score is 79.24, 69.21 for E. European countries and 74.09 overall.
- Estonia takes up the 5th place relying on its 1st rank in the *Competition of network services* criterion.
- Netherlands and Luxembourg place 2nd and 7th in this category. Belgium, though, ranks only 20th mostly due to poor performance on their network competitiveness.

3.6 Demand

This category includes factors that relate to the adoption of new fixed and mobile technologies as well as the use of the Internet. Technology development and adoption is like the 'chicken or the egg dilemma' in the telecoms world. In other words, some believe in the 'if you build it, they will come' theory, whereby operators offer the latest and greatest technologies to their clients with the hope that they will adopt them, whereas others think that customer demand is what drives investment by the operators and not the other way around. In any case, technology adoption is critical for the sustainability of the operators' business model.

The greatest variability between the countries across the criteria exists in the 4G penetration criterion. This is due to the fact that Bosnia and Herzegovina and Ukraine were really late bloomers when it comes to 4G launch. As a result of that they rank in the last two positions of the table as demand has not yet reached other countries' levels.

Customer demand for connectivity services continues to grow as digital literacy improves across the board.



Interesting Data Points

- The average score for W. European countries is 56.23, 45.96 for E. European countries and 50.96 for all countries.
- Latvia ranks 3rd in this category, its highest rank across all categories, due to its high scores in the *4G penetration* (2nd) and *mobile data traffic* (4th) criteria. Latvia is the only E. European country that achieves this high a rank across any category.
- Austria and Norway manage to position themselves in the top 15 despite low penetration. Norway ranks 26th in *4G penetration* and Austria 28th in *NGA penetration.*

3.7 Correlation Analysis

To identify the relationship between the various factor categories a correlation analysis was conducted. The results show that there is positive and statistically significant correlation between the different factors, ranging from 47% between *Regulation and Policy* and *Infrastructure and Technology* to 85% between *Innovation Landscape* and *Country Profile*. These results could be explained as follows:

1. From Table 4, it seems that there is a positive relation between most factors. Therefore countries that are performing well in multiple categories are usually able to project this advantage into other areas as well.
2. The high correlation between the *Country Profile* and *Innovation Landscape* factors implies that the better the economic status and the state's vision to support new technologies, the more financial support is provided to R&D purposes. The relationship between *Country Profile* and *Regulation and Policy* could also be interpreted in the same way.
3. The 'low' correlation between *Infrastructure and Technology* and *Regulation and Policy* is likely due to the fact that the *Regulation and Policy* category does not exclusively include ICT-specific criteria. But, if one calculates the correlation between the *Public sector corruption* criterion and *Infrastructure and Technology,* the correlation increases to 67%. Although the *Regulation and Policy* category does not include only ICT-specific criteria, it was included in the construction of the Index due to several legal considerations that 5G will complicate, such as site planning, licensing and rights of way.

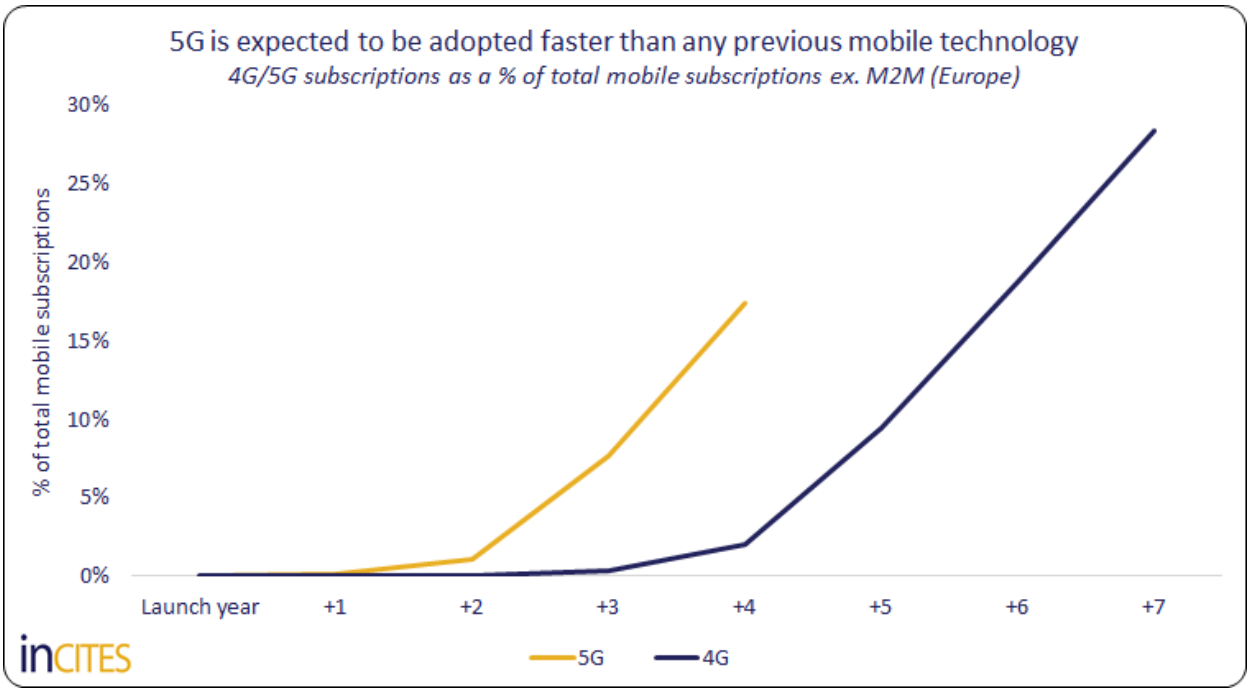
Table 4 Correlation between main factors

Correlation matrix	Infrastructure & Technology	Regulation and Policy	Innovation Landscape	Human Capital	Country Profile	Demand
Infrastructure & Technology	100%	47%	65%	61%	83%	68%
Regulation and Policy		100%	85%	76%	79%	69%
Innovation Landscape			100%	82%	85%	80%
Human Capital				100%	80%	67%
Country Profile					100%	81%
Demand						100%

04 inCITES Europe 5G Subscription Forecast

As part of our Mobile and Fixed Connectivity database, Prognosis, we generate granular market sizing forecasts for 41 European countries, across over 160 KPIs, totalling over 110k unique data points. inCITES Consulting's mobile and fixed connectivity historical data are based on a number of inputs from trusted sources, including regulator reports, network operator reports, news articles, statistics agencies, international bodies and other insights from conversations with our clients and partners. We place data integrity and robustness on top of our agenda and we have implemented a robust research and analysis process of all available datasets of operational, demographic and socioeconomic data.

inCITES forecasts that 5G will reach 181 million subscriptions by 2023, accounting for 17.4% of total mobile subscriptions excluding M2M, up from a few thousand connections in 2019. W. Europe will account for the vast majority of 5G subscriptions throughout the forecast period, ahead of E. Europe.



Key takeaways:

- **5G will be adopted faster than its predecessors.** Widen installed customer base, higher tech savviness, fiercer operator competition and faster smartphone price erosion will drive this.
- **5G take-up will accelerate after 2022**. Coverage expansion, network upgrade from NSA to SA, device price erosion, technology maturity, availability of 5G-enabled devices and introduction of advanced services and applications will drive this.
- **W. Europe will have over 150m 5G subscriptions by 2023.** This figure is over 9x higher than the 4G subscriptions after the launch of 4G on a like-for-like basis. A handful of countries have launched in 2019, though the bulk of them will go live in 2020, in-line with EU's digital agenda targets.
- **E. Europe will have over 30m 5G subscriptions by 2023.** This figure is over 7x higher than the 4G subscriptions after the launch of 4G on a like-for-like basis. Several countries will launch 5G in 2020, though its take-up will lag behind that of W. Europe.

05 Scenario Analysis

In order for the factors that constitute the Europe 5G Readiness Index to have a fair representation in the overall Index score, the data analysis performed in the former sections comes from a weighted Index.

Both the weights of the criteria within each category as well as the weights of the categories themselves were based on discussions with clients and partners as well as inCITES experts' opinions and expectations (more info can be found in the Europe 5G Readiness Index Methodology document).

An alternative scenario was examined by setting equal weights of both the factor categories and criteria. This implies that all categories and criteria within them are of equal importance to a country's readiness for 5G. The results of this analysis show that there was little variation between the initial and new overall rankings as shown in the Table below.

Interesting Data Points

- Romania saw the highest overall rank improvement (+4 positions) mostly driver by its good scores in *4G availability, fiber coverage* and their early 5G deployment, all cornerstones of a 5G ready country.
- The greatest drop comes for Greece (-4 positions) mainly resulting from low scoring in criteria related to stability in policy, regulation and the nourishment of the right conditions for ICTs to thrive.
- The average position change across all criteria was 0.86 positions compared to the weighted ranking.

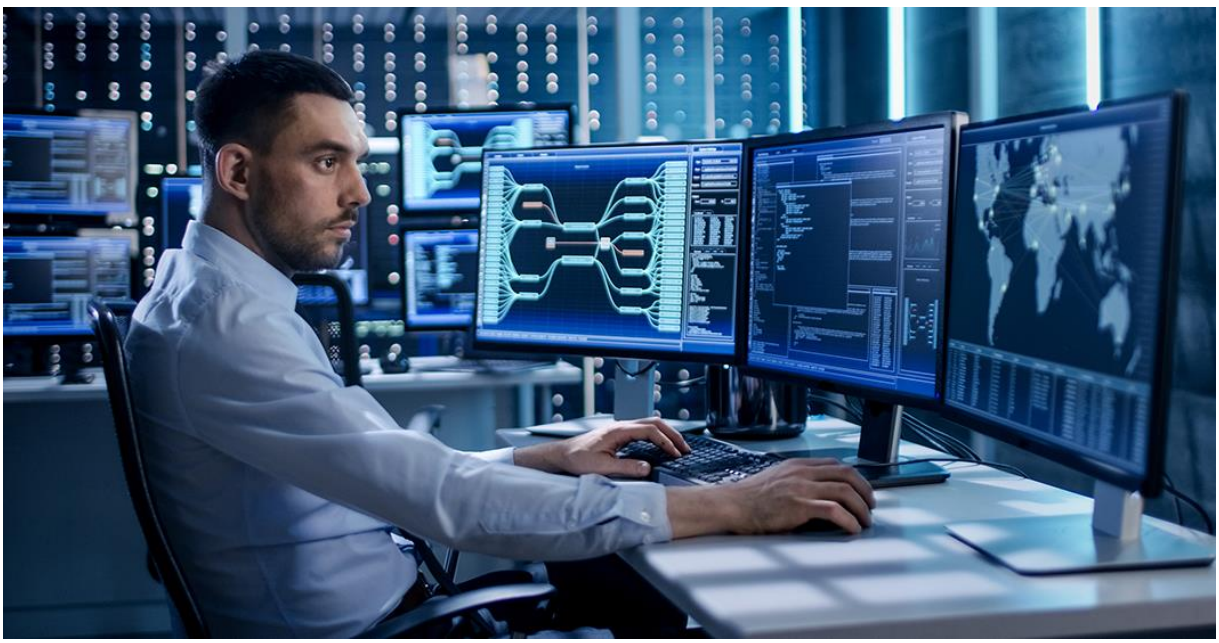


Table 5 5G Readiness Index – Unequal weights

Total Rank (+/-)	Country Name	Total Score	Infrastructure and Technology		Regulation and Policy		Innovation Landscape		Human Capital		Country Profile		Demand	
			Score	Rank (+/-)	Score	Rank (+/-)	Score	Rank (+/-)	Score	Rank (+/-)	Score	Rank (+/-)	Score	Rank (+/-)
1 (0)	Finland	70.95	67.44	4 (1)	75.62	1 (0)	64.24	3 (-1)	76.04	1 (0)	85.06	1 (0)	62.23	5 (0)
2 (0)	Switzerland	69.00	65.16	6 (0)	74.62	2 (0)	64.17	4 (1)	69.74	2 (1)	81.12	8 (0)	61.77	6 (0)
3 (2)	Germany	66.68	69.99	3 (-2)	68.95	6 (0)	63.83	5 (-1)	64.79	10 (1)	82.35	4 (1)	51.82	19 (0)
4 (0)	Denmark	65.93	51.18	21 (-3)	69.49	5 (0)	65.52	2 (1)	65.00	8 (-1)	79.93	12 (-1)	71.23	1 (0)
5 (-2)	Sweden	65.91	56.58	13 (-4)	66.64	9 (0)	68.00	1 (0)	65.15	7 (2)	83.02	3 (0)	63.39	4 (-1)
6 (1)	United Kingdom	65.26	66.09	5 (-2)	66.74	8 (0)	55.53	11 (-4)	60.54	13 (0)	81.90	6 (-2)	61.42	7 (0)
7 (-1)	Netherlands	65.24	52.48	19 (-3)	73.13	4 (-1)	59.75	6 (0)	68.71	3 (-1)	84.77	2 (0)	60.28	8 (0)
8 (0)	Norway	64.08	62.53	7 (0)	67.03	7 (0)	56.21	9 (-1)	66.70	4 (1)	80.92	9 (0)	55.50	13 (0)
9 (0)	Luxembourg	62.97	54.15	17 (-2)	73.74	3 (1)	54.23	12 (-2)	55.18	22 (2)	81.80	7 (-1)	58.92	10 (-1)
10 (0)	Austria	62.61	59.09	9 (3)	62.49	13 (1)	56.57	8 (4)	65.58	6 (0)	80.05	11 (3)	58.28	12 (0)
11 (0)	Iceland	61.00	44.44	27 (-1)	65.38	10 (0)	55.98	10 (1)	64.34	11 (1)	77.07	15 (1)	67.57	2 (0)
12 (1)	Estonia	60.46	57.32	11 (2)	63.24	12 (0)	46.33	17 (0)	58.73	15 (0)	82.02	5 (2)	58.64	11 (0)
13 (-1)	France	59.38	56.97	12 (-4)	60.18	14 (-1)	52.99	13 (0)	59.98	14 (0)	80.20	10 (0)	51.74	20 (0)
14 (0)	Ireland	59.06	54.89	14 (5)	60.12	15 (0)	51.28	14 (0)	64.92	9 (-1)	75.57	18 (-1)	54.56	15 (-1)
15 (0)	Spain	58.63	73.58	1 (1)	49.23	20 (0)	40.31	20 (1)	58.11	16 (0)	79.63	14 (-1)	52.49	18 (-1)
16 (1)	Portugal	55.76	57.32	10 (4)	48.53	21 (0)	46.35	16 (0)	57.24	17 (1)	79.67	13 (-1)	53.17	16 (2)
17 (-1)	Belgium	55.71	42.83	28 (0)	56.77	16 (0)	56.71	7 (2)	64.00	12 (-2)	73.37	20 (0)	52.66	17 (-1)
18 (1)	Latvia	55.07	59.34	8 (2)	46.46	22 (0)	37.29	25 (0)	53.81	23 (-1)	73.37	21 (2)	63.54	3 (1)
19 (-1)	Lithuania	54.92	49.43	24 (-3)	52.29	19 (0)	43.64	19 (-1)	55.65	20 (0)	76.25	16 (2)	59.37	9 (1)
20 (1)	Italy	53.01	71.60	2 (2)	35.83	33 (1)	36.75	26 (2)	52.32	27 (-1)	76.05	17 (-2)	49.05	21 (1)
21 (-1)	Slovenia	51.32	50.29	23 (0)	46.19	23 (0)	45.21	18 (1)	55.35	21 (-2)	73.04	22 (-1)	46.63	25 (1)
22 (0)	Russia	49.90	50.79	22 (-11)	44.15	24 (2)	36.58	27 (0)	53.28	24 (-1)	74.22	19 (0)	48.28	22 (-1)
23 (1)	Czech Republic	49.83	51.81	20 (0)	41.37	31 (1)	47.11	15 (0)	52.71	25 (0)	67.21	33 (0)	46.42	26 (-1)
24 (-1)	Azerbaijan	49.52	32.92	32 (0)	63.73	11 (0)	40.02	21 (-1)	52.48	26 (1)	71.95	27 (-1)	43.02	32 (0)
25 (0)	Poland	49.21	54.47	15 (2)	34.86	35 (2)	36.11	28 (-2)	50.34	28 (0)	72.39	23 (-1)	54.91	14 (1)
26 (1)	Hungary	48.90	54.44	16 (8)	41.44	30 (-2)	38.30	23 (0)	44.54	32 (0)	71.13	28 (0)	47.05	24 (0)
27 (4)	Romania	47.18	53.54	18 (4)	41.80	29 (2)	32.11	30 (0)	43.99	33 (1)	70.18	30 (0)	44.25	28 (0)
28 (1)	Slovakia	46.27	47.83	25 (0)	35.13	34 (2)	38.60	22 (0)	43.90	34 (-1)	72.26	25 (-1)	47.97	23 (0)
29 (-1)	Cyprus	46.24	36.64	31 (0)	53.54	18 (0)	30.76	32 (-1)	56.28	19 (2)	72.26	24 (1)	38.14	36 (0)
30 (-4)	Greece	45.76	44.91	26 (1)	34.59	36 (-3)	31.44	31 (1)	65.96	5 (-1)	70.78	29 (0)	44.04	31 (-1)
31 (-1)	Bulgaria	45.27	37.94	29 (1)	42.82	27 (2)	37.50	24 (0)	47.37	30 (0)	71.99	26 (1)	44.21	29 (0)
32 (1)	Georgia	42.36	27.60	37 (0)	55.87	17 (0)	28.48	35 (0)	39.67	36 (0)	63.46	36 (0)	42.34	33 (1)
33 (-1)	Serbia	42.17	31.41	33 (2)	43.86	25 (0)	34.92	29 (0)	48.45	29 (0)	68.88	31 (0)	37.38	37 (0)
34 (0)	Albania	41.23	29.67	36 (0)	43.72	26 (-2)	28.14	36 (-2)	47.36	31 (0)	64.29	35 (0)	44.12	30 (1)
35 (0)	Croatia	39.97	37.81	30 (-1)	28.55	38 (0)	28.72	34 (2)	42.15	35 (0)	68.22	32 (0)	45.66	27 (0)
36 (0)	Moldova	39.07	30.76	35 (-2)	39.65	32 (-2)	25.68	38 (0)	38.80	37 (0)	64.95	34 (0)	42.17	34 (-1)
37 (0)	Ukraine	37.98	22.87	38 (0)	41.89	28 (-1)	30.04	33 (0)	57.09	18 (-1)	61.83	38 (0)	31.26	39 (0)
38 (0)	North Macedonia	35.94	30.86	34 (0)	34.54	37 (-2)	26.24	37 (0)	27.35	39 (0)	62.44	37 (0)	38.57	35 (0)
39 (0)	Bosnia and Herzegovina	28.33	19.42	39 (0)	19.91	39 (0)	23.58	39 (0)	33.34	38 (0)	54.07	39 (0)	33.45	38 (0)

06 About inCITES Consulting

inCITES Consulting is an innovative research, data and advisory firm specialising in the ICT market. Our mission is to support business and technology leaders make informed decisions on technology purchases and business strategy. Our executives have extensive experience in network engineering and the economics of the ICT sector with more than 100 scientific publications and over 300 citations in the past 20 years.

The list of our satisfied customers includes some of the largest telecoms operators, vendors, integrators, governments, universities and telecom regulators globally. We also act as a trusted research and innovation partner for the European Commission on cutting edge research projects mainly in the areas of 5G, Cyber Security and Data Centres.

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