European Commission

Measuring the economic impact of cloud computing in Europe

FINAL REPORT

A study prepared for the European Commission DG Communications Networks, Content & Technology by Deloitte.

Digital Single Market

This study was carried out for the European Commission by

AUTHORS

Patrick Wauters

Sebastiaan Van Der Peijl

Valentina Cilli

Marco Bolchi

Pawel Janowski

Marie Moeremans

Hans Graux

Graham Taylor

Diana Cocoru

Internal identification

Contract number: Contract amendment No 2-29 CE 0674504/02-39 to Contract No 30-CE-0674504/00-76

SMART number: 2014/0031

ISBN 978-92-79-63570-0

DOI:10.2759/75071

Abstract

The study provides an overview of the development of cloud computing in Europe in absence of policy measures, and of the most important barriers for its further development. It provides an assessment of the likely impacts (costs and benefits) of policy measures supporting cloud computing to be implemented consistently with the free flow of data initiative recently launched by the Commission, i.e. introduction of security certifications and removal of data location restrictions. The study developed a model for the cost-benefit analysis based on a large literature review, on available datasets and statistics, and on primary data collected via stakeholders' consultation.

Executive Summary

Cloud computing allows users to access scalable, shareable, elastic pool of computing resources (such as networks, servers, storage, applications and services) hosted remotely, instead of investing capital in their own IT infrastructure or enables them to better share that IT infrastructure.

Status of cloud computing in Europe

Cloud computing technology has become increasingly widespread since the late 2000's and adoption of cloud computing services has been growing steadily, in all sectors of the economy and by all economic operators. Such growth is expected to be **sustained globally over the next 10 years**[1], from an estimated USD 180 billion in 2015 to USD 1.3 trillion in 2018[2] at global level. A recent study estimated that the **total cloud market in the EU by 2020 is expected to be worth EUR 44.8 billion**[3]**.**

While estimates differ among sources, all available sources point to a steady increase of cloud computing in Europe until 2020.

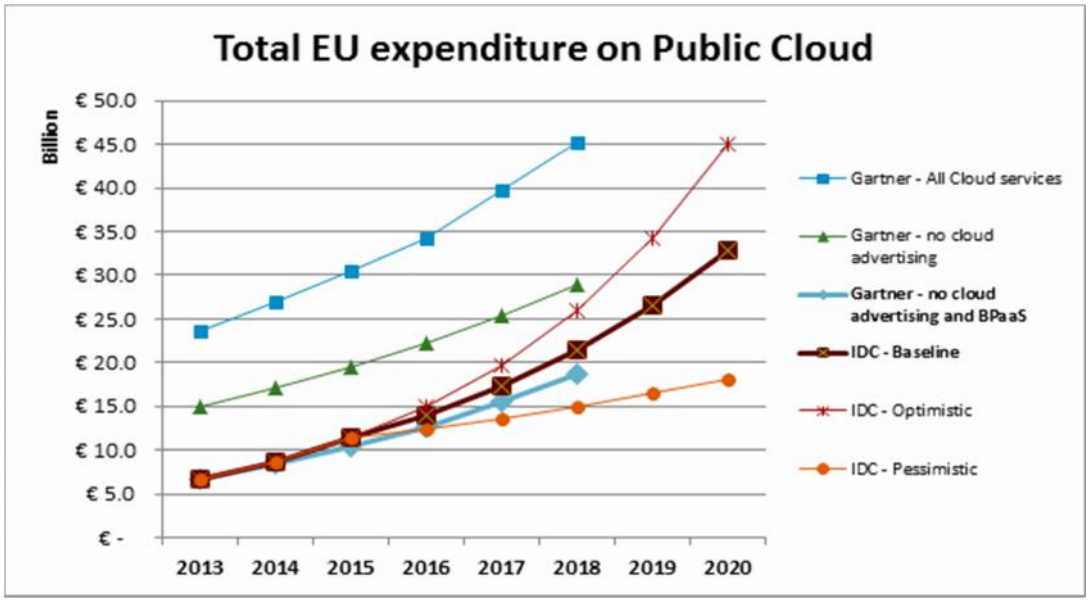
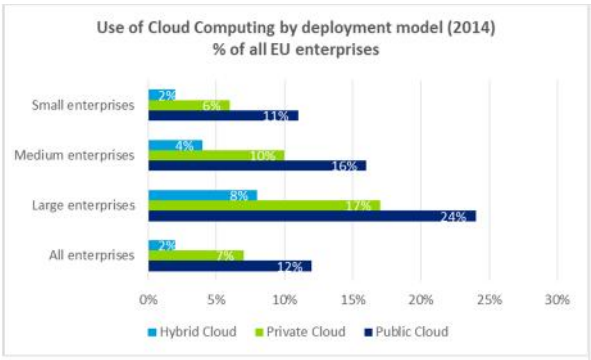


Figure 1 – Total EU expenditure in public cloud computing services

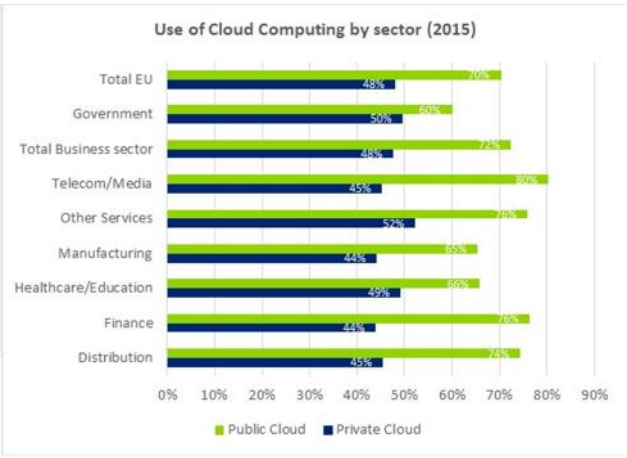
Definition of cloud computing within the scope of different studies has varied, so have the approaches adopted to measure it. Therefore, the adoption rate of cloud computing services by professional users (i.e. enterprises) is difficult to compare directly. A previous study[4] estimated take-up at 70% (public cloud) and 48% (private cloud), while Eurostat estimated that only a fifth (19%) of EU companies used cloud computing services in 2014.

Overall, all sources estimate that SMEs are lagging behind medium and large enterprises.

[1] Disruptive technologies: Advances that will transform life, business, and the global economy (2013). See: http://www.mckinsey.com/insights/business_technology/disruptive_technologies
[2] Gartner, Forecast: Public cloud Services, 2012 – 2018, Q3 2014 update.
[3] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742
[4] IDC, Ibid.



Source: Eurostat (2014)



Source: Uptake of Cloud in Europe – Follow-up study (2014)

Figure 2 – Estimates for take-up of cloud computing in Europe:

Furthermore, Eurostat data point out large variations in take-up among Member States, with the highest percentages in Finland (51%), Italy (40%), Sweden (39%) and Denmark (38%), while in six countries (Romania, Latvia, Poland, Bulgaria, Greece and Hungary) less than 10% of enterprises use cloud computing services.

Large differences in adoption of cloud computing services exist also across industries, with finance and banking being the sector of economic activity with the most intensive use of cloud computing services, followed by public sector and the Telecom/media sector.

Several factors limit the adoption of cloud computing services by professional users. Stakeholders consulted as part of the study identified the following barriers to adoption of cloud computing services.

Professional users' perspective

High impact	Medium impact	Low impact
• Data location requirements • Data access and control • Data portability • Information security • Interoperability	• Ownership of customisation • Evaluation of usefulness • Local support • Procurement rules • Trust	• Local support • Change control • Local language • Tax incentives • Slow Internet Connection

Providers' perspective

High impact	Medium impact	Low impact
• Data location requirements • Local support • Trust • Information security • Procurement rules	• Data access and control • Evaluation of usefulness • Legal jurisdiction • Data access and control • Change control	• Ownership of customisation • Slow Internet Connection • Tax incentives • Local language • Data portability • Interoperability

Figure 3 – Barriers to cloud computing from stakeholders' consultation

Barriers identified by stakeholders include data location requirements, security of data and data protection and, linked to that, SLAs and legal requirements, many of which confirm the analysis of earlier studies and surveys.

For **professional users**, the barriers identified reduce the likelihood to adopt cloud computing services, and those identified as 'high impact' are more likely to impose costs to businesses, often in order to understand and compare offers. Such costs include the time of internal staff to understand and compare the different offers, and in some cases, external advisory fees to have additional guidance before being able to choose the most viable offer.

For **providers**, the barriers mentioned are likely to reduce their sales/turnover in their domestic market, while the impacts on cross-border sales/turnover are less clear, as small providers (like those that answered the survey) tend to focus on domestic markets.

In addition, the relevance of increasing **awareness and education** among current and perspective users of cloud computing services was mentioned repeatedly by stakeholders interviewed, both by providers and by business representative organisations.

Both professional users and providers of cloud computing services identified **data location requirements as a high-impact barrier**, limiting the adoption of cloud computing services by users and reducing sales/turnover for providers. Indeed, data location requirements limit the choice of available offers for users, that may be prevented from adopting cloud computing services due to their costs (as the most economically efficient offer may not be available). On the other hand, providers may face higher costs for providing cloud computing services, as they may be forced to establish in locations with higher production costs.

Despite the barriers to wider adoption, cloud computing is a **crucial driver for growth** in the EU.

Available studies have identified a series of benefits for society as whole and for businesses and governments in particular directly linked to cloud computing.

Estimates regarding the impact of cloud computing adoption to the macro-economic performance of the EU (including impact on GDP) vary. All of them, however, agree in identifying a positive impact. It is estimated that **over the next five years**, cloud computing could add a **cumulative total revenue of EUR 449 billion to the EU28 GDP** (including in the public sector). Of these, EUR 57.7 billion and EUR 103.2 billion would be net new GPD generated in the years 2016 and 2020 respectively, representing a share of 0.4 and 0.71% of total EU GDP respectively[5]. It is estimated that in 2013, the adoption of cloud computing contributed EUR 27.9 billion to EU GDP, making up 0.2% of total EU GDP[6].

All analyses agree on the **positive impact of cloud computing on job creation and employment**. Estimates for job creation vary widely between sources and scenarios: between 300 000 and 2.5 million jobs have been created through cloud computing for the 2012 – 2015 period. According to study on the cloud computing uptake, the cumulative impact on employment is expected to reach 1.6 million jobs

[5]Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC
[6]Ibid

created between 2008 and 2020 (ranging from 2.5 million according to the optimistic scenario and slightly over 1 million in the pessimistic scenario)[7].

In terms of **business creation**, approximately 303 000 new businesses, in particular SMEs, could be created between 2015 and 2020 through the development and deployment of cloud computing[8]. Such estimate refers to the baseline scenario, figures range from about to 800 000 under the more optimistic scenario to about 96 000 under the pessimistic scenario in the same time period[9].

The main benefits of cloud computing for professional users, i.e. businesses and public sector organisations using cloud computing services, from cloud computing adoption have been identified and can be categorised along the following main elements:

- Reduction of ICT costs;
- Shift of IT costs from capital expenditure to operating expenses;
- Scalability and adaptability;
- Time to market;
- Management time.

The table below summarises the main benefits for professional users arising from cloud computing, the mechanisms for those benefits to manifest, and the quantitative estimates available.

Table 1 – Summary of benefits of cloud computing for companies/users

Benefit	Definition	Quantitative estimates
Costs savings	The largest and most identifiable economic benefit of cloud computing is the direct cost savings from changes within the organisation (such as from reduced IT infrastructural investment and maintenance).	• Reduction of total IT costs between 20% and 50% • Overall savings in IT costs of EUR 140,74 million between 2010 and 2015 in across the UK, Germany, France, Italy and Spain
Operating expenses	Cloud computing costs lowers the operating expenses of firms (OPEX). This allows firms to have more capital available for other investments (CAPEX) fostering productivity and growth.	• IT OPEX savings of over EUR 130 million between 2010 and 2015 in across the UK, Germany, France, Italy and Spain (EUR 73, 829 million related to FTE/productivity and EUR 56, 349 billion related to power and cooling) • IT CAPEX savings of EUR 154, 7 million between 2010 and 2015 in across the UK, Germany, France, Italy and Spain (73, 829 million related to FTE/productivity and EUR 56, 349 million related to power and cooling)
Scalability and Adaptability	Grid computing provides cloud with elastic scalability, i.e. the ability to add and remove computing capacity on demand. This has a significant advantage in applications with a highly variable workload (such as seasonal	N/A

[7] Ibid.
[8] Ibid.
[9] Ibid.

Benefit	Definition	Quantitative estimates
	peaks) or unpredictable growth, or for temporary applications. In addition, cloud computing minimises or eliminates planned and unplanned downtime, improving user service levels and business continuity.	
Time to market	Application deployment is greatly accelerated as cloud computing shorten the product deployment cycle, improve the quality and availability of applications and maximize resources. Companies can rely on a ready-to-use infrastructure, easily customisable. This reduces the time needed to launch a new product/service on the market.	N/A
Management time	With IT management and computing processes on cloud computing, managers can re-shape the use of their time and dedicate more time and energy to strategy and innovation.	N/A

Costs and benefits of cloud computing in Europe

Approach to estimating costs and benefits of cloud computing in Europe

The study developed a model for the identification and quantification of the costs and benefits of cloud computing in Europe, based on the studies and estimated available and on the mechanisms and impacts of cloud computing described in literature.

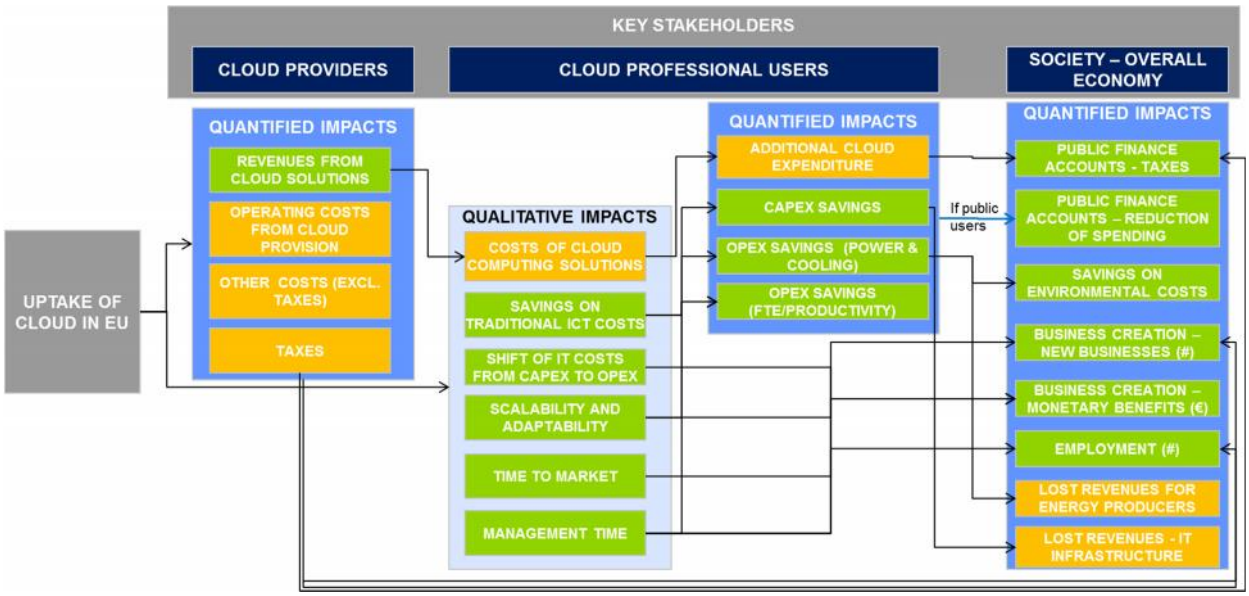


Figure 4 – Model developed for the CBA of cloud computing in Europe

The uptake of cloud computing services in EU is the "engine" of the model, since it represents the key enabler of business generation for cloud providers, benefits from use (as well as additional cloud expenditure) for professional users, as well as a range of impact for the wider economy and the society.

The model was then populated with a set of secondary data from available datasets and literature review, as well as with inputs from the stakeholders' consultation carried out as part of the study.

Costs and benefits under the baseline scenario

The estimates for the baseline scenario of cloud computing in Europe answers to the question '*how will the market for cloud computing evolve in absence of further policy measures?'* (Status Quo)

Based on the model developed for the study, the net benefits for the three main groups of stakeholders identified (i.e. professional users, providers of cloud computing services and society as a whole) will grow to 2020, reaching a total of EUR 202 billion. All the three groups would see a net benefit, while the benefits for (professional) users will exceed those for providers and society.

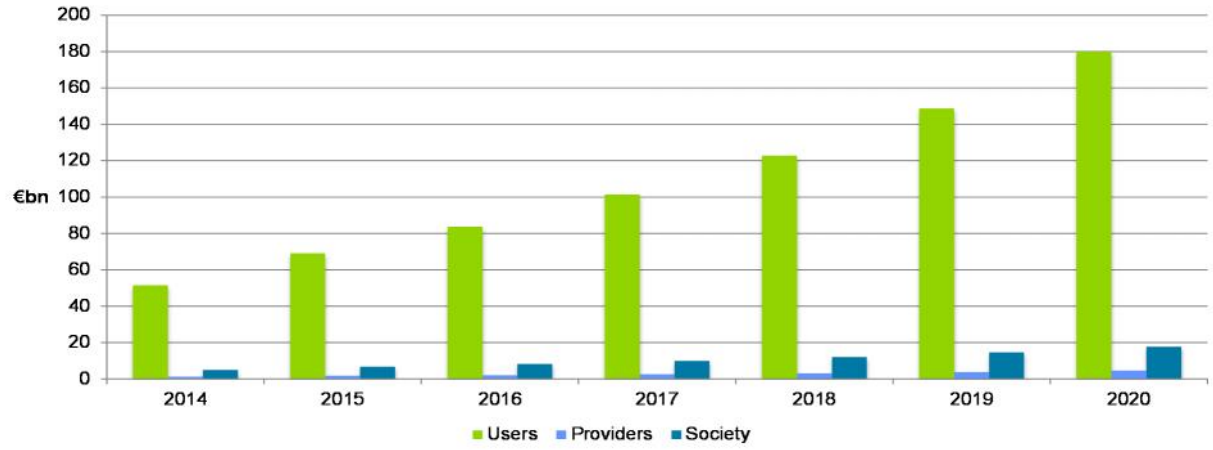


Figure 5 – Costs and benefits of cloud computing (baseline scenario)

In more details, the average annual net benefit for **professional users** is estimated to be EUR 108 billion, with expenditure for cloud computing services estimated to increase up to EUR 35 billion by 2020. Such benefits include are CAPEX and OPEX savings (estimated to reach about EUR 116 billion by 2020) as a result of:

- Shift from CAPEX to OPEX;
- Power and cooling savings; and
- Additional lowering of IT operating costs (OPEX).

Providers of cloud computing services are estimated to have an average annual net benefit of EUR 2.8 billion, raising over time to 2020. The quantified benefits are the revenues from provision of cloud solutions, which are expected to rise to EUR 45 billion by 2020 in EU28. Such estimated benefits exceed the operating costs for providers, estimated to rise to EUR 36 billion by 2020 in EU28.

For society as a whole, the average annual net benefit is estimated to be EUR 11 billion, increasing up to EUR 35 billion in 2020. Such benefits include tax revenues and savings on environmental costs, as well as the business creation benefits included in user calculations.

Concerning the distribution of costs and benefits of cloud services to cloud users across sectors, the highest benefits can be observed by cloud users in the Distribution, Retail & Hotels sectors, followed by Finance & Business services sectors. Based on our estimations, these two sectors account for, respectively, 34% and 24% of the overall net benefit to cloud users. Government, Education & Health sector account for 14% of the net benefits, and Manufacturing for 13%.

Policy measures for cloud computing in Europe

Policy initiatives supporting cloud computing in Europe

The policy measures considered for the cost-benefits analysis can be divided in three groups. The first and second group include measures that have already been taken and can be further developed to support the free flow of data, i.e. measures on standards and schemes, certification, and trust and on Safe and fair contractual terms for cloud computing. The third group includes measures to remove data location requirements, which directly relate to the Free Flow of Data Initiative (FFDI) recently launched by the Commission.

Out of these measures, only two were included in the cost-benefit analysis of policy initiatives supporting cloud computing in Europe, based on expected (qualitative) impacts and on available literature and data upon which to base the analysis. These measures were the following:

- Promotion of existing relevant certifications and standards; and
- Removal of data location restrictions.

These policy initiatives were first considered separately and then combined together.

Costs and benefits of policy initiatives supporting cloud computing in Europe

Promotion of existing relevant certifications and standards

The promotion of existing relevant certifications and standards is likely to provide assurance to the cloud users that the service is safe and reliable, an additional user uptake is expected of 1%. The results of the cost-benefit analysis on this policy initiatives indicate that **all the stakeholders** under consideration, namely cloud professional users, cloud service providers, and the society will **benefit** from this policy option, although the additional benefits to the overall value chain are mild (less than 1%).

Table 2 – Changes in NPV across all three stakeholders after introducing security certifications

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 538.4 billion	0.64%
Cloud providers	EUR 16.2 billion	0.94%
Society	EUR 57.3 billion	1.02%
Total NPV added	**EUR 4.2 billion**	**0.70%**

Overall, cloud **users** are expected to experience an additional NPV creation of 0.64% (which corresponds to around EUR 3.5 billion) compared with the baseline scenario. This is due to the additional user uptake generated by these certifications and standards and the reassurance they provide that these cloud services can be considered safe and reliable.

C**loud service providers** are the category of stakeholders directly targeted by this policy measure. Facing additional costs associated with acquiring these security certifications, they are estimated to increase their price by 0.5%. Overall, the profitability of cloud providers remains the same, but they generate additional revenues due to the additional user uptake of +1% linked with the promotion of these

certifications and standards. Over the period 2015-2020, an additional EUR 184 million NPV value is generated, equal to an increase of 0.94% compared to the baseline scenario.

Finally, **society as a whole** witnesses a similar impact. The additional net benefits for society are linked to a higher VAT income and additional net income taxes associated with the higher prices for cloud computing services, higher expenditure and higher uptake of cloud services in the EU. Overall, an additional EUR 586 million (+1.02%) of discounted NPV is generated over the period 2015-2020 with respect to the baseline scenario.

When considering the impact of this policy initiative on different industries, promotion of certifications and standards has a rather uniform impact on the 5 different sectors under considerations. Both the Finance & business services sector and the Government, Education & Health sector have an increase of 0.71% followed by the Distribution, Retail & Hotels with 0.69% and the Manufacturing sector with an additional NPV over the period 2015-2020 of 0.53% with respect to the baseline scenario.

Removal of data location restrictions

The cost-benefit analysis of the policy measurement to remove the data location requirement for cloud service providers provides **overall positive net benefits** to users, providers and the wider economy and society.

Table 3 – Changes in NPV across all three stakeholders after removal of data location requirements

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 542.2 billion	1.36%
Cloud providers	EUR 19.5 billion	21.53%
Society	EUR 57.6 billion	1.49%
Total NPV added	**EUR 11.6 billion**	**1.90%**

The net benefits for **cloud professional users** are estimated to be rather modest in relative terms. Compared with the baseline scenario, the removal of the data location requirement would generate an additional net benefit of EUR 7.2 billion or 1.36% over the period 2015-2020. Such effect is produced mainly by a reduction in prices of cloud solutions.

The stakeholder category that benefits the most, in relative terms, of this policy measurements are **cloud service providers**. The decrease in operating costs is expected to prevail over the decrease of revenues. As the policy measure is expected to start producing effects from 2018, cloud service providers are expected to benefit mainly due to the drop in operating costs. Over the period 2015-2020, the measurement would result in the generation of almost EUR 3.5 billion compared with the baseline scenario, meaning an increase by 21.53% in terms of net benefits. This significant increase depend on the higher margins and the higher uptake of cloud services in the EU.

Finally, **society as a whole** is also likely to experience additional benefits with respect to the baseline scenario via the combined effect of:

- Decreasing VAT due to lower prices;
- Higher overall income taxes due to improved profitability of cloud providers;

- Additional benefits generated through the reduction of the environmental impact due to higher adoption and uptake of cloud solutions.

All the five sectors of economic activities considered in this study are expected to benefit from this policy option. The manufacturing sector achieves the largest benefit with a generation of 2.23% additional NPV over the period 2015-2020. Following is the Distribution, retail & hotels sector with 2.12%. Both the Finance & business services and Government, Education & Health sector benefit similarly under this measure with respectively 1.77% and 1.76%. Finally, the sector with Other Industries generates an additional 1.42% NPV over the period 2015-2020.

Combination of both policy measures

If the decision is made to introduce both the security certification in 2017 and the removal of the data location requirement is implemented starting from 2018, the cost-benefit analysis of shows that **all stakeholders will experience a significant increase in additional net benefits**. Overall, the introduction of these two policy measures could create an additional NPV over the period of 2015-2020 of 3.25% with respect to the baseline scenario.

Table 4 – Changes in NPV across all three stakeholders after introducing both policy measures

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 549.0 billion	2.63%
Cloud providers	EUR 19.9 billion	23.57%
Society	EUR 58.5 billion	3.15%
Total NPV added	**EUR 19.8 billion**	**3.25%**

Over the period under consideration, the additional amount of net benefits for **cloud professional users** is expected to reach around EUR 14 billion. This can mainly be explained by the additional users' uptake in 2017 (+1%) associated with the security certification and in 2018 (+1.04%) due to the lower price and some further reinvestment in cloud services.

Cloud providers are the stakeholders experiencing the largest relative gains (+23.57%) under the scenario of the implementation of both policy measures. Starting in 2017 with the introduction of the security certifications, cloud providers are likely to gain additional net benefits due to the slightly higher service price (+0.5%) and the additional users' uptake (+1%). However, the largest effect takes place from 2018 onwards, when the removal of the data location requirement is expected to decrease the total costs of operations by 9%.In addition, the lower price increases the additional user uptake with another 1.04%. Overall, the cloud providers could generate additional NPVs over the period 2015-2020 of EUR 3.8 billion.

Finally, **society as a whole** is expected to gain additional 3.15% NPVs over the period of 2015-2020 (or about EUR 1.8 billion). This can mainly be explained by the lower VAT associated with the lower prices, the overall higher tax income linked with the higher profitability of cloud service providers and the additional benefits generated through the reduction of the environmental impact due to the higher uptake of cloud computing in the EU.

The analysis carried out does not allow differentiating amongst the different types of service providers (e.g. SMEs and large enterprises providing cloud computing services). Therefore, while the policy measures assessed are expected to bring positive net benefits for cloud service providers, it is possible that they have a detrimental effect on some segments for providers. For instance, it is extremely likely that the removal of data location restrictions will impact negatively those small service providers that use data location as a competitive advantage necessary for their survival in a competitive market against large competitors.

Looking to the combined effect of both policy measures on the five different sectors, a similar positive trend can be identified. All sectors generate additional net benefits after the introduction of the security certifications in 2017 and the removal of the data location requirement in 2018 onwards. The Manufacturing sector is the sector achieving the largest gain with additional NPV over the period of 2015-2020 of 3.57%. The Distribution, Retail & Hotel sector follows closely with an increase of 3.46% followed by both the Finance & business service sector and the Government, Education & Health sector with 3.12% and 3.11% respectively. The fifth category grouping all Other sectors sees additional NPV growth over the period 2015-2020 of 2.78%.

Overall, despite the current barriers to adoption, cloud computing is a growing market and a crucial driver for economic growth in Europe. Policy initiatives aiming at promoting existing relevant certifications and standards and at removing data location restrictions will support such growth, increasing benefits for users and providers of cloud computing, as well as for society as a whole (3.25% increase in NPV compared to the baseline scenario).

Résumé

L'informatique en nuage permet aux utilisateurs d'accéder à un ensemble de ressources informatiques (réseaux, serveurs, stockage, logiciels et services) évolutif, élastique, pouvant être partagé et hébergé à distance, leur évitant ainsi d'investir du capital dans leur propre infrastructure informatique ou leur permettant de mieux la partager.

Etat de l'informatique en nuage en Europe

La technologie de l'informatique en nuage s'est largement répandue depuis la fin des années 2000 et l'adoption de services d'informatique en nuage n'a cessé de s'accroître dans tous les secteurs de l'économie et chez tous les opérateurs économiques. Cette croissance devrait **se poursuivre au niveau mondial au cours des dix prochaines années**[10], passant d'un niveau estimé à 180 milliards de dollars en 2015 à 1,3 mille milliards de dollars en 2018. Une étude récente estime que la **valeur totale du marché de l'informatique en nuage dans l'Union européenne attendra 44,8 milliards d'euros d'ici 2020**[11].

Bien que les estimations varient d'une source à l'autre, toutes les sources disponibles prévoient un essor croissant de l'informatique en nuage en Europe jusqu'à 2020.

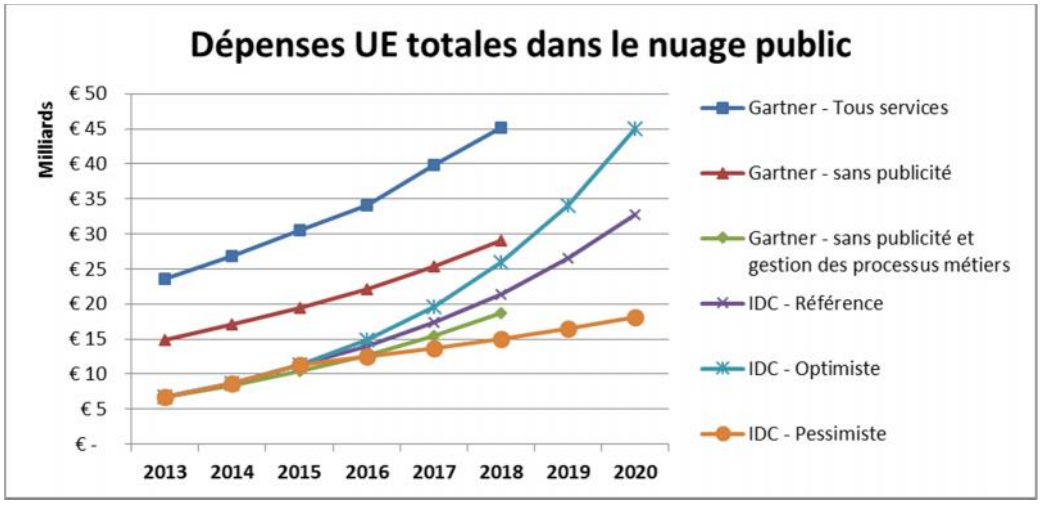


Figure 6 – Dépenses totales de l'UE dans les services d'informatique en nuage

La définition de l'informatique en nuage et la façon de la mesurer varient d'une étude à l'autre. Il est donc difficile de comparer directement l'adoption des services d'informatique en nuage par des utilisateurs professionnels (c'est-à-dire des entreprises). D'après une étude précédente[12], le taux d'adoption de l'informatique en nuage publique s'élève à 70% et celui de l'informatique en nuage privée

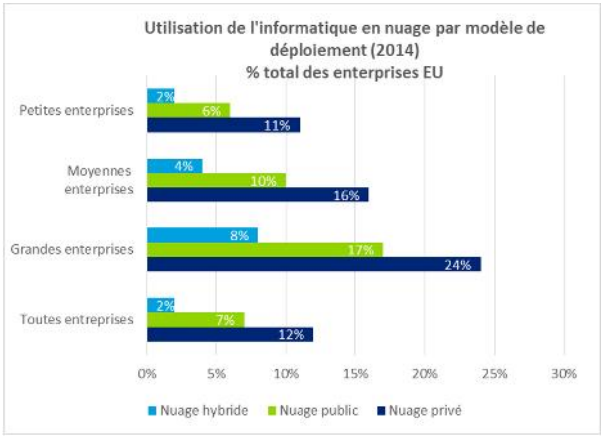
[10] Disruptive technologies: Advances that will transform life, business, and the global economy (2013). Voir: http://www.mckinsey.com/insights/business_technology/disruptive_technologies

[11] « L'adoption de l'informatique en nuage en Europe : suivi de l'étude d'IDC sur les estimations quantitatives de la demande de services informatiques en nuage en Europe et des obstacles probables à leur utilisation : résumé et note de synthèse » (2014). Voir: http://publications.europa.eu/fr/publication-detail/-/publication/7f0f48ca-32ef-489d-aa19-bc62e5044f1f/language-fr.

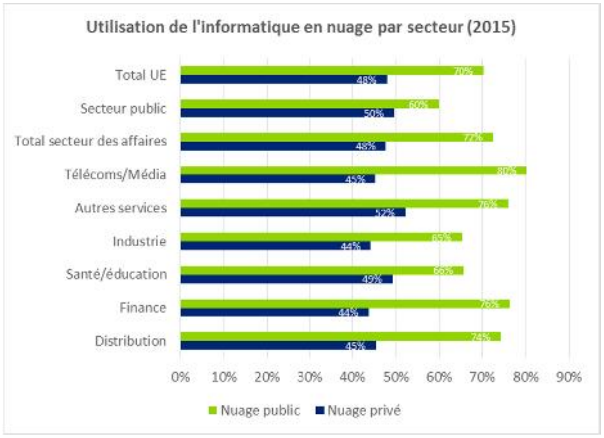
[12] IDC, ibid.

à 48%, tandis qu'Eurostat estime que seulement un cinquième (19%) des entreprises européennes ont utilisé des services d'informatique en nuage en 2014.

Globalement, toutes les sources indiquent que les PME sont à la traîne par rapport aux moyennes et grandes entreprises.



Source: Eurostat (2014)



Source: Adoption du nuage en Europe – suivi de l'étude (2014)

Figure 7 – Estimations de l'utilisation de l'informatique en nuage en Europe

De plus, les données d'Eurostat indiquent de fortes disparités de taux d'adoption entre Etats membres : les pourcentages les plus élevés sont recensés en Finlande (51%), Italie (40%), Suède (39%) et au Danemark (38%), tandis que dans six pays (Roumanie, Lettonie, Pologne, Bulgarie, Grèce et Hongrie), moins de 10% des entreprises ont recours aux services d'informatique en nuage.

Il existe également des différences importantes dans l'adoption de ces services entre secteurs. La finance et la banque sont le secteur économique ayant le plus recours aux services d'informatique en nuage, suivi par le secteur public et le secteur des télécoms et des médias.

Plusieurs facteurs limitent l'adoption de services d'informatique en nuage par les utilisateurs professionnels. Les parties prenantes consultées dans le cadre de cette étude ont identifié les barrières suivantes à l'adoption de ces services :

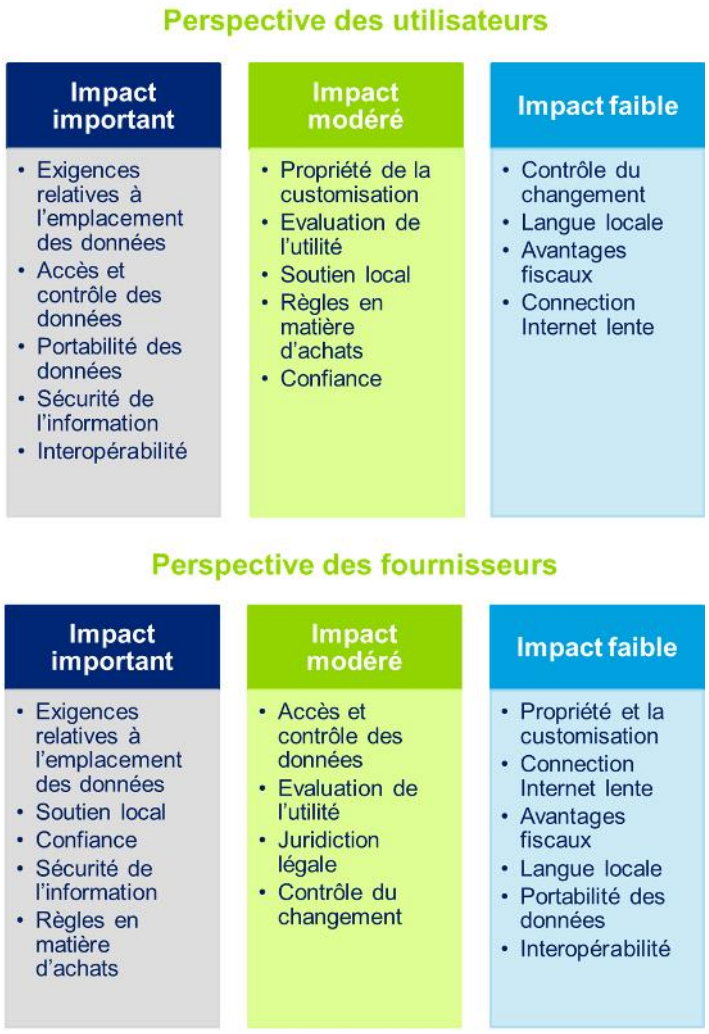


Figure 8 – Barrières à l'adoption de l'informatique en nuage d'après la consultation des parties prenantes

Les barrières identifiées par les parties prenantes incluent notamment les exigences relatives à l'emplacement des données, la sécurité et la protection des données et, en lien direct, les *service-level agreements* (SLA) et obligations légales. La plupart de ces obstacles confirme l'analyse des études et sondages précédents.

Pour les **utilisateurs professionnels**, les obstacles identifiés réduisent la probabilité d'adopter des services d'informatique en nuage, et ceux catégorisés comme ayant un impact important sont plus susceptibles d'imposer des coûts aux entreprises, notamment pour la compréhension et la comparaison des offres. Ces coûts incluent le temps passé par le personnel à comprendre et comparer les différentes offres, et dans certains cas, les honoraires de consultation externe afin d'obtenir des conseils supplémentaires avant de choisir l'offre la plus viable.

Pour les **fournisseurs**, les barrières mentionnées sont susceptibles de réduire leurs ventes/chiffre d'affaires sur leur marché national, tandis que les impacts sur les ventes/chiffre d'affaires transfrontaliers sont moins clairs dans la mesure où les petits fournisseurs (à l'instar de ceux qui ont répondu au sondage) ont tendance à se concentrer sur les marchés nationaux.

De plus, l'importance d'accroître **la sensibilisation et l'éducation** parmi les utilisateurs actuels et potentiels de services d'informatique en nuage a été mentionnée à de nombreuses reprises par les parties prenantes interrogées, tant les fournisseurs que les organisations représentant les entreprises.

Les utilisateurs professionnels comme les fournisseurs de services ont identifié les **exigences relatives à l'emplacement des données comme un obstacle à fort impact** limitant l'adoption de services d'informatique en nuage par les utilisateurs et réduisant les ventes/le chiffre d'affaires pour les fournisseurs. En effet, ces exigences limitent le choix d'offres disponibles pour les utilisateurs, que les coûts peuvent empêcher d'adopter des services d'informatique en nuage, l'offre la plus économiquement efficace n'étant pas forcément disponible. Par ailleurs, les fournisseurs peuvent faire face à des coûts plus importants pour la provision de ces services puisqu'ils peuvent être contraints de s'établir dans des sites aux coûts de production plus élevés.

Malgré les barrières à une adoption à plus grande échelle, l'informatique en nuage est un **moteur essentiel de la croissance** de l'UE.

Les études disponibles ont identifié un ensemble d'avantages directement liés à l'informatique en nuage pour la société, en particulier les entreprises et les gouvernements.

Les estimations de l'impact de l'adoption de l'informatique en nuage sur la performance macro-économique de l'Union (y compris sur le PIB) varient. Cependant, toutes s'accordent sur l'existence d'un impact positif. **Au cours des cinq prochaines années**, l'informatique en nuage pourrait générer **un apport total cumulé de 449 milliards d'euros au PIB de l'Union à 28**, y compris dans le secteur public. 57,7 milliards d'euros et 103,2 milliards d'euros de PIB net seraient générés respectivement en 2016 et 2020, représentant 0,4 et 0,71% du PIB européen total[13]. Selon les estimations, en 2013, l'adoption de l'informatique en nuage a contribué au PIB européen à hauteur de 27,9 milliards d'euros, soit 0,2% du PIB total[14].

Toutes les analyses concordent sur le fait que **l'informatique en nuage a un impact positif sur la création et le niveau d'emploi**. Les estimations pour la création d'emplois varient considérablement d'une source et d'un scénario à l'autre : entre 300 000 et 2,5 million d'emplois ont été créés grâce à l'informatique en nuage entre 2012 et 2015. D'après l'étude sur l'adoption de l'informatique en nuage, l'impact cumulé sur l'emploi devrait atteindre 1,6 million de nouveaux emplois créés entre 2008 et 2020 – allant de 2,5 millions dans le scénario optimiste à 1 million dans le scénario pessimiste[15].

En termes de **création d'entreprises**, environ 303 000 nouvelles entreprises, en particulier des PME, pourraient être créées entre 2015 et 2020 grâce au développement et au déploiement de l'informatique en nuage[16]. Cette estimation se rapporte au scénario de référence ; pour la même période, les chiffres varient de 800 000 dans le scénario optimiste à 96 000 dans le scénario pessimiste[17].

Les principaux avantages de l'informatique en nuage pour les utilisateurs professionnels, soit les entreprises et les organismes publics utilisant ces services, ont été identifiés et peuvent être catégorisés selon les éléments suivants :

- Réduction des coûts liés aux technologies de l'information et de la communication (TIC) ;
- Glissement des coûts informatiques de dépenses en capital à dépenses opérationnelles ;
- Evolutivité et adaptabilité ;

[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Ibid.

- Délai de commercialisation ;
- Temps de gestion.

Le tableau ci-dessous résume les principaux avantages de l'informatique en nuage pour les utilisateurs professionnels, les mécanismes permettant à ces avantages de se manifester et les estimations quantitatives disponibles.

Tableau 5 – Résumé des avantages de l'informatique en nuage pour les entreprises/utilisateurs

Avantage	Définition	Estimations quantitatives
Economies de coût	Les économies de coût directes découlant de changements organisationnels, tels qu'un moindre investissement et entretien des infrastructures informatiques, constituent l'avantage économique le plus important et visible de l'informatique en nuage	▪ 20% à 50% de réduction des coûts informatiques totaux ▪ Économies totales sur les coûts informatiques de 140,74 millions d'euros entre 2010 et 2015 au Royaume-Uni, Allemagne, France, Italie et Espagne
Dépenses opérationnelles	Les coûts liés à l'informatique en nuage réduisent les dépenses d'exploitation des entreprises (OPEX). Cela leur permet de disposer de plus de capital pour les dépenses d'investissement (CAPEX) destinées à accroître leur productivité et leur croissance.	▪ Economies de dépenses d'exploitation informatiques de 130 millions d'euros entre 2010 et 2015 au Royaume-Uni, Allemagne, France, Italie et Espagne (dont 73,829 millions d'euros liés à l'ETP/productivité et 56,349 millions d'euros liés à l'électricité et au refroidissement) ▪ Economies de dépenses d'investissement de 154,7 million d'euros entre 2010 et 2015 au Royaume-Uni, Allemagne, France, Italie et Espagne (dont 73,829 millions d'euros liés à l'ETP/productivité et 56,349 millions d'euros liés à l'électricité et au refroidissement)
Evolutivité et adaptabilité	Les grilles informatiques offrent une évolutivité élastique aux nuages, c'est-à-dire la capacité d'ajouter et de retirer de la capacité informatique sur demande. Cela est particulièrement avantageux pour les applications avec une charge de travail très variable (par exemple des pics saisonniers) ou une croissance imprévisible, ainsi que pour les applications temporaires. De plus, l'informatique en nuage minimise voire élimine les temps d'arrêt prévus et imprévus, améliorant ainsi le service aux utilisateurs et la continuité de l'activité.	N/A

Avantage	Définition	Estimations quantitatives
Délai de commercialisation	Le déploiement d'applications est considérablement accéléré car l'informatique en nuage réduit le cycle de déploiement des produits, améliore la qualité et la disponibilité des applications et maximise les ressources. Les entreprises peuvent s'appuyer sur une infrastructure prête à l'emploi, facilement paramétrable. Ceci réduit le temps nécessaire au lancement d'un nouveau produit ou service sur le marché.	N/A
Temps de gestion	La gestion de l'informatique et des processus informatiques étant prise en charge par l'informatique en nuage, les gérants peuvent réorganiser leur emploi du temps et consacrer plus de temps et d'énergie à la stratégie et à l'innovation.	N/A

Coûts et avantages de l'informatique en nuage en Europe

Approche adoptée pour l'estimation des coûts et avantages de l'informatique en nuage en Europe

Cette étude développe un modèle pour l'identification et la quantification des coûts et avantages de l'informatique en nuage en Europe sur la base des études et estimations disponibles et des mécanismes et impacts de l'informatique en nuage décrits dans la littérature.

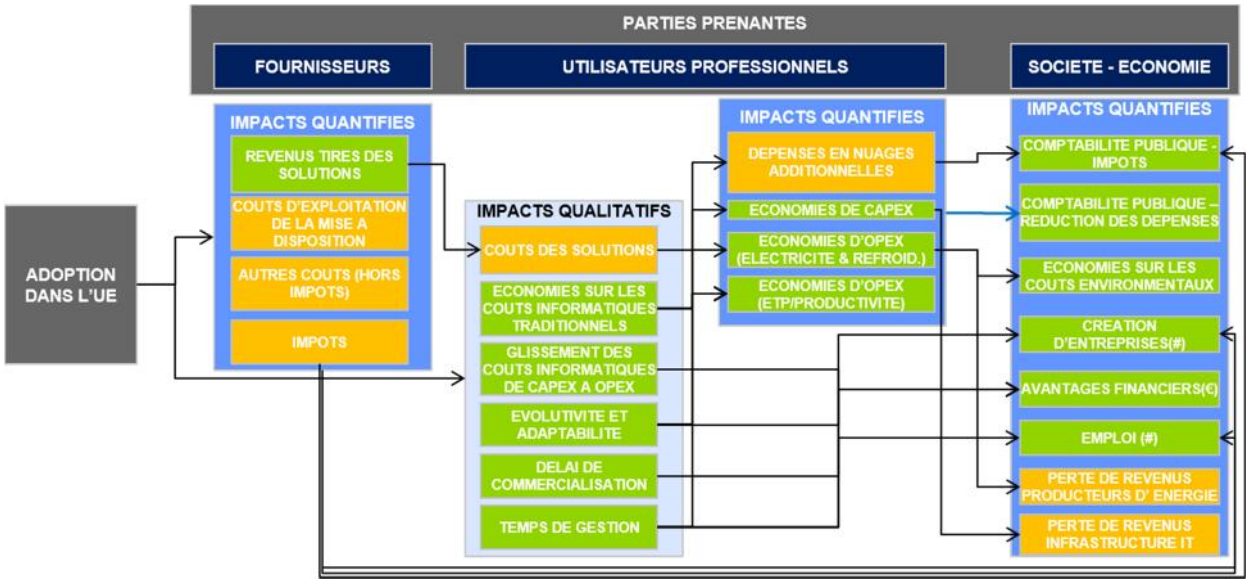


Figure 9 – Modèle développé pour l'analyse coût-avantage de l'informatique en nuage en Europe

L'adoption des services d'informatique en nuage en Europe est le « moteur » du modèle puisqu'elle constitue l'élément-clé du développement des affaires pour les fournisseurs, bénéficie de l'utilisation

(ainsi que des dépenses additionnelles en nuages) pour les utilisateurs professionnels, en plus d'un vaste ensemble d'impacts pour le reste de l'économie et de la société.

Le modèle a ensuite été rempli de données secondaires tirées des ensembles de données disponibles et de la revue de la littérature, ainsi que des contributions des parties prenantes obtenues lors de la consultation menée dans le cadre de cette étude.

Coûts et avantages dans le scénario de référence

Les estimations pour le scénario de référence pour l'informatique en nuage en Europe répondent à la question : « *Comment le marché de l'informatique en nuage va-t-il évoluer en l'absence de nouvelles mesures de politique publique ?* » (status quo).

Sur la base du modèle développé pour l'étude, les avantages nets pour les trois principaux groupes de parties prenantes identifiés (utilisateurs professionnels, fournisseurs de services d'informatique en nuage et ensemble de la société) augmenteront jusqu'à 2020, atteignant un total de 202 milliards d'euros. Chacun des trois groupes bénéficierait d'un avantage net, les avantages pour les utilisateurs (professionnels) dépassant ceux des fournisseurs et de la société.

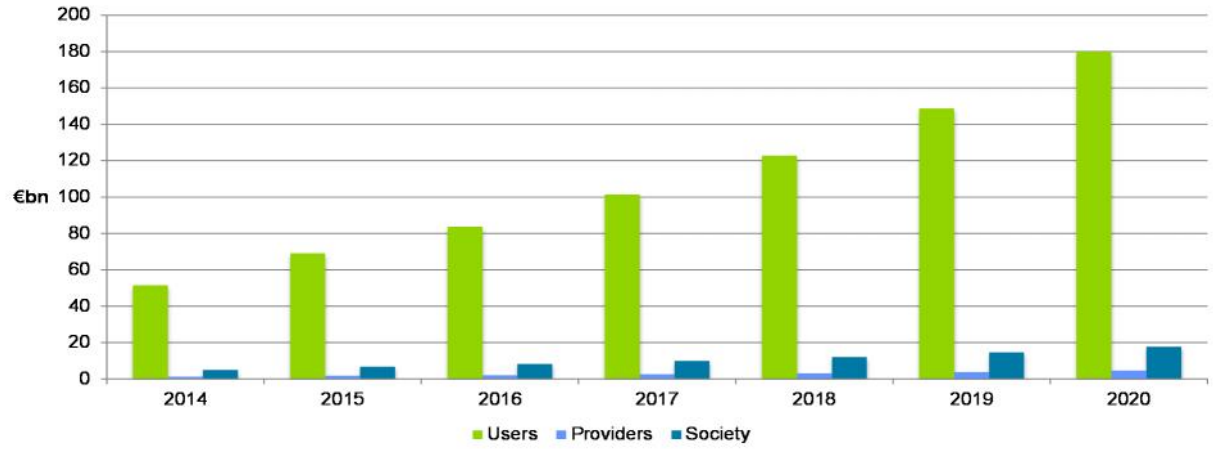


Figure 10 – Coûts et avantages de l'informatique en nuage (scénario de référence)

Plus précisément, le bénéfice annuel net pour les **utilisateurs professionnels** devrait atteindre 108 milliards d'euros, les dépenses pour les services d'informatique en nuage augmentant à 35 milliards d'euros d'ici 2020 dans ce scénario. Ces bénéfices incluent des économies de dépenses d'exploitation et d'investissement, qui devraient atteindre 116 milliards d'euros d'ici 2020, du fait de :

- Un glissement des dépenses d'exploitation vers les dépenses d'investissement ;
- Des économies d'électricité et de refroidissement ; et
- Une réduction supplémentaire des coûts d'exploitation informatiques.

D'après ces estimations, les **fournisseurs** de services d'informatique en nuage verraient un bénéfice net annuel moyen de 2,8 milliards d'euros, en constante augmentation jusqu'à 2020. Les avantages quantifiés sont les revenus tirés de la provision de solutions d'informatique en nuage, qui devraient s'accroître jusqu'à 45 milliards d'euros d'ici à 2020 dans l'Union à 28. Ces bénéfices dépassent les coûts d'exploitation pour les fournisseurs, qui devraient atteindre 36 milliards d'euros en 2020 dans l'Union à 28.

Pour l'ensemble de la **société**, le bénéfice annuel moyen devrait s'élever à 11 milliards d'euros, atteignant jusqu'à 35 milliards d'euros en 2020. Ces bénéfices incluent des recettes fiscales et des économies sur les coûts environnementaux, ainsi que les bénéfices de la création d'entreprises compris dans les calculs pour les utilisateurs.

Quant à la distribution des coûts et avantages des services d'informatique en nuage aux utilisateurs entre secteurs, les avantages les plus importants sont observés chez les utilisateurs dans les secteurs de la distribution, du commerce et de l'hôtellerie, suivis de la finance et des services commerciaux. D'après nos estimations, ces deux secteurs captent respectivement 34% et 24% des bénéfices nets totaux pour les utilisateurs. Le secteur public, éducation et santé couvre 14% des bénéfices nets, et l'industrie, 13%.

Mesures de politique publique pour l'informatique en nuage en Europe

Initiatives politiques de soutien à l'informatique en nuage en Europe

Les mesures de politique public prises en considération dans l'analyse coût-avantage peuvent être catégorisées en trois groupes. Les premier et second groupes incluent les mesures existantes et pouvant être développées davantage afin d'appuyer le développement de la libre circulation des données, soit les mesures relatives aux normes et systèmes, à la certification, à la confiance et à des termes contractuels équitables et sûrs pour l'informatique en nuage. Le troisième groupe comprend les mesures destinées au retrait des obligations relatives à l'emplacement des données, ce qui se rapporte directement à l'initiative en faveur de la libre circulation des données lancée récemment par la Commission.

Seules deux de ces mesures ont été prises en compte dans l'analyse coût-avantage des initiatives politiques de soutien à l'informatique en nuage en Europe, sur le fondement des impacts (qualitatifs) attendus, de la littérature et des données sur lesquelles se fonde l'analyse. Il s'agit des mesures suivantes :

- Promotion des certifications et standards applicables existants ; et
- Suppression des restrictions sur l'emplacement des données.

Ces initiatives ont été analysées séparément puis de manière combinée.

Coûts et avantages des initiatives politiques de soutien à l'informatique en nuage en Europe

Promotion des certifications et standards applicables existants

Il est probable que la promotion des certifications et standards applicables existants garantisse la sûreté et la fiabilité du service aux utilisateurs de l'informatique en nuage, ce qui devrait augmenter son adoption de 1%. Les résultats de l'analyse coût-bénéfice montrent que **toutes les parties prenantes** prises en considération, soit les utilisateurs professionnels d'informatique en nuage, les fournisseurs de services et la société, bénéficieront de cette option, bien que les avantages additionnels pour la chaîne de valeur globale soient limités (moins de 1%).

Tableau 6 – Variation de la valeur actuelle nette (VAN) pour les trois types de parties prenantes après l'introduction de certifications de sécurité

Parties prenantes	VAN 2015-2020 (€)	Evolution par rapport au scénario de référence (%)
Utilisateurs	538.4 milliards	0.64%
Fournisseurs	16.2 milliards	0.94%
Société	57.3 milliards	1.02%
VAN totale ajoutée	**4.2 milliards**	**0.70%**

Dans l'ensemble, les **utilisateurs** devraient bénéficier d'une création de VAN supplémentaire de 0,64% (correspondant à 3,5 milliards d'euros) par rapport au scénario de référence. Cela est dû à l'adoption supplémentaire par les utilisateurs générée par ces certifications et ces standards et à la garantie de sûreté et de fiabilité des services d'informatique en nuage qu'ils fournissent.

Les **fournisseurs de services** d'informatique en nuage sont les parties prenantes directement concernées par cette mesure. Face aux coûts supplémentaires associés à l'acquisition de ces certifications de sécurité, on estime qu'ils augmenteront leurs prix de 0,5%. Leur profitabilité resterait globalement inchangée mais ils dégageraient des revenus supplémentaires du fait de l'augmentation de l'adoption par les utilisateurs de 1% liée à la promotion de ces certifications et standards. Entre 2015 et 2020, 184 millions d'euros de VAN supplémentaire seraient générés, soit une augmentation de 0,94% par rapport au scénario de référence.

Enfin, la **société** verrait un impact similaire. Les avantages nets additionnels pour la société sont liés à des recettes de TVA plus élevées et à des impôts nets supplémentaires générés par le prix plus élevé des services d'informatique en nuage, les dépenses additionnelles et l'adoption accrue des services d'informatique en nuage dans l'Union européenne. Dans l'ensemble, 586 millions d'euros (+1,02%) de VAN seraient générés entre 2015 et 2020 par rapport au scénario de référence.

La promotion des certifications et standards a donc un impact relativement uniforme sur les cinq secteurs considérés. Le secteur de la finance et des services commerciaux comme le secteur public, de l'éducation et de la santé verraient une augmentation de 0,71%, suivis de la distribution, du commerce et de l'hôtellerie avec 0,69% et de l'industrie avec une VAN additionnelle de 0,53% entre 2015 et 2020 par rapport au scénario de référence.

Suppression des restrictions sur l'emplacement des données

L'analyse coût-avantage de la suppression des exigences relatives à l'emplacement des données pour les fournisseurs de services d'informatique en nuage montre des **avantages nets globaux** pour les utilisateurs, les fournisseurs, l'économie et la société.

Tableau 7 – Variation de la VAN pour les trois types de parties prenantes après la suppression des restrictions sur l'emplacement des données

Parties prenantes	VAN 2015-2020 (€)	Evolution par rapport au scénario de référence (%)
Utilisateurs	542.2 milliards	1.36%
Fournisseurs	19.5 milliards	21.53%
Société	57.6 milliards	1.49%
VAN totale ajoutée	**11.6 milliards**	**1.90%**

Les avantages nets pour les **utilisateurs professionnels** seraient assez limités en termes relatifs. La suppression des exigences relatives à l'emplacement des données générerait un bénéfice additionnel net de 7,2 milliards d'euros (soit 1,36%) entre 2015 et 2020 par rapport au scénario de référence. Cet effet tiendrait principalement à la réduction du prix des solutions d'informatique en nuage.

La catégorie de parties prenantes bénéficiant le plus, en termes relatifs, de l'introduction de ces mesures serait les **fournisseurs de services**. La réduction des coûts d'exploitation devrait surpasser celle des revenus. La mesure devant commencer à produire des effets à partir de 2018, les fournisseurs devraient bénéficier principalement de la réduction des coûts d'exploitation. Entre 2015 et 2020, la mesure s'élèverait à 3,5 milliards d'euros additionnels par rapport au scénario de référence, soit une augmentation de 21,53% en termes d'avantages nets. Cette augmentation significative découlerait des marges plus élevées et de l'adoption supplémentaire des services d'informatique en nuage dans l'Union.

Enfin, **l'ensemble de la société** devrait bénéficier d'avantages additionnels par rapport au scénario de référence de par l'effet combiné de :

- La réduction de TVA conséquente à la chute des prix ;
- Les impôts supplémentaires générés par la profitabilité accrue des fournisseurs ;
- Les bénéfices additionnels générés par la réduction de l'impact environnemental liée à l'adoption de solutions d'informatique en nuage.

Les cinq secteurs d'activité économique pris en compte dans cette étude devraient bénéficier de cette mesure. L'industrie en tirerait les avantages les plus importants : elle générerait 2,23% de VAN supplémentaire en 2015 et 2020, suivie de la distribution, du commerce et de l'hôtellerie qui en générerait 2,12%. La finance et le secteur public seraient également favorisés par cette mesure, avec respectivement 1,77% et 1,76% de VAN supplémentaire. Enfin, le secteur comprenant les autres industries générerait 1,42% de VAN additionnelle entre 2015 et 2020.

Combinaison des deux mesures

Si la certification de sécurité est introduite en 2017 et l'exigence relative à l'emplacement des données est supprimée à partir de 2018, l'analyse coût-avantage montre que **toutes les parties prenantes verront une augmentation significative de leurs bénéfices nets additionnels**. L'introduction de ces deux mesures pourrait créer une VAN supplémentaire de 3,25% entre 2015 et 2020 par rapport au scénario de référence.

Tableau 8 – Variation de la VAN pour les trois types de parties prenantes après l'introduction de deux mesures

Parties prenantes	VAN 2015-2020 (€)	Evolution par rapport au scénario de référence (%)
Utilisateurs	549.0 milliards	2.63%
Fournisseurs	19.9 milliards	23.57%
Société	58.5 milliards	3.15%
VAN totale ajoutée	**19.8 milliards**	**3.25%**

Au cours de la période considérée, les avantages nets supplémentaires pour les utilisateurs professionnels devraient atteindre environ 14 milliards d'euros. Ceci tiendrait principalement à l'adoption supplémentaire par les utilisateurs (+1%) associée à la certification de sécurité en 2017 et à la baisse des prix et aux réinvestissements dans les services d'informatique en nuage en 2018 (+1,04%).

Dans ce scénario, les **fournisseurs** obtiendraient les gains les plus importants (+23,57%). Les fournisseurs bénéficieraient d'avantages nets supplémentaires grâce à l'augmentation du prix des services (+0,5%) et l'adoption supplémentaire par les utilisateurs (+1%) à partir de 2017. Toutefois, l'essentiel de l'augmentation aurait lieu à partir de 2018, quand la suppression de l'exigence relative à l'emplacement des données abaisserait les coûts d'exploitation de 9%. De plus, la baisse du prix accroîtrait l'adoption par les utilisateurs d'1,04% supplémentaire. Globalement, les fournisseurs pourraient dégager des VAN additionnelles de 3,8 milliards d'euros entre 2015 et 2020.

Enfin, l'**ensemble de la société** devrait bénéficier de 3,15% de VAN supplémentaires (soit 1,8 milliards d'euros) entre 2015 et 2020. Ceci tiendrait à la baisse de TVA associée à celle des prix, aux impôts supplémentaires liés à la profitabilité accrue des fournisseurs et aux bénéfices additionnels générés par la réduction de l'impact environnemental permise par l'adoption accrue de l'informatique en nuage dans l'Union.

L'analyse ne permet pas de distinguer les différents types de fournisseurs de services, tels que PME et grandes entreprises fournissant des services d'informatique en nuage. Bien que les mesures évaluées soient susceptibles d'apporter des avantages nets aux fournisseurs de services, il est donc possible qu'elles aient un effet négatif sur certains segments pour les fournisseurs. Ainsi, il est très probable que la suppression des restrictions sur l'emplacement des données impactera négativement les petits fournisseurs de services qui utilisent l'emplacement des données comme un avantage compétitif nécessaire à leur survie dans un marché particulièrement compétitif face à leurs concurrents importants.

Une tendance similaire se dessine lors de l'examen de l'effet combiné de deux mesures sur les cinq secteurs. Tous génèrent des avantages nets additionnels après l'introduction des certifications de sécurité en 2017 et la suppression des exigences relatives à l'emplacement des données à partir de 2018. L'industrie est le secteur bénéficiant des gains de VAN les plus importants, avec 3,57% entre 2015 et 2020. La distribution, le commerce et l'hôtellerie verraient une hausse de 3,46%, suivis de près par la finance et le secteur public avec respectivement 3,12% et 3,11%. La catégorie des autres secteurs verrait une croissance de son VAN de 2,78% entre 2015 et 2020.

Malgré l'existence de barrières à son adoption, l'informatique en nuage est un marché en pleine expansion et un moteur déterminant pour la croissance en Europe. Les initiatives politiques visant à promouvoir les certifications et normes existants et à la suppression des restrictions liées à

l’emplacement des données soutiendront cette croissance, permettant ainsi d’accroître les bénéfices pour les utilisateurs et fournisseurs d’informatique en nuage et pour la société dans son ensemble (3,25% d’augmentation de la VAN par rapport au scénario de référence).

Table of Contents

Table of Figures

Table of Tables

1 Introduction

This section provides an introduction to the report, by summarising its scope and objectives, and by presenting the structure of the document.

1.1 Introduction

This report is the final report of the study on "measuring the economic impact of cloud computing in Europe".

1.2 Objective and scope of the study

The objective of the study is to *"analyse the cloud computing market in the European Union, and provide quantitative estimates, including the analysis of micro- and macro-economic as well as social and environmental impact of cloud computing in the European Union".*

The aim of this study is to provide an overview of the development of cloud computing in Europe and of the most important barriers, a description of the measures to support cloud computing implemented at EU level, and an analysis of the costs and benefits of cloud computing (and of the policy measures implemented).

The study focuses on the EU as a whole. Attention is also given to the analysis of the adoption rates and to the costs and benefits of cloud computing in different sectors of economic activity.

1.3 Structure of the report

The present report is structured as follows

- A brief introduction to the purpose and structure of the document, which also include an overview of the approach adopted for the assignment (**section one**);
- The overview of the policy measures currently undertaken by the EU to support cloud computing and a summary of the measures and initiatives for cloud computing included in the Digital Market Strategy (**section two**);
- The overview of the market trends for cloud computing in Europe, and of the main barriers to the wider adoption of cloud computing in Europe (**section three**);
- The overview of the key costs and benefits from cloud computing at both macro-economic (such as on GDP and employment) and micro-economic level (on businesses' performance), and of the approach undertaken by our study to estimate the costs and benefits from cloud computing (**section four**);
- The results of our model to the baseline scenario for measuring the economic impact of cloud computing in Europe (**section five**);
- The description of the policy measures on cloud computing implemented at EU level as part of the free flow of data initiative and the approach adopted to estimate costs and benefits of cloud computing (**section six**);

- The results of our model to the measurement of costs and benefits of measures for cloud computing as part of the free flow of data initiative (**section seven**);
- Conclusions from our study (**section eigh**t).

In addition to these chapters, there are a number of annexes:

- Acronyms and abbreviations (Annex A);
- The cloud computing professional users' Survey (Annex B);
- The cloud computing providers and intermediaries' Survey (Annex C);
- The overview of the interviews carried out (Annex D);
- The alternative scenarios and sensitivity analysis for the assessment of the costs and benefits of cloud computing in Europe (Annex E); and
- References (Annex F).

2 Policy context of cloud computing in the EU

This section presents the policy measures currently undertaken by the EU to support cloud computing and a summary of the measures and initiatives for cloud computing included in the Digital Market Strategy. Such measures represent the current policy context for the development of cloud computing in the EU.

2.1 Early policy initiatives: the EU expert group on cloud computing

Already at the early stages of the broader adoption of cloud computing the European Commission recognised the need for a coherent policy vision on cloud computing for Europe and future research and policy directions[18], in order to ensure that EU citizens, businesses and administrations could reap the full potential benefits of the cloud. An expert group was established in 2009 and in subsequent years provided vision documents on 'the future of cloud computing'[19], 'advances in cloud s'[20] as well as 'A Roadmap for Advanced Cloud Technologies under H2020'[21].

The experts observed that in 2010 cloud technologies and models had "not yet reached their full potential and many of the capabilities associated with cloud s [were] not yet developed and researched to a degree that allows their exploitation to the full degree, respectively meeting all requirements under all potential circumstances of usage". By 2012, however, the expert group noted that "Cloud computing is ubiquitous" and "most CIOs are considering cloud computing, some have converted their in-house data centres to using cloud technology, some have experimented with outsourcing parts (usually not all) of their ICT production to a public cloud and most wish for interoperable hybrid cloud s providing seamless elastic ICT resource provision". The expert group concluded that "there is no doubt that cloud s have the potential for being the next generation model of utility computing" but there remains "a wide range of concerns that need to be addressed in future cloud iterations in order to reach its full potential." The concerns identified by the expert group included notably the following points:

- There is still a lot of confusion caused by cloud computing terminology and claimed advantages;
- A central concern for all cases consists in usability of the environment affecting cloud users who will either consume the offered services or who will develop services for a cloud infrastructure, respectively even enhance the cloud environment themselves. The relevant expertise is generally lacking as to how to best exploit the cloud , which use cases apply, which

[18] See: http://ec.europa.eu/digital-agenda/en/cloud-computing-expert-group-research
[19] The future of cloud computing, Opportunities for European cloud computing beyond 2010 (2010). See: http://ec.europa.eu/information_society/newsroom/cf//document.cfm?doc_id=1175
[20] Advances in cloud s, Research in Future cloud computing (2012). See: http://ec.europa.eu/information_society/newsroom/cf//document.cfm?doc_id=1174
[21] A Roadmap for Advanced cloud Technologies under H2020 (2012). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=2165

cost models apply, which guaranteed Service Level Agreements (SLAs) and Quality of Service (QoS) can be maintained, including availability, security, privacy and dynamic elasticity;

- The European ICT industry is not characterised by some large suppliers who may compete in public cloud provision with the major US suppliers but mainly by innovative SMEs with particular skills especially in provision of software services. A major opportunity for Europe involves finding a SaaS interoperable solution across multiple cloud platforms and migrating legacy applications without losing the benefits of the cloud , i.e. exploiting the main characteristics such as elasticity;
- General ICT challenges include:
  - Large data transmission time due to inadequate bandwidth;
  - Proprietary services and programming interfaces causing lock-in;
  - Severe problems with trust, security and privacy (which has legal as well as technical aspects);
  - Varying capabilities in elasticity and scaling;
  - Lack of interoperable interfaces between cloud (resources and services) offerings and between cloud s and other infrastructures.

The expert group provided recommendations for a roadmap for further research under the Horizon 2020, the EU's biggest Research and Innovation Programme (2014-2020)[22], identifying "10 main technological topics that need to be addressed in order to create the necessary advance in the cloud environment".

While research is aimed at addressing such concerns with a focus on long-term impact, "the market continues to evolve and industrial development strives for short-term solutions that satisfy the immediate customer needs".

In 2012, and partially as a follow-up to these recommendations, the European Commission adopted the European cloud computing Strategy[23] that aimed at "enabling and facilitating faster adoption of cloud computing throughout all sectors of the economy which can cut ICT costs, and when combined with new digital business practices, can boost productivity, growth and jobs". The European cloud computing Strategy supports actions set out in the Communication on e-Commerce and online services[24] aimed at increasing trust in the Digital Single Market by "stimulating the sector and providing the legal certainty which economic operators need" and thereby enabling businesses (in particular SMEs) to make "more intensive use of online services and access to cloud computing [to] improve the productivity [..] finding new market niches [..] compete with the rest of the world".

2.2 European Cloud Computing Strategy

Cloud computing is a disruptive technology with the potential of generating substantial productivity, growth and employment, by changing the cost structure of companies, simplifying the creation of new enterprises, lowering the time to market and fostering the creation of new methods of working.

[22] See: http://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020

[23] Unleashing the Potential of cloud computing in Europe (COM(2012) 529). See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0529:FIN:EN:PDF

[24] A coherent framework for building trust in the Digital Single Market for e-commerce and online services (2011). See: http://eur-lex.europa.eu/resource.html?uri=cellar:87375c7c-1bd0-445d-b251-60599af8c73b.0009.03/DOC_1&format=PDF

It is a crucial component for the full realisation of the Digital Single Market and thus an element of the Digital Agenda for Europe[25]. The many actions to stimulate the development and adoption of cloud computing were identified already by the Single Market Pillar of the Digital Agenda and by the Single Market Act[26]. These concern several areas, such as copyright issues and access to digital content and cross-border licensing, the adoption of common standards that permit safe but seamless use of services requiring reliable identification and authorisation, data protection and the application of the Data Protection Directive[27].

Indeed, one of the key issues in relation to cloud computing identified in the European cloud computing Strategy is fragmentation of the Digital Single Market "due to differing national legal frameworks and uncertainties over applicable law, digital content and data location". In a complex environment of the management and usage of services across borders and spanning multiple jurisdictions these issues are particularly relevant in relation to building trust and ensuring security in fields such as data protection, contracts and consumer protection or criminal law.

Concerning security issues, the very recently adopted Network and Information Security Directive[28] i is a key part of the broader EU Cyber Security Strategy[29] within the third pillar (Trust and Security) of the Digital Agenda, and aims to ensure a high common level of network and information security (NIS) across the EU[30]. This legislation includes an obligation for key digital service providers (including search engines, cloud computing services and online marketplaces) to comply with the security and notification requirements under the Directive. This will undoubtedly have a significant impact on the core services provided by cloud operators who are active in the EU.

Another overarching issue is related to the available bandwidth online in relation to the transmission of large amount of data as mentioned before. To address this issue the Commission adopted the legislative package for the Connected Continent with a view to building a Single Market for Telecommunications[31], which could "boost the cloud computing market in Europe, as, among others, it aims at improving the quality of service that new services (such as cloud computing) [..] can offer"[32].

The European cloud computing Strategy identified three key areas for action in the field of cloud computing:

- **Key Action 1**: Cutting through the Jungle of Standards;
- **Key Action 2**: Safe and Fair Contract Terms and Conditions;
- **Key Action 3**: European Cloud Partnership to drive innovation and growth from the Public Sector.

The combined effect of these actions is expected to support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology. These actions contribute to address some of the main concerns and potential barriers for cloud computing, such as building trust and confidence in the technology (by the identification of

[25] See: http://ec.europa.eu/digital-agenda/
[26] See: http://ec.europa.eu/internal_market/smact/index_en.htm
[27] Directive on the protection of individuals with regard to the processing of personal data and on the free movement of such data (95/46/EC). See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31995L0046:en:HTML
[28] As adopted on 6 July 2016, see https://ec.europa.eu/digital-single-market/en/network-and-information-security-nis-directive
[29] See: http://ec.europa.eu/digital-agenda/en/news/eu-cybersecurity-plan-protect-open-internet-and-online-freedom-and-opportunity-cyber-security
[30] COM(2013) 48 final
[31] See: https://ec.europa.eu/digital-agenda/node/67489
[32] See: http://ec.europa.eu/digital-agenda/en/cloud

appropriate standards and certifications and contract terms and conditions for use), supporting adoption by public sector organisations and SMEs.

For the implementation of these actions, the European Commission has been working closely with a wide variety of stakeholders and has established different working groups.

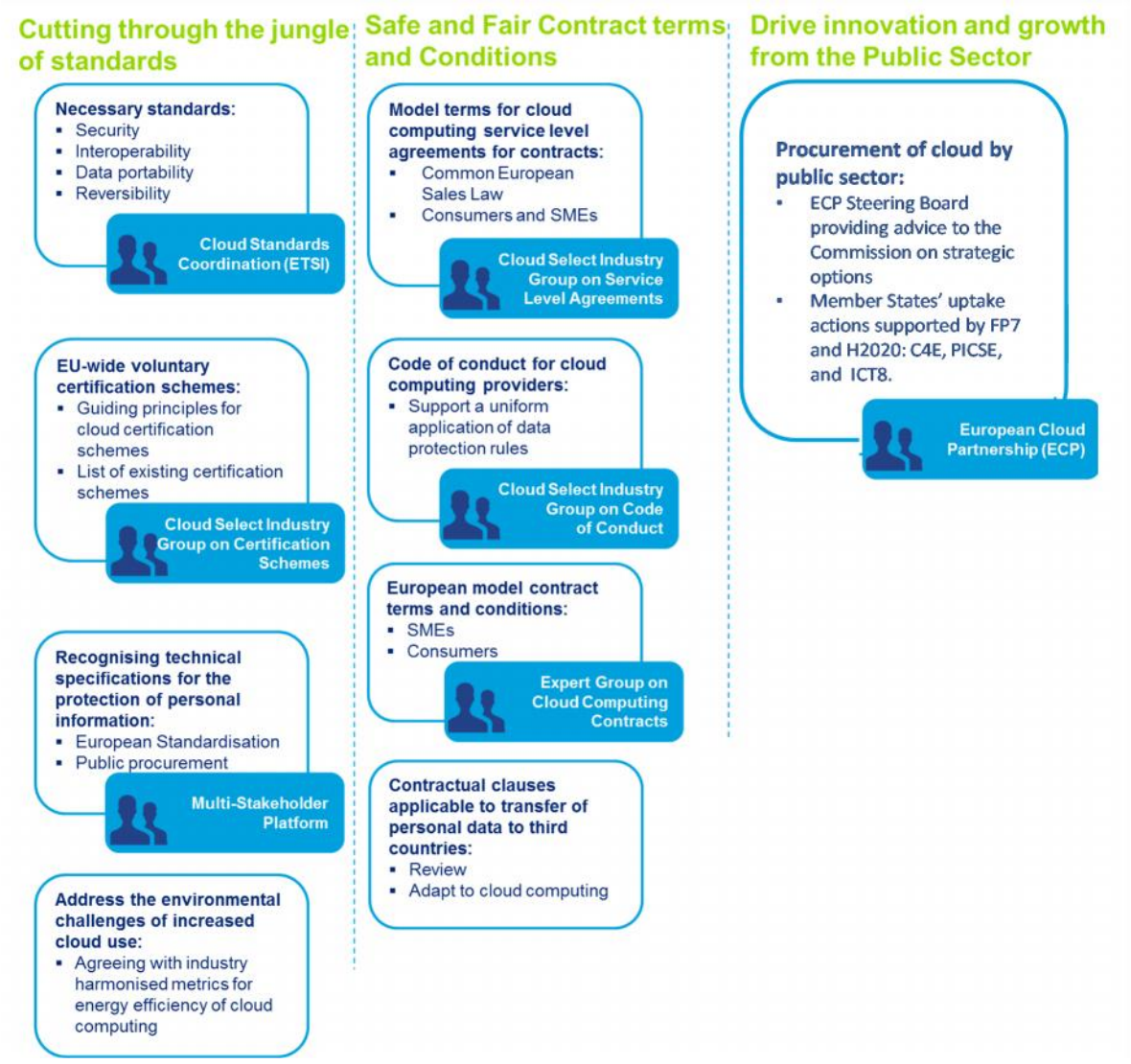


Figure 11 –Commission's working groups on cloud computing

The following sections provide an overview of the implementation of these actions.

2.2.1 Cutting through the Jungle of Standards

The first area of action under the European cloud computing Strategy aims for "a wider use of standards, the certification of cloud services to show they meet these standards and the endorsement of such certificates by regulatory authorities as indicating compliance with legal obligations".

The focus on the use of standards in cloud computing is important for several reasons:

- **Avoiding lock-in**: Individual cloud computing providers "have an incentive to fight for dominance by locking in their customers, inhibiting standardised, industry-wide approaches".

The more cloud computing providers offer their services based on proprietary solutions that do not sufficiently comply with standards, despite numerous standardisation efforts led by industry, the higher the risk of locking in customers into specific solutions and limiting the possibility for cloud users to make different cloud and IT environments work together (interoperable) and make data in the cloud portable across IT environments and between different cloud providers as well as making this data 'reversible', i.e. the ability for cloud users to retrieve all their data in a standard format at any time[33];

- **Appropriate protection of personal information**: as mentioned above, the application of data protection rules is crucial in cloud computing as cloud users allow cloud computing providers to handle (typically large amount of) their data. Therefore, recognising standards (technical specifications) concerning the handling of this data at EU level are crucial, as well as the adherence to such recognised standards by cloud computing providers;
- **Supporting (potential) cloud users to evaluate cloud computing offers**: cloud users, whether businesses (B2B), governments (B2G) or individual consumers (B2C), "are rarely able to evaluate suppliers' claims as to their implementation of standards, the interoperability of their cloud s or the ease with which data can be moved from one provider to another". Independent and trusted certification is needed in order to provide a clear and transparent view on the cloud computing services provided on by cloud computing Providers and making it easier for cloud users to compare and evaluate these offers to make the selection that best suits their needs;
- **Addressing environmental challenges of increased cloud use**: increasing the adoption of cloud computing provides important benefits for society and may also have an impact on the environment. As data flows increase and more and more information is processed over the Internet, this will impact the environment. cloud computing could help mitigate this by enabling more efficient use of hardware, as well as building data centres to use low-energy servers and green energy. To monitor this standard metrics should be agreed for the energy consumption, water consumption and carbon emissions of cloud services;

The European cloud computing Strategy includes a number of key actions to address these issues. The following sections elaborate on these actions and provide an overview of their current status.

Identify a detailed map of the necessary standards (inter alia for security, interoperability, data portability and reversibility)

The Commission requested the European Telecommunications Standards and Technology (ETSI)[34] to lead the Cloud Standards Coordination initiative (CSC)[35]. ETSI has coordinated with stakeholders in the cloud standards ecosystems (including cloud industry players, public authorities, user associations and more than 20 standards setting organisations) to work collectively on identifying a detailed map of the standards required to support EU policy in critical areas such as security, interoperability, data portability and reversibility.

[33] "Reversibility: "Customers should be able in full autonomy at any time (e.g. through night scheduling) to get back all their data, in a standard format, for a predefined cost and timescale"" See: http://docbox.etsi.org/Workshop/2012/201212_CSC/REVERSIBILITY/REVERSIBILITY.pdf
[34] http://www.etsi.org/
[35] See: https://ec.europa.eu/digital-agenda/en/etsi-cloud-standards-coordination

The CSC was carried out in two phases. Phase 1 was undertaken in 2013 and has resulted in a final report[36] addressing both standards that can help avoid lock-in and support the protection of personal information. The final report provides:

- A definition of roles in cloud computing;
- The collection and classification of over 100 cloud computing use cases;
- A list of around 20 relevant organizations in cloud computing Standardisation and a selection of around 150 associated documents, Standards & Specifications as well as Reports & White Papers produced by these organizations;
- A classification of activities that need to be undertaken by cloud Service Customers or cloud Service Providers over the whole cloud Service Life-Cycle;
- A mapping of the selected cloud computing documents (in particular standards & specifications) on these activities.

The report concluded that standardisation in the area of cloud was rather focused, *"the cloud Standardisation landscape is complex but not chaotic [..] standards are maturing in some areas (for example, for IaaS machine control, vocabularies, SLA or security) while maturation is slower in other areas*". The main issue identified is that although cloud computing standards are successfully being adopted as part of small-scale and research projects, the adoption is not wide-spread by cloud providers. The latter can be encouraged if "mechanisms are found for domain specific stakeholders to agree on shared vocabularies and formal definitions that are machine readable". In addition, a number of important gaps were identified giving rise to the need for "new cloud computing standards or cloud computing specific extensions to existing standards". These gaps include:

- **Interoperability**: "*Coverage of management protocols and interfaces is maturing, particularly regarding IaaS"* while "management specifications for PaaS and SaaS require more effort". This is a significant concern particularly for vendor lock-in;
- **Security and Privacy**: There is a *"need for a common vocabulary [and metrics] to enable the cloud service customer to express their requirements and understand the capabilities offered by a cloud service provider"*. In addition, "further standardization efforts in the area of accountability and cloud incident management (e.g., related with a SLA infringements)" are needed, which *"would greatly benefit the whole cloud supply chain"* although the main challenge of trust/security assurance remains;
- **Service Level Agreements**: Although some work is underway for standardisation of "the creation of an agreed set of terminology and definitions for Service Level Objectives, and an associated set of metrics for each service level objective" this needs to be completed and adopted by cloud service providers;
- **Regulation, Legal and Governance aspects**: "*The legal environment for cloud computing is highly challenging and a key barrier for adoption [..] there is a need for international Framework and Governance, underpinned via global standards".*

The latter remains the major challenge for which *"standardised ways of describing, advertising, consuming and verifying legal requirements is necessary [..] to accommodate both national and international (e.g. EU) legal requirements"*.

[36] Cloud Standards Coordination Final Report (2013). See: http://www.etsi.org/images/files/Events/2013/2013_CSC_Delivery_WS/CSC-Final_report-013-CSC_Final_report_v1_0_PDF_format-.PDF

The second phase of CSC was launched in February 2015 to address issues left open after phase 1. The outcomes have been finalised and presented in January 2016, in the form of a series of reports on cloud computing users' needs, Standards and Open Source, Interoperability and Security, and a Standards Maturity Assessment. It provided an overview of relevant and applicable cloud standards, but also highlighted the importance of future initiatives to address gaps in use of existing standards, the use of cloud certification schemes, adherence to legal frameworks, finalisation and use of the SLA standardisation framework (ISO/IEC FDIS 19086), and acceleration of collaborations between cloud computing stakeholders.

Recognising at EU-level technical specifications for the protection of personal information

In accordance with the new Regulation on European Standardisation[37], the European Commission has established the Multi-stakeholder Platform on ICT standardisation[38] (MSP). The MSP has been established "*as a forum for consultation of European and national stakeholders, European standardisation organisations and Member States*" with the aim to *"identify ICT technical specifications that are not national, European or international standards, but meet the requirements [of the Regulation], which may be referenced, primarily to enable interoperability, in public procurement".*

The rolling plan of the MSP includes cloud computing and notes that *"existing standards should be checked for account to the protection of individuals with regards to the processing of personal data and the free movement of such data in the light of the proposal for a General Data Protection Regulation"*[39] and refers to the need to identify or develop specific Privacy by Design standards.

The MSP organises frequent meetings to discuss and identify potential action points[40], building also on the new framework provided by the finalised General Data Protection Regulation[41].

Develop EU-wide voluntary certification schemes in the area of cloud computing

In 2013, the Commission has setup the Cloud Select Industry Group (C-SIG) on Certification Schemes (abbreviated as CERT-SIG)[42] to support the development of EU-wide voluntary certification schemes in the area of cloud computing and publish a list of such schemes.

The group consists of members of more than 30 organisations in the field of cloud computing and certification. The Commission and the CERT-SIG were supported by the European Union Agency for Network and Information Society (ENISA)[43]. The CERT-SIG defined the scope of their work as cloud computing security is concerned.

[37] Regulation on European Standardisation (EU No 1025/2012).http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:316:0012:0033:EN:PDF
[38] For more information see: http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=2758
[39] Proposal for a Regulation on the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation) (COM(2012) 11). See: http://ec.europa.eu/justice/data-protection/document/review2012/com_2012_11_en.pdf
[40] See https://ec.europa.eu/digital-single-market/en/european-multi-stakeholder-platform-ict-standardisation
[41] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC; see http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.119.01.0001.01.ENG&toc=OJ:L:2016:119:TOC
[42] See: http://ec.europa.eu/digital-agenda/en/cloud-select-industry-group-certification-schemes
[43] See: http://www.enisa.europa.eu/activities/Resilience-and-CIIP/cloud-computing

ENISA published a working paper in 2013[44] summarising the CERT-SIG work on a list of 'guiding principles' for cloud certification schemes and a first list of existing security certification schemes, and setting out a project plan for further steps of the CERT-SIG to deliver their work.

Based on that project plan, ENISA and CERT-SIG published a validated list of identified security certification schemes (Cloud Certification Schemes List (CCSL)) in February 2014. The list is maintained on ENISA's cloud Certification page[45].

CCSL is a list of (existing) certification schemes, relevant for cloud computing customers. CCSL provide potential customers with an overview of objective characteristics per scheme, to help them understand how the scheme works and if it is appropriate for their setting.

In November 2014, ENISA also delivered a tool that can be used in addition to CCSL, a cloud Certification Schemes Metaframework[46] (CCSM) that provides *"a neutral high-level mapping from the customer's Network and Information Security requirements to security objectives in existing cloud certification schemes, which facilitates the use of existing certification schemes during procurement"*.

The CCSM is based on "*relevant public sector requirements*" and aimed at "*experts in the public sector involved with procurement of cloud computing services*". cloud providers and industry experts can also make use of this framework as it provides an overview of relevant public sector requirements across a number of EU countries. This first version is restricted to network and information security requirements, and covers 27 security objectives, mapped to five cloud certification schemes. As a next step, the CCSM could be expanded to include NIS requirements from other countries and NIS requirements specific for personal data protection.

Environmental challenges of increased cloud use

In 2013, the ICT footprint project delivered a report on pilot testing on methodologies for energy consumption and carbon footprint of the ICT-sector[47]. This project was conducted in relation to key action 12 of the Digital Agenda for Europe concerning the compliance of the ICT sector to adopt common measurement methodologies for the sector's own energy performance and greenhouse gas emissions. The project tested 10 methodologies and looked at their compatibility and workability for ICT companies.

Several companies have tested the methodologies, including for cloud hosting services. *"They have concluded that the methodologies form a coherent framework and that more detailed guidance could be required"*[48]. Further actions are being carried out under the initiative for Single Market for Green Products in Europe aimed at *"promoting common methods for the measurement of the environmental footprint of all products and organisations (including ICT)"*. A three year piloting phase started in 2013 after which further relevant measures may be proposed.

[44] See https://resilience.enisa.europa.eu/cloud-computing-certification/certification-in-the-eu-cloud-strategy
[45] See: https://resilience.enisa.europa.eu/cloud-computing-certification
[46] See: https://resilience.enisa.europa.eu/cloud-computing-certification/Cloud_Certification_Schemes_Metaframework_version_1.2.pdf
[47] ICT footprint Pilot testing on methodologies for energy consumption and carbon footprint of the ICT-sector (2013). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=1710
[48] See: https://ec.europa.eu/digital-agenda/en/pillar-vii-ict-enabled-benefits-eu-society/action-69-assess-whether-ict-sector-has-complied-common

2.2.2 Safe and Fair Contract Terms and Conditions

The second area of action under the European Cloud Computing Strategy is aimed at "identifying and disseminating best practices in respect of model contract terms [that] will accelerate the take up-of cloud computing by increasing the trust of prospective customers".

The European Cloud Computing Strategy identified several reasons for which the focus on contract terms in cloud computing is important:

- **Ensuring a trusted relationship between cloud providers and cloud users**: cloud computing contracts often do not provide transparent clauses for liability, data integrity, confidentiality or service continuity. The use of transparent Service Level Agreements (SLAs) is key as the basis of a trust relationship between cloud providers and cloud users. The SLA specifies the technical conditions of service delivery (e.g. the extent of guaranteed availability as a percentage), and should enhance the trust of cloud users in the ability of the cloud provider to deliver services based on agreed terms. This is particularly important for professional users of cloud computing;
- **Providing safe and fair contract terms and conditions for cloud users**: There is a general lack of awareness among (potential) cloud users of their rights following from the applicable law and jurisdiction in civil and commercial matters (notably contract law) as well as what constitutes safe and fair conditions in the domain of cloud computing. Cloud computing contracts are often complex and accompanied with SLAs with extensive disclaimers. This represent serious issues for cloud users as contracts may impose conditions such as the choice of applicable law or inhibit data recovery. Whereas standard contracts can be cost-saving for cloud providers, such a 'take-it-or-leave-it' approach is often undesirable for the user and even larger professional users (companies) have little negotiation power. It is therefore important to standardise and propose to consumers and small firms European model contract terms and conditions for those issues that fall within the Common European Sales Law proposal[49] as well as beyond. The latter concerns issues such as data preservation after termination of the contract, data disclosure and integrity, data location and transfer, direct and indirect liability, ownership of the data, change of service by cloud providers and subcontracting. Therefore identifying safe and fair terms for such matters and developing European model contract terms as well as disseminating the best practices would help to create transparent and fair cloud services contracts and "accelerate the take up-of cloud computing by increasing the trust of prospective customers";
- **Ensuring data protection for the geographical and technical realities of cloud computing**: as mentioned, ensuring data protection is a crucial concern for cloud users (in particular for sectors such as the public sector, healthcare and legal services, media and entertainment, financial services, etc.)[50]. To support this the Commission together with industry worked on a code of conduct to support a uniform application of data protection rules;
- **Facilitate Europe's participation in the global growth of cloud computing**: The proposed Regulation on personal Data Protection aims to "guarantee a high level of protection for individuals by ensuring continuity of protection when data is transferred outside the EU and EEA". For these standard contractual clauses governing international data transfers as well as

[49] Regulation on a Common European Sales Law (COM(2011) 635). See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0635:FIN:en:PDF

[50] Establishing a Trusted cloud Europe (2014). See: http://ec.europa.eu/digital-agenda/sites/digital-agenda/files/discussions/TrustedCloudEurope_3.pdf

establishment of the necessary conditions for the adoption of cloud -friendly Binding Corporate Rules for cloud providers are necessary.

The European cloud computing Strategy includes a number of key actions to address these issues. The following sections elaborate on these actions and provide an overview of their current status.

Developing model terms for cloud computing SLAs together with stakeholders

The Commission established the Cloud Select Industry Group on Service Level Agreements (C-SIG SLA)[51] in 2013 to develop together with stakeholders model terms for cloud computing SLAs for contracts between cloud providers and professional cloud users.

The Commission together with the C-SIG SLA have delivered in 2014 standardisation guidelines for cloud SLAs[52]. The aim of these guidelines is to improve clarity and understanding of cloud SLAs in the market by standardising specific aspects of SLAs as well as providing information on the concepts usually covered by an SLA.

The guidelines provide an extensive cloud SLA vocabulary with key terms and an overview of different kinds of service level objectives:

- **Performance service level objectives**: availability, response time, capacity, capability, support, reversibility and termination;
- **Security service level objectives**: reliability, authentication and authorisation, cryptography, security incident management and reporting, logging and monitoring, auditing and security verification, vulnerability management and governance;
- **Data Management Service Level Objectives**: data classification, cloud service customer data mirroring, backup & restore, data lifecycle and portability;
- **Personal Data Protection Service Level Objectives**: Codes of conduct, standards and certification mechanisms, purpose specification, data minimisation, use, retention and disclosure limitation, openness, transparency and notice, accountability, geographical location of cloud service customer data, and intervenability.

The guidelines are intended to be used by professional cloud users when agreeing on an SLA with cloud providers. Another recommendation is that such standardisation is best done at international level based on international standards (such as ISO/IEC 19086[53]), for which the C-SIG SLA has established a liaison with the International Standardisation Organisation (ISO) ISO/IEC JTC1 cloud computing Working Group[54] and have provided the guidelines as input from the European perspective and contribution to the ISO/IEC 19086 project.

The European Commission has furthermore conducted a study that has produced model terms for SLAs, along with an SLA checklist[55]. Further interactions with stakeholder groups and cloud industry will be needed to ensure that the model terms are adopted in practice. EU research activities working around cloud SLAs (SPECS, SLALOM, A4Cloud, etc.) should also be engaged to ensure that advanced use cases such as automated comparison and negotiation can be supported.

[51] See: https://ec.europa.eu/digital-agenda/en/cloud-select-industry-group-service-level-agreements
[52] Cloud Service Level Agreement Standardisation Guidelines (2014). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?action=display&doc_id=6138, and https://ec.europa.eu/digital-agenda/en/news/cloud-service-level-agreement-standardisation-guidelines
[53] See: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=601355
[54] See: http://www.iso.org/iso/jtc1_sc38_home
[55] See http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=10860

Uniform safe and fair contract terms and conditions

The Commission has proposed a Regulation for a Common European Sales Law[56] to overcome issues stemming from the fact that the buying and selling of goods in the EU is governed by different national contract laws making cross-border trade more complex and costly than domestic trade. This situation "hinders traders and consumers who want to engage in cross-border trade within the internal market". In particular, traders (SMEs especially) are dissuaded to enter into cross-border trade or expanding into new Member States' markets and consumers from accessing products in other Member States. The proposal would give traders "the choice to sell their products to citizens in another Member State on the basis of a single set of contract law rules which would stand as an alternative alongside the national contract law of each Member State. Parties to a cross-border sales contract anywhere in the EU would be able to choose, by express agreement, to apply the Common European Sales Law."[57]

Consumers and companies are often "reluctant to take advantage of cloud computing services either because contracts are unclear or are unbalanced in favour of service providers".[58] This is due to the fact that in addition to differences in national contract laws these "may not always be adapted to cloud - based services". In order to adapt contract law to the specific cloud environment the Commission setup the Expert Group on cloud computing Contracts (EGCCC)[59] in 2013 to "define safe and fair conditions and identify best practices for cloud computing contracts". The EGCCC has since delivered a number of working papers on the following topics:

- **Availability of service**: "availability of service is a key element of cloud service contracts" dealing with the event of a cloud user not being able to "access his data, a server is down or the software cannot be accessed, a service is unavailable; this may trigger certain contractual consequences, depending on what has been agreed upon by the parties in the contract as regards the functionalities and features of the services".[60]
- **Liability (including remedies)**: failure of a cloud service may impact many cloud users at the same time, which leaves the cloud providers potentially exposed to multiple liabilities. For cloud providers it is often difficult to assess "their potential liability and financial risks resulting from a failure of the service". When cloud services do not function properly. Cloud users should be entitled to "remedies which properly address the loss/inconvenience incurred". Striking a balance between the rights of users and business stability of providers is key.[61]
- **Control and use of content**: cloud providers experience legal uncertainty due to "differences at national level (e.g. varying implementation of optional copyright exceptions)" within the EU and in third countries. Providers need to understand the content of the different applicable rules and identify their scope in relation to the type of user content (e.g. personal data, trade secrets, content protected by copyright, trademark, databases rights or professional confidentiality standards). Therefore, "many providers offer detailed clauses on control of data to reduce legal uncertainty" which can result in contract clauses that may "contravene

[56] Regulation on a Common European Sales Law (COM(2011) 635). See: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011PC0635&from=en
[57] See: http://ec.europa.eu/justice/contract/cesl/index_en.htm
[58] See: http://ec.europa.eu/justice/contract/cloud-computing/index_en.htm
[59] See: http://ec.europa.eu/justice/contract/cloud-computing/expert-group/index_en.htm
[60] EGCCC Working Paper on Availability (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/availability_working_paper_en.pdf
[61] EGCCC Working Paper on Liability for non-performance including remedies (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/liability_working_paper_en.pdf

applicable national rules relating to confidentiality, IP rights, consumer or general contract law".[62]

- **Switching – transfer and deletion of data after the end of the relationship**: when cloud users wish to change cloud providers this is usually allowed under the contract "at any time for any reason" however the conditions are often not clear or a payment may be required. There is a risk for cloud users to lose their data stored on the cloud as they may not be able to retrieve it. "As most cloud contracts which are offered to consumers and small businesses are not negotiable, users depend on the contractual switching rights and modalities provided by the respective cloud provider".[63]

In addition, the EGCCC has also provided discussion papers on these topics and others including subcontracting[64], audit and reporting[65], data transfer in the cloud[66], and data disclosure and integrity[67].

The Commission also launched a comparative study on cloud computing contracts[68] to supplement the work of the Expert Group; their final report was published in 2015. The study covers the EU Member States and the United States and serves as a "knowledge base to understand to which extent the existing laws, case law and administrative guidance apply to cloud computing contracts" and assesses the extent to which "key contractual legal issues which are typically mentioned in relation to the cloud ,are adequately dealt with by existing national law or case law, or, as the case may be, by guidelines issued by administrative authorities".

[62] EGCCC Working Paper on Control and Use of Content (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/control_use_working_paper_en.pdf
[63] EGCCC Working Paper on Switching – transfer and deletion of data after the end of the relationship (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/switching_working_paper_en.pdf
[64] EGCCC Discussion Paper on subcontracting (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/expert_group_subcontracting_discussion_paper_en.pdf
[65] EGCCC Discussion Paper on audit and reporting (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/dp_audit_reporting__cloud_services_en.pdf
[66] EGCCC Discussion Paper on data transfers in the cloud (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/discussion_paper_data_transfers_in_cloud.pdf
[67] EGCCC Discussion Paper on data disclosure and integrity (2014). See: http://ec.europa.eu/justice/contract/files/data_disclosure__integrity_en.pdf
[68] Comparative study on cloud computing contracts (2015). See: http://bookshop.europa.eu/en/comparative-study-on-cloud-computing-contracts-pbDS0115164/

Agreeing with industry on a Code of Conduct for uniform application of data protection rules

The recently finalised General Data Protection Regulation (GDPR)[69]will ensure that the EU data protection rules can more effectively and efficiently cater for the geographical and technical features of cloud computing, taking into account the opinions and Guidelines of the Article 29 Working Party (to be succeeded under the GDPR by the European Data Protection Board).

Within the scope of the Data Protection Directive the Article 29 Data Protection Working Party[1] was established to:

- Provide expert opinion from member state level to the Commission on questions of data protection;
- Promote the uniform application of the general principles of the Directives in all Member States through co-operation between data protection supervisory authorities;
- Advise the Commission on any Community measures affecting the rights and freedoms of natural persons with regard to the processing of personal data and privacy;
- Make recommendations to the public at large, and in particular to Community institutions on matters relating to the protection of persons with regard to the processing of personal data and privacy in the European Community.[1]

In the context of cloud computing the Commission has established the cloud Select Industry Group on Code of Conduct (C-SIG CC) in 2013 to agree on a code of conduct for cloud computing providers that "would support a uniform application of data protection rules and may be submitted to the Article 29 Working Party" for approval. [70] "The purpose of the Code of Conduct is to assist prospective cloud users in evaluating whether personal data under the Cloud Service Agreement is processed with an appropriate level of data protection, and to help cloud service providers to comply with the data protection framework".[71]

An initial version of the Code of Conduct was finalised within the C-SIG and submitted to the Article 29 Working Party in February 2014. Following a first round of feedback, a second draft was developed and submitted in January 2015. Further feedback and revisions[72] were made thereafter, principally to strengthen the governance of the Code and to align it better with the terms of the now finalised GDPR. At present, the C-SIG is examining cooperation options with existing cloud certification scheme operators, in order to be able to benefit from their expertise in administering and applying such frameworks in the market.

In parallel, two other Codes were developed by some stakeholders. One was drafted by the cloud Security Alliance, which was already final but then it was taken back to include the GDPR requirements. Another one is the Cloud Infrastructure Services Providers of Europe (CISPE), which is registered in the Transparency Register, and it is also aimed to be incorporated as an association[73]. The latter is argued to be specifically tailored for the IaaS market, and it also argues to answer to all questions that infrastructure providers had, which are very different than SaaS providers (because data management is different between the two types of providers). CISPE arguably gives a strong voice to SMEs and thus has a majority of SMEs and a majority of EU headquartered companies in the governance body, with the aim to "defend firstly the interests of European industry". The CISPE is based on the C-SIG Code

[69] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC; see http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.119.01.0001.01.ENG&toc=OJ:L:2016:119:TOC
[70] See: https://ec.europa.eu/digital-agenda/en/cloud-select-industry-group-code-conduct
[71] See: http://ec.europa.eu/justice/fundamental-rights/files/2014_charter_staff_working_document_en.pdf
[72] The CC as modified to take into account A29WP Opinion is available at: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=11194
[73] 56The Code was supposed to be made public at the end of June 2016 but it was still not available at the moment of finalisation of the present report.

of Conduct. At the C-SIG plenary meeting in June 2016 there was no agreement reached about how the three codes would apply in practice or how they would refer or interact with each other.

Facilitate Europe's participation in the global growth of cloud computing

In order to facilitate Europe's participation in the global growth of cloud computing, the European cloud computing Strategy calls for a review of standard contractual clauses applicable to transfer of personal data to third countries and adapting these to cloud computing, as well as calling upon national data protection authorities to approve Binding Corporate Rules for cloud providers. This work has presently not yet been entirely completed. While work at the EU level has been initiated based on a specific set of standard contractual clauses for processor–to-sub-processor transfers developed by the Spanish data protection authority, the resulting draft model clauses[74] have been adopted by the Working Party, but are still to be formally adopted by the European Commission. As a result, they can therefore not be used yet by cloud providers across the EU.

Binding Corporate Rules (BCR) are "internal rules (such as a Code of Conduct) adopted by multinational group of companies which define its global policy with regard to the international transfers of personal data within the same corporate group to entities located in countries which do not provide an adequate level of protection"[75] and are as such "one means to allow for legal international data transfers: they govern in an enforceable manner how the different parts of a corporation, regardless of their international location, deal with personal data".[76] A BCR should include in particular privacy principles (transparency, data quality, security, etc.), tools of effectiveness (audit, training, complaint handling system, etc.) and an element proving that BCR are binding. For a Commission draft[77] of such rules, the relevant Article 29 Working Party opinions and recommendations will serve as a basis.

In 2013, last revised in May 2015, the Article 29 Working Party on Data Protection published a Working Document on Processor Binding Corporate Rules[78] regarding data transfers outside the EU. The working document states that "guaranteeing a continuously adequate level of protection with the use of available tools for framing international data transfers [..] is proving difficult, which is mainly due to the increasing number and complexity of international data transfers" including in the realm of cloud computing. Given that industry has "been constant in its request for a new legal instrument that would allow for a global approach to data protection [..] and officially recognise internal rules organisations may have implemented". The Working Party adopted the Working Document to provide the elements and principles to be found in BCRs for Data Processors[79] and an application form for submitting binding corporate rules for Processors[80]. The objective of these initiatives is to facilitate the conclusion and approval of BCRs, including in the cloud computing sector; at present, the procedural formalities

[74] See http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2014/wp214_en.pdf
[75] See: http://ec.europa.eu/justice/data-protection/document/international-transfers/binding-corporate-rules/index_en.htm
[76] c.f. European cloud computing Strategy
[77] See http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2012/wp195_en.pdf for the main elements and principles to be contained in BCRs
[78] Explanatory Document on the Processor Binding Corporate Rules (2013-215). See: http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2015/wp204.rev_en.pdf
[79] Working Document 02/2012 setting up a table with the elements and principles to be found in Processor Binding Corporate Rules (2012). See: http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2012/wp195_en.pdf
[80] Application form for approval of Binding Corporate Rules for the transfer of personal data for processing activities (2012). See: http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2012/wp195_application_form_en.doc

surrounding BCRs have made the instrument principally useful and feasible to a relatively limited set of large undertakings[81].

Industry needs legal certainty when it comes to international data transfers and this applies to cloud computing services given that many times data is stored in another jurisdiction than the one where the data is generated. With respect to legal mechanisms for transferring EU personal data, companies have hugely relied on the Safe Harbour agreement which was struck down by the ECJ in 2015. Its replacement, the Privacy Shield adopted in July 2016, besides better responding to the concerns expressed in regards to the Safe Harbour Agreement, is considered more flexible, more convenient and less costly to implement than standard contractual clauses and binding corporate rules. Moreover, the latter are being challenged[82] by the Irish Data Protection Authority, as they may suffer from the same deficiencies raised by the EJC in regards to the Safe Harbour Agreement. The BCRs are arguably considered inadequate, given that they are private contracts with little transparency, therefore self-certification under the Privacy Shield is considered to better respond to the privacy protection for international data transfers.

The recently adopted GDPR, which enters into force on 25 May 2018, continues to support the future use of both standard contractual clauses and BCRs to establish lawful transfers of personal data to third countries (including in a cloud computing context). Furthermore, the GDPR streamlines the procedures for applying these mechanisms in practice, especially in relation to BCRs, through an improved harmonisation of their substance and by formalising a consistency mechanism at the EU level to facilitate their approval. This should alleviate the impact of some of the barriers to the free flow of data, including for cloud services.

2.2.3 European cloud Partnership to drive innovation and growth from the Public Sector

The third key action of the European Strategy on cloud computing focuses on the public sector, and on its key role in shaping the cloud computing market. As one of the main players in the area, public organisations can contribute greatly to the development of cloud computing, by setting requirements, fostering service integration and giving citizens the best value for money. Under the support of the Commission, the European Cloud Partnership (ECP)[83] brought together industry expertise and public sector users to work on common procurement requirements for cloud computing in an open and transparent way. Via the exchange of best practices, the ECP aimed at changing the mind-set of procurers, stimulating cloud adoption and gradually converging requirements for public procurement of cloud computing.

In 2014, the ECP provided a policy vision document on establishing a Trusted Cloud Europe[84] that assessed the different legal, technical, operational or economic barriers that may impede the adoption of cloud computing depending on the type of data, type of service, and need for enforcement. The report presented different cloud use cases across different sectors (including the public sector, healthcare and

[81] See http://ec.europa.eu/justice/data-protection/document/international-transfers/binding-corporate-rules/bcr_cooperation/index_en.htm for a list of users of BCRs.
[82] See: https://www.dataprotection.ie/docs/25-05-2016-Statement-by-this-Office-in-respect-of-applicationfor-Declaratory-Relief-in-the-Irish-High-Court-and-Referral-to-the-CJEU/1570.htm
[83] See: https://ec.europa.eu/digital-agenda/en/european-cloud-partnership
[84] Establishing a Trusted cloud Europe (2014). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=4935

legal services, media and entertainment, financial services) highlighted the need for a common framework of best practices as well as systematic consensus building among stakeholders.

The general strategic objective of the Trusted Cloud Europe report was to gradually remove barriers to the cross border use of cloud computing, thus ultimately supporting the Digital Single Market. While the ECP's activities concluded after the publication of the TCE report, the European Commission ran a survey to assess the wider opinion of the TCE report[85]. The conclusions from the TCE report and analysis of the accompanying survey have been taken into account when establishing priorities for the Digital Single Market Strategy for a European Cloud Initiative and European Research Open Science Cloud.

2.2.4 Additional actions

In addition to the above described initiatives, the Commission will also implement its own cloud plan under the eCommission strategy[86], including a programme of actions to move public services implemented under other Community programmes into the cloud. In December 2014 The Directorate-General for Informatics (DG DIGIT) launched a call for tender, cloud 1, for the procurement of cloud services by EU Institutions[87]. Furthermore, the Commission has published a Communication[88] "Towards a thriving data-driven economy", which also sets out current and future activities in the field of cloud computing. The support to research on cloud computing is also a crucial element of the Commission's activities in the field. Within the 2013 Work Programme, the Commission committed about EUR 10 million for research activities on cloud computing, which funded the activity of the ECP and lead to the set-up of the cloud for Europe project[89] as an instrument to address the objectives of the ECP and to support the realisation of the European Cloud Computing Strategy for the public sector. The Cloud for Europe project is led by a Consortium with 24 members from 12 countries and its main objectives are identifying obstacles for cloud use in the public sector, defining services that overcome these obstacles and procuring research from industry to find innovative solutions for cloud services. Its objectives and activities are directed to the public sector, as it has a key role in the adoption of cloud computing in Europe and in the creation of the right conditions for citizens and businesses (including SMEs).

Under the Horizon 2020 programme, the Commission has given strong emphasis to cloud computing. The 2015 work package has provided EUR 22million of support for the development of cloud computing services in public sector innovation, mostly under the activities: ICT 7 – 2014 (Advanced Cloud Infrastructures and Services and ICT 8 – 2015 (Boosting public sector productivity and innovation through cloud computing services)[90]. International dialogue on issues relevant for cloud computing development will be undertaken with third countries that have already developed or are developing a strategy for cloud computing, such as the US, Japan, Canada, Australia and South East Asia countries. Dialogue will be pursued in international fora such as the WTO and the OECD to advance common objectives for cloud computing and key related themes including data protection, access to data by law enforcement agencies, liability of intermediate service providers, etc. In addition, specific activities (and funding) on international cooperation on cloud computing have been foreseen under the Work

[85] Trusted Cloud Europe Survey - Assessment of Survey Responses (2014). See: https://ec.europa.eu/digital-agenda/en/news/trusted-cloud-europe-survey-assessment-survey-responses
[86] See: http://ec.europa.eu/dgs/informatics/ecomm/index_en.htm
[87] DIGIT/R2/PO/2014/043 cloud services. See: http://ted.europa.eu/udl?uri=TED:NOTICE:440399-2014:TEXT:EN:HTML
[88] COM(2014) 442 final
[89] See: http://www.cloudforeurope.eu/
[90] See: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-leit-ict_en.pdf

Programme 2014-2015 of Horizon 2020 with Brazil (EUB 1 2015, in the area of Cloud Computer Security) and with Japan (EUJ 1 2014, in the areas of bid data, Internet of Things and cloud computing)[91].

2.3 Digital Single Market Strategy

On 6 May 2015, the Commission adopted the Digital Single Market Strategy for Europe[92] that aims to "ensure that Europe maintains its position as a world leader in the digital economy" and help "European companies to grow globally". The Strategy is composed of three main pillars:

- **Better access for consumers and businesses to online goods and services across Europe**: which require the removal of "key differences between the online and offline worlds to break down barriers to cross-border online activity";
- **Creating the right conditions for digital networks and services to flourish**: which requires "high-speed, secure and trustworthy infrastructures and content services, supported by the right regulatory conditions for innovation, investment, fair competition and a level playing field";
- **Maximising the growth potential of our European Digital Economy**: which requires "investment in ICT infrastructures and technologies such as cloud computing and Big Data, and research and innovation to boost industrial competiveness as well as better public services, inclusiveness and skills".

The second pillar is crucial to establish a key enabler to the adoption of cloud computing by ensuring "a strong, competitive and dynamic telecoms sector to carry out the necessary investments, to exploit innovations such as cloud computing". The third pillar is aimed at the "integration of digital technology by businesses" which it identifies as the weakest element to maintain the EU's competitiveness. This pillar is aimed at building a data economy, given that data is considered "a catalyst for economic growth, innovation and digitisation across all economic sectors, particularly for SMEs (and start-ups) and for society as a whole". As such, cloud computing services (as well as Big Data and the Internet of Things) "are central to the EU's competitiveness".

Market fragmentation is one of the major hurdles as it hinders providing "sufficient scale for cloud computing [..] to reach full potential in Europe". Benefiting fully from the potential of digital and data technologies requires removing "a series of technical and legislative barriers" such as:

- **Data location restrictions**: "(i.e. Member States requirements to keep data inside their territory) force service providers to build expensive local infrastructures (data centres) in each region or country";
- **Fragmented implementation of copyright rules**: result in a "lack of clarity over rights to use data further obstruct the development of cross-border data use and new applications of technologies";
- **Lack of open and interoperable systems and services and of data portability between services**: are a barrier to "the cross-border flow of data and the development of new services".

Concerning cloud computing in particular this means that business and consumers "still do not feel confident enough to adopt cross-border cloud services for storing or processing data, because of concerns relating to security, compliance with fundamental rights and data protection more generally". Remaining issues with contracts excluding or limiting the liability of the cloud provider "means that the

[91] Ibid.
[92] Communication on a Digital Single Market Strategy for Europe (2015). See: http://ec.europa.eu/priorities/digital-single-market/docs/dsm-communication_en.pdf

data is effectively not portable". While the "current and the future legislative frameworks prevent restrictions to the free movement of personal data within the Union" so that Member States may not inhibit the free movement of personal data on grounds of privacy and personal data protection they may still do so for other reasons. The Strategy therefore aims to prevent and remove "any unnecessary restrictions regarding the location of data within the EU". To this end the Commission will:

- "Propose in 2016 a European 'Free flow of data' initiative that tackles restrictions on the free movement of data for reasons other than the protection of personal data within the EU and unjustified restrictions on the location of data for storage or processing purposes".

This initiative is intended to address issues related to "unjustified data location restrictions" and "ownership, interoperability, usability and access to data in situations such as business-to-business, business to consumer, machine generated and machine-to-machine data". In addition, the Commission will "launch a European Cloud Initiative including cloud services certification, contracts, switching of cloud services providers and a research open science cloud".

Within the same pillar aimed at maximising the growth potential of the European Digital Economy the Commission aims to boost competitiveness through interoperability and standardisation. Standardisation can "help steer the development of new technologies" such as cloud services but it requires "an increased effort to ensure that standardisation output keeps pace with changes in technologies" and defining "missing technological standards that are essential for supporting the digitisation of our industrial and services sectors" including cloud computing. To this end the Commission will:

- "launch an integrated standardisation plan to identify and define key priorities for standardisation with a focus on the technologies and domains that are deemed to be critical to the Digital Single Market, including essential sectoral interoperability and standards", and
- "revise and extend the European Interoperability Framework"

Within the package of Communications on the Digital Single Market as announced by the Commission on the 19th April 2016, the objectives of the Free Flow of Data initiative were confirmed[93] as being to *"ensure that data can circulate without obstacles within the Union by removing unjustified restrictions to the location of data and by addressing emerging issues on 'data ownership', (re)usability and access to data (including research data), and liability amongst others in relation to the Internet of Things."* The same document evidenced opinion from certain stakeholders that obstacles relevant in the context of data flow and access to data were:

- Uncertainties as regards data ownership in relation to non-personal data-driven;
- Uncertainty as regards data ownership;
- Restrictions to data location; and
- Obstacles linked to data interoperability and reliability.

The Free Flow of Data initiative applies equally to cloud based solutions. Therefore, a key objective of this study is to assess to what extent the envisaged cloud actions support the objectives of the DSM Strategy, and what the anticipated impact would be.

The package of Communications on the Digital Single Marked launched on the 19th April 2016 by the Commission also included measures on security certifications, switching of cloud service providers and

93 SWD(2016) 110/2

research cloud, and on ICT standardisation. Both those Communications and related initiatives are part of a comprehensive package, designed to enhance the EU's position in the global, data-driven economy.

The Communication on the European Cloud Initiative[94] aims at '*building a competitive data and knowledge economy in Europe*', and focuses on the role of Open Science and Open Data to support scientific knowledge and innovation in the EU, and ultimately economic growth. It identifies five main issues preventing the EU from fully achieving the potential of data for innovation, namely:

- Lack of awareness, incentives and clear legal basis for sharing data;
- Lack of interoperability of computer systems within the scientific community;
- Fragmentation of data infrastructures among different domains and Member States
- The lack of High-Performance Computing (HPC) infrastructure to process data (only one out of ten HPC infrastructures is located in Europe); and
- Requirements on the use and re-use of personal data under EU data protection rules.

The European Cloud Initiative proposes a set of solutions to deal with the issues identified, namely:

- Establishing the European Open Science Cloud:
- Implementing a European Data Infrastructure; and
- Measures to extend access to and trust in Open Science Cloud.

The **European Open Science Cloud (EOSC)** would offer 1.7 million researchers and 70 million professionals in science and technology cloud-based services, for the storage, analysis and re-use of research data within the EU. It would also be available for education and training purposes, primarily for higher education institutions. In particular, the EOSC would make all data produced the Horizon 2020 Programme, open by default. To improve the interoperability of systems, it would also create a fit-for-purpose governance structure across the EU and provide specifications for data sharing across disciplines and infrastructures. The initiative states that privacy and data protection would be based on recognised standards and guaranteed by design of the EOSC. The EC aims to connect priority European research infrastructures to the EOSC by 2017.

The **European Data Infrastructure (EDI)** intends to provide a high-performance computing (HPC) framework with the capability to support the EOSC. These supercomputers will connect to mid-range EU national computing centres and to software infrastructure to offer what is basically supercomputing-as-a-service across the EU. The framework will be developed from 2016 to 2020. The EDI would also be accompanied by a large-scale initiative to develop supercomputing through quantum technology, to begin by the end of 2017.

Over time, the EOSC and the EDI will **be extended to the public sector and industry**. Suggested uses of the proposals include piloting so-called e-Government schemes. The EC acknowledges the production of more data will present challenges in terms of compliance with data protection law. It suggests that data transfers will be dealt with through a certification scheme, whereby binding and enforceable commitments must be made by the transferor to apply the appropriate safeguards to the transferred data, in line with the new General Data Protection Regulation (GDPR).The aim is to widen access to the EOSC and EDI to the public sector by 2020.

[94] COM(2016) 178 final

The Communication on ICT Standardisation Priorities for the Digital Single Market[95] is another component of the package of Communications adopted by the Commission on 19th April 2016 and builds on Regulation 1025/2012 and is linked to the Joint Initiative on Standardisation[96] that is part of the Single Market Strategy[97].

This Communication focuses on two pillars. On the one hand, it aims to guarantee a fresh approach to standards in five domains identified as especially relevant: 5G, Internet of Things, Cybersecurity, Cloud and Big Data. On the other, it tries to ensure that all forces in Europe pull in the same direction, using standardisation as a strategic instrument to EU industrial policy.

Within the first pillar, a specific set of actions focuses on cloud computing. In detail, two main actions are set for cloud computing. The Commission intends to support the development and adoption of ICT standards improving the portability of cloud computing services, by increasing the use of open source elements in the standard setting process of Standards' Development Organisations, by the end of 2016. Furthermore, the Commission intends to increase transparency and quality of cloud computing services for final users (especially SMEs) by supporting the finalisation of international standards on service leval agreements by mid-2017.

As part of the second pillar, the Commission suggests a multi-stakeholders strategy and process to achieve the prioritised actions, which builds on and complements the European Multi-Stakeholders Platform, the ICT Rolling Plan on ICT Standardisation and the Annual Union Work Programme for European Standardisation.

[95] COM(2016) 176 final
[96] See: http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8852&lang=it
[97] See: https://ec.europa.eu/growth/single-market_en

3 Current situation: cloud computing in Europe

This section presents overview of the market trends for cloud computing in Europe, and of the main barriers to the wider adoption of cloud computing in Europe.

3.1 Cloud computing in Europe: Market trends

As is clear from the previous chapter cloud computing presents important opportunities for Europe while there are still many issues to be addressed before the full potential can be reached. In order to gain more insight into what this potential could be it is important to look at the cloud computing market, its structure and the expected trends in the coming years.

3.1.1 European Market for cloud computing Services

Cloud computing allows users to access on-demand, shared configurable computing resources (such as networks, servers, storage, applications and services) hosted by third parties on the internet, instead of building their own IT infrastructure.

These cloud services are deployed through three main models: public cloud services, private cloud services or a combination of both (hybrid cloud services). According to one of the most well-known definition of cloud computing, (US National Institute of Standards and Technology (NIST)) it is *"a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released"*[98].

The ISO standard from 2014 defines cloud computing as a "paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand". It is composed of "cloud computing roles and activities, cloud capabilities types and cloud service categories, cloud deployment models and cloud computing cross cutting aspects"[99].

Cloud computing has been developing along three main concepts, as shown by the figure below.

[98] Mell, P. and Grance, T. (2011), Recommendations of the National Institute of Standards and Technology, US Department of Commerce and Special Publication

[99] ISO/IEC 17788: 2014, Information technology – cloud computing – Overview and Vocabulary, p. 4. See: http://www.iso.org/iso/catalogue_detail?csnumber=60544

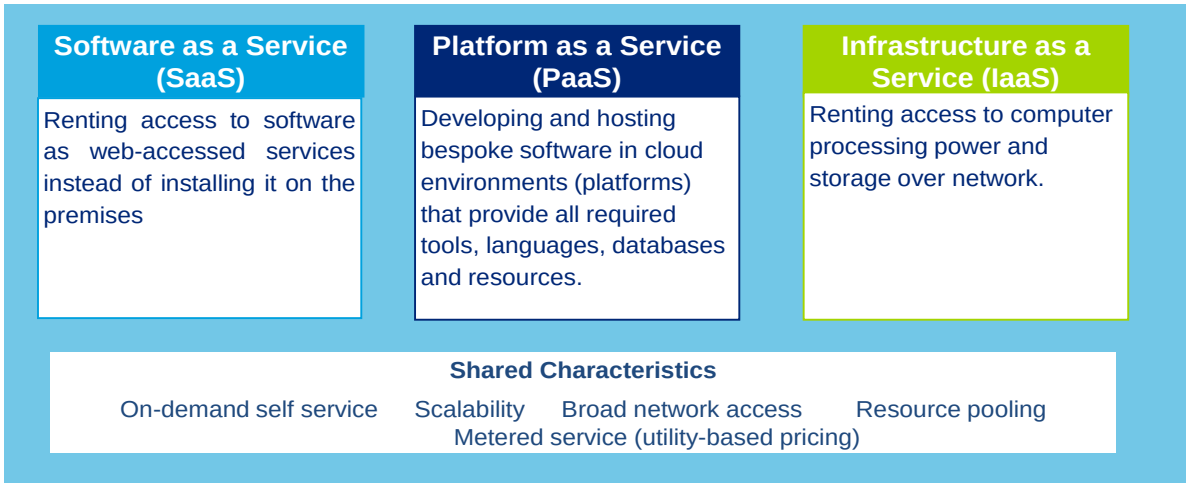


Figure 12 – Cloud computing offering[100]

There are three main deployment models for cloud service offering types: Public, Private and Hybrid. The main features and benefits associated with each are summarised below.

Table 9 – Cloud computing deployment models

Cloud deployment type	Features	Benefits
Public	For use by multiple organisations (tenants) on a shared basis and hosted and managed by a third-party service provider. Computing resources accessed as external services, instead of as products purchased, installed and managed within the organisation.	Ability to rapidly sale the allocation of computing resources to match fluctuations in business demand. Utility-based pricing. Potentially, large economies of scale.
Private	For exclusive use by a single organisation and typically controlled, managed and hosted in private data centres. The hosting and operation may be outsourced to a third-party service provider, but a private cloud remains for the exclusive use of one organisation.	Considered the most secure option, but with reduced potential for economies of scale and productivity gains available through multi-tenant options.
Hybrid	Both private and public cloud models are adopted by a single organisation.	Allows for multiple deployment methods to meet specific business/agency needs.

Cloud computing technology has become increasingly widespread since the late 2000's and adoption of cloud computing services has been growing steadily, in all sectors of the economy and by all economic operators, both private companies, including SMEs, and public sector organisations. Such growth is expected to be **sustained globally over the next 10 years**[101], globally the cloud computing market is expect to grow from an estimated USD 180 billion in 2015 to USD 1,3 trillion in 2018[102]. A

[100] KPMG (2012), Modelling the Economic Impact of cloud Australian Lessons and Experiences, available at: https://www.kpmg.com/AU/en/IssuesAndInsights/ArticlesPublications/Documents/modelling-economic-impact-cloud-computing.pdf accessed July 2015

[101] Disruptive technologies: Advances that will transform life, business, and the global economy (2013). See: http://www.mckinsey.com/insights/business_technology/disruptive_technologies

[102] Gartner, Forecast: Public cloud Services, 2012 – 2018, Q3 2014 update.

recent study estimated that the **total cloud market in the EU by 2020 is expected to be worth EUR 44.8 billion**[103] (note that the report provides estimates ranging from EUR 28.4 billion (the pessimistic scenario) to EUR 59.6 billion (the optimistic scenario). This study covered both Public and Private cloud for the EU (all 28 Member States), whereby EUR 32.7 billion for the Public cloud and EUR 12.06 billion for Private cloud[104].

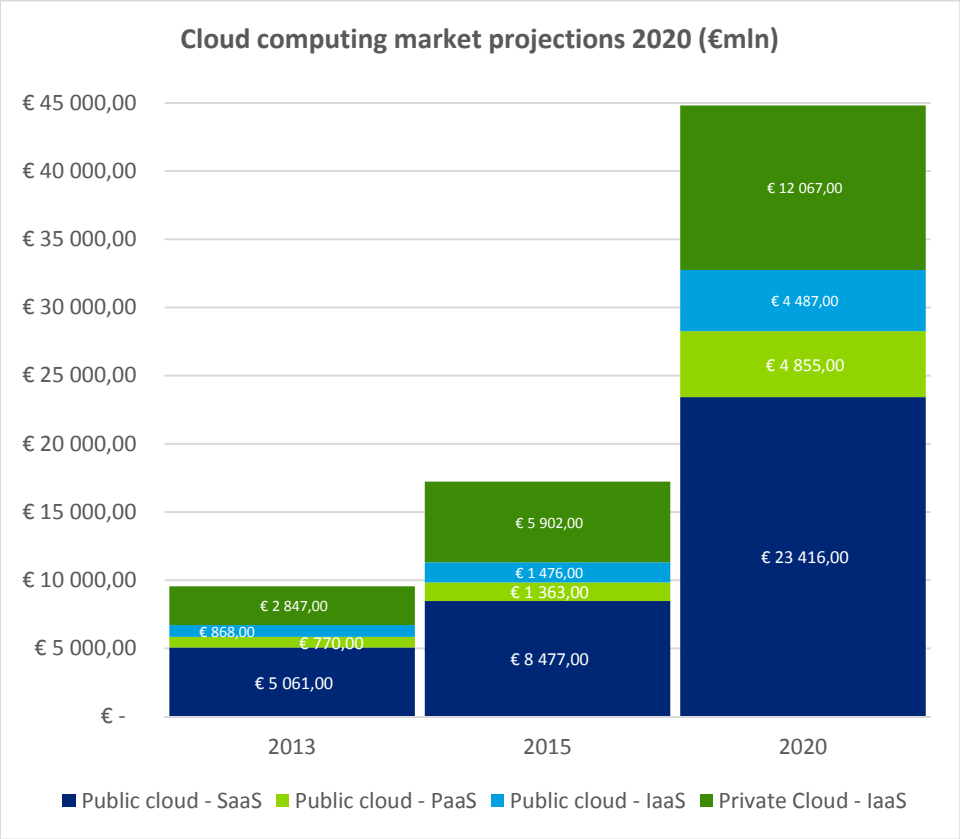


Figure 13 – Estimates of the cloud computing market

Public cloud services are used by multiple organisations (tenants) on a shared basis and hosted and managed by a third-party service provider. The computing resources are accessed as external services, instead of as products purchased, installed and managed within the organisation, resulting in the ability to rapidly scale the allocation of computing resources to match fluctuations in business demand, providing the advantage of utility-based pricing and has the potential of generating large economies of scale. As shown in Figure 13 **by 2015**, public cloud computing spending in the EU was expected to reach **EUR 11.3 billion,** more than double that the amount spent in 2011 of about EUR 4.6 billion[105]. **By 2020, the market for public cloud would be worth EUR 32.7 billion in EU28**[106] (up to EUR 45 billion in the optimistic scenario and EUR 18.1 billion in the pessimistic one).

Private cloud services are for exclusive use by a single organisation and typically controlled, managed and hosted in private data centres. The hosting and operation may be outsourced to a third-party service

[103] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742
[104] Note that the report provides a range of estimates, total cloud market ranging from EUR 28,4 billion to EUR 59,6 billion (EUR 18.1 billion to EUR 45 billion and EUR 10.3 billion to EUR 14.6 billion for Public cloud and Private cloud respectively).
[105] SMART 2011/0045, (2012), Quantitative Estimates of the Demand for cloud computing in Europe and the Likely Barriers to Up-take, IDC
[106] Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC

provider, but a private cloud remains for the exclusive use of one organisation. For this reason, private cloud is considered as the most secure option, but has a reduced potential for economies of scale and productivity gains available through multi-tenant options. Private cloud services "(both on premise and dedicated off-premise) [..] are deemed to be essentially Infrastructure based services", i.e. Private cloud IaaS.[107] Globally, through 2015, more than 90% of private cloud computing deployments will be for infrastructure as a service according to Gartner[108]. As shown in Figure 13, the market for **Private cloud is estimated at EUR 5.9 billion in 2015**. **By 2020, the market value of private cloud would be worth EUR 12.06 billion across EU Member States[109]** (up to EUR 14.6 billion in the optimistic scenario and EUR 10.3 billion in the pessimistic one).

The type of cloud computing services most prevalently offered on the market is SaaS, followed by PaaS and IaaS (each representing about 14-15% of the Public cloud market according to that study). Other sources provide estimations of similar magnitudes, according to Gartner[110] the market for Public cloud in Europe for SaaS, PaaS and IaaS[111] was USD 10.3 billion in 2014 and is expected to grow up to about USD 23 billion in 2018, whereby SaaS also represents the largest share of the market and PaaS represents 10%. However, Gartner estimates IaaS to play a more important role representing 28% of the Public cloud market in 2014:

- **Software as a Service (SaaS)**: defined by Gartner as "application software owned, delivered and managed remotely by one or more providers [..] based on a single set of common code and data definitions that is consumed in a one-to-many model by all contracted customers at any time". It is defined by the ISO standard as: "A cloud service category in which the cloud capabilities type provided to the cloud service customer is an application capabilities type"[112]. (SaaS includes the following sub-segments: business intelligence applications, customer relationship management, digital content creation, enterprise content management, enterprise resource planning, office suites, project and portfolio management, supply chain management, web conferencing, teaming platforms and social software suites and other application software):
  - in Europe, end-user spending for SaaS on public cloud was of USD 6,4 billion in 2014. In 2012, SaaS end-user spending on public cloud was of USD 4.1 billion and is expected to increase to USD 13 billion by 2018, representing an CAGR of 20.6% between 2013 and 2018.
- **Infrastructure as a Service (IaaS)**: defined by Gartner as "a standardised, highly automated offering in which compute resources, complemented by storage and networking capabilities, are owned and hosted by a service provider and offered to the customer on demand ". Defined by the ISO standard as "cloud service category in which the cloud capabilities type provided to

[107] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742
[108] Gartner, cloud computing Innovation Key Initiative Overview, April 2014.
[109] Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC
[110] Gartner, Forecast: Public cloud Services, 2012 – 2018, Q3 2014 update.
[111] Note: coverage of Europe includes Eastern Europe (Poland and regional forecast for: Albania, Bosnia and Herzegovina, Czech Republic, Bulgaria, Croatia, Estonia, Hungary, Kosovo, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Romania, Serbia, Slovakia and Slovenia) and Western Europe (France, Germany, Italy, Netherlands, Spain, United Kingdom and regional forecast for: Andorra, Austria, Belgium, Cyprus, Denmark, Finland, Greece, Iceland, Ireland, Liechtenstein, Luxembourg, Malta, Norway, Portugal, Sweden and Switzerland).
[112] ISO/IEC 17788: 2014, Information technology – cloud computing – Overview and Vocabulary, p. 6. See: http://www.iso.org/iso/catalogue_detail?csnumber=60544

the cloud service customer is an infrastructure capabilities type"[113]. (IaaS includes the following sub-segments: compute, print and storage services):

- In Europe, end-user spending for IaaS on public cloud was USD 2.8 billion in 2014, up from USD 1.6 billion in 2012 and expected to reach USD 7.9 billion by 2018, showing a CAGR of 29.6% over the period of 2013 – 2018.

- **Platform as a Service (PaaS)**: defined by Gartner as "suites of application infrastructure services, such as application PaaS and integration PaaS, as well as specialist application infrastructure services, such as database management system (DBMS) as a service, messaging as a service, portal technology as a service and other functional types of middleware offered as a cloud service". Defined by the ISO standard as: "A cloud service category in which the cloud capabilities type provided to the cloud service customer is a platform capabilities type"[114]. (PaaS includes the following sub-segments: application development, application infrastructure and middleware, business intelligence platform, database management systems):

  - in Europe, end-user spending for PaaS on public cloud was of USD 1 billion in 2014. PaaS end-user spending on public cloud thus doubled since 2012 (USD 462 million in 2012) and is expected to reach USD 1.98 billion in 2018, with an CAGR of 21.6% for the 2013-2018 period.

In contrast with the estimates provided by IDC, Gartner projects a more important role for IaaS in the market for Public cloud in 2014 and projects this to diverge even more by 2018 up to 34% of the market (compared to 28% in 2014), while PaaS is projected to be only 9% of the Public cloud market in 2018. The Gartner estimates of the IaaS Public cloud market are largely in line with estimates from Forrester[115] that provide an estimation of the total value of EU spending (businesses and governments) on IaaS cloud services in 2015 of EUR 3.5 billion in Europe compared to the estimated USD 3.6 billion in 2015 from Gartner.

In addition to these cloud service offerings, Gartner also identifies an additional segment of cloud services referred to as cloud Business Process Services (BPaaS). BPaaS is defined as "the delivery of business process outsourcing (BPO) services that are sourced from the cloud and constructed for multitenancy [..] used mostly for standalone service modules, not core applications" (BPaaS includes the following sub-segments: cloud payments, e-commerce, customer management, finance and accounting, human resources, industry operations and supply management).[116] Including BPaaS, Gartner estimates that the market for Public cloud in Europe will grow to USD 37 billion in 2018, a CAGR of 14.5% between 2013 and 2018 (see Figure 14 below).

[113] ISO/IEC 17788: 2014, Information technology – cloud computing – Overview and Vocabulary, p. 6. See: http://www.iso.org/iso/catalogue_detail?csnumber=60544
[114] ISO/IEC 17788: 2014, Information technology – cloud computing – Overview and Vocabulary, p. 6. See: http://www.iso.org/iso/catalogue_detail?csnumber=60544
[115] At Last, A Tech Market Recovery In Europe (Forrester, 2014)
[116] Market Definitions and Methodology: Public cloud Services (Gartner, 2014)

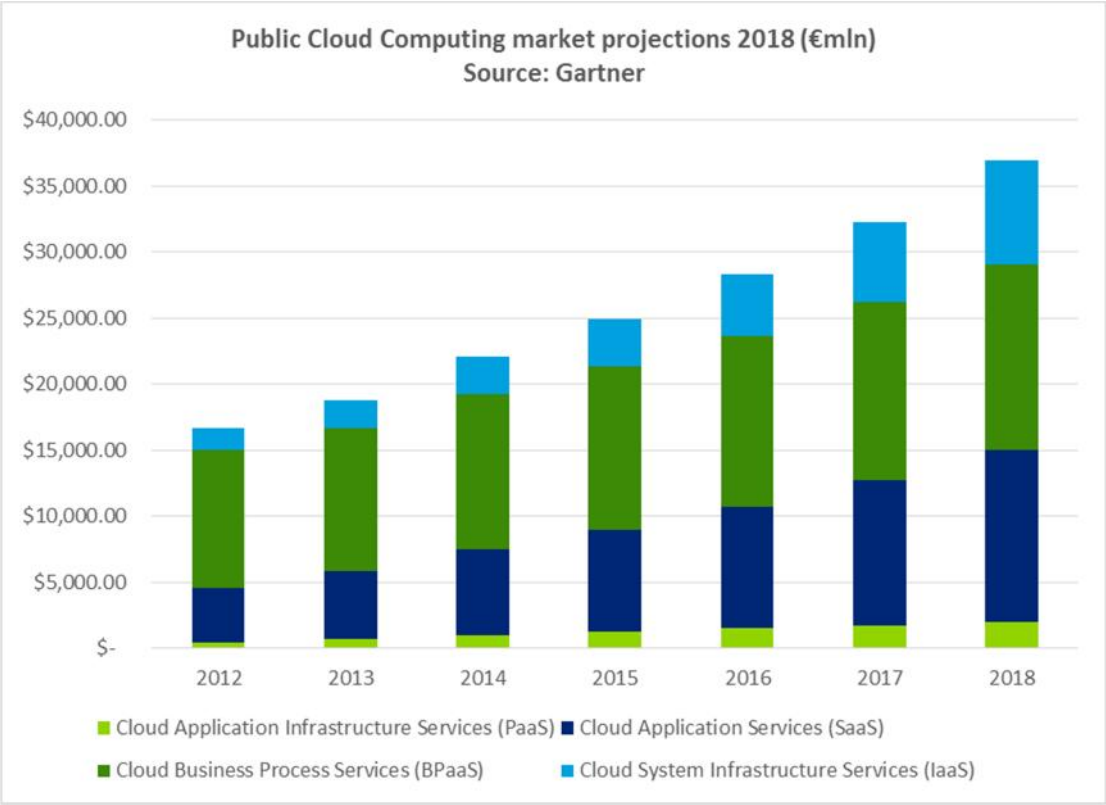


Figure 14 – Estimates of the Public cloud market (Gartner)

3.1.2 Take-up of cloud computing

According to a recent survey from Eurostat, only a fifth (19%) of EU companies used cloud computing services in 2014[117]. The highest shares of firms using cloud services in the EU in 2014 were in Finland (51%), Italy (40%), Sweden (39%) and Denmark (38%). In six Member States, less than 10% of enterprises used cloud computing services: Romania (5%), Latvia and Poland (both 6%), Bulgaria, Greece and Hungary (all 8%) (See Figure 16).

In terms of the deployment model, the most used is Public cloud across large, medium and small enterprises (12% of all enterprises) followed by Private cloud (7% across all enterprises) followed by a hybrid use of cloud deployment models across different cloud services.[118] Out of the enterprises that are using cloud computing services two thirds (67%) uses Public cloud, which is consistent across small, medium and large enterprises, while the uptake of Private cloud and Hybrid cloud is higher for large enterprises (48% and 24% respectively) than for small (40% and 16% respectively) and medium enterprises (37% and 11% respectively).

[117] Eurostat News Release, 9 December 2014, ICT usage in enterprises in 2014 cloud computing services used by one out of every five enterprises in the EU28 Lack of knowledge main reason for not using cloud services.

[118] See: http://ec.europa.eu/eurostat/statistics-explained/index.php/Cloud_computing_-_statistics_on_the_use_by_enterprises#Main_statistical_findings

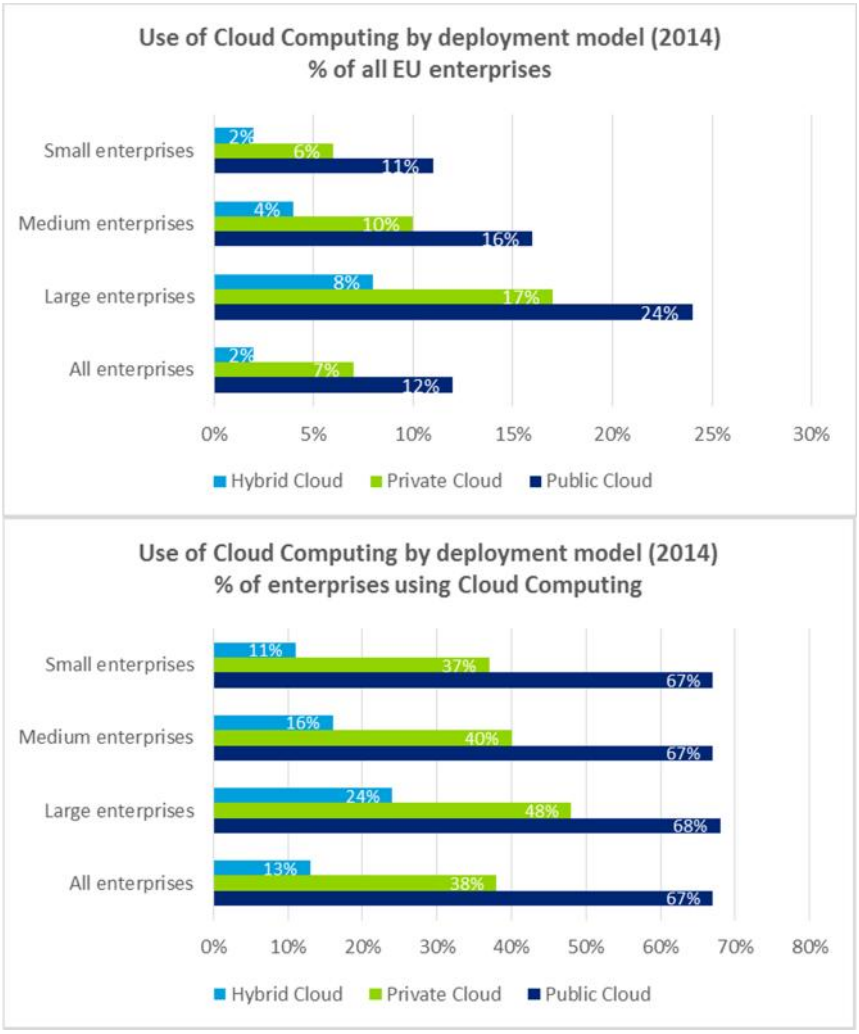


Figure 15 – Use of cloud computing by type deployment model (Eurostat)

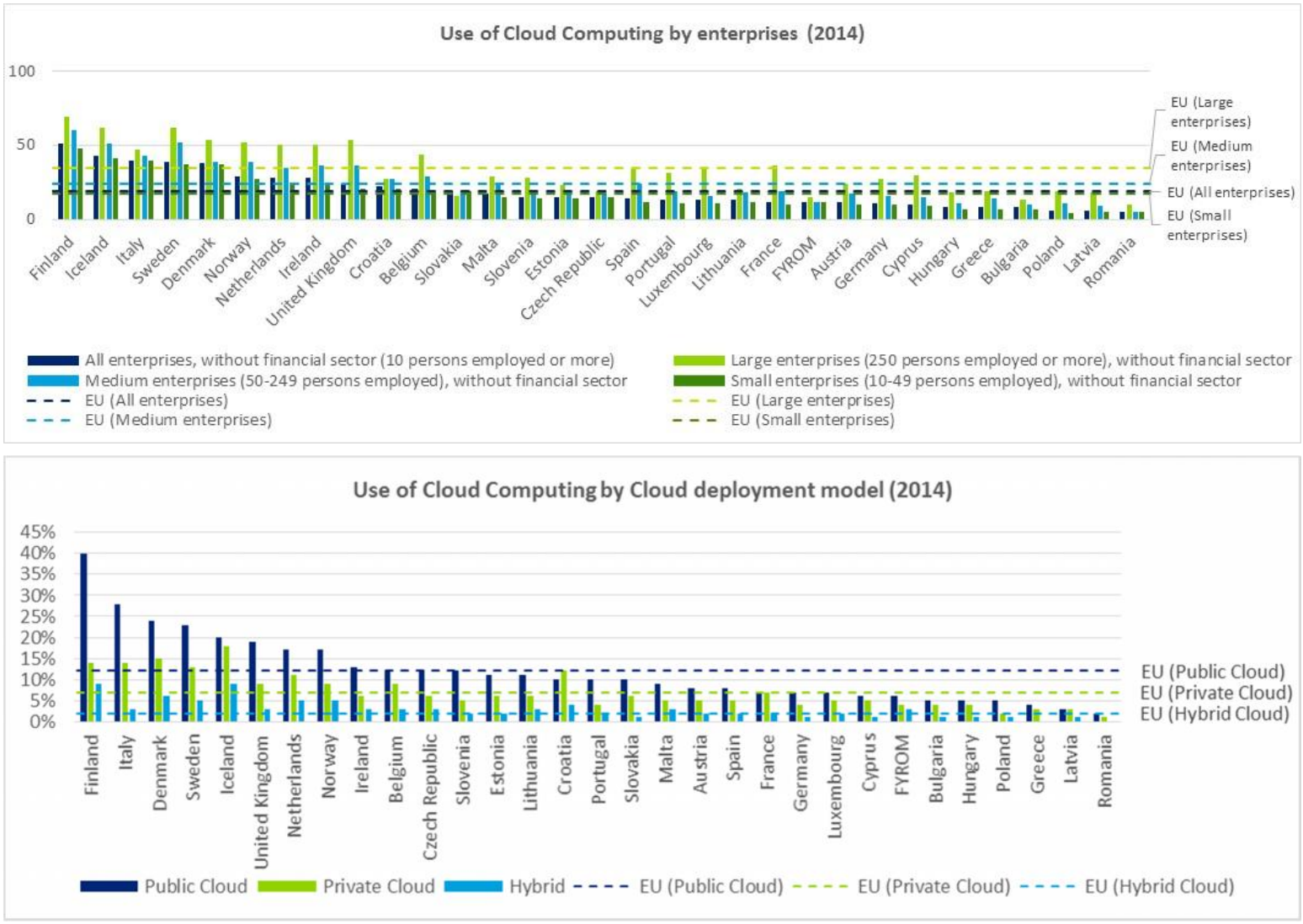


Figure 16 – Use of cloud computing by enterprises and cloud deployment model (Eurostat)

The IDC vertical markets survey[119] estimated that of out of the companies adopting cloud computing in the EU, about 72% indicated to expect to use at least one Public cloud service in 2015 (up from 63% in 2013) while 48% indicated the use of at least one Private cloud service in 2015 (a significant increase from 26% in 2013).

These estimates are considerably different from the estimates of Eurostat in 2014. It is important to note the methodological differences in terms of size of the sample (including 1 651 responses in the IDC study, compared to 151 000 businesses covered by the Eurostat statistics) as well as the coverage (the Eurostat survey covered the entire EU as well as non-EU countries but excluded the financial sector, while the financial sector is included in the IDC survey but it covers only France, Germany, Italy, Spain and the United Kingdom). Such methodological differences make it difficult to compare the results. Nevertheless, it is clear that estimates of overall cloud adoption by companies in the EU could be somewhere in the range of:

- Public cloud : 12% to 72% of EU enterprises, with
  - Large enterprises: 24% to 76%;
  - SMEs: 12% to 63%;
- Private cloud : 7% to 48% of EU enterprises, with
  - Large enterprises: 17% to 49%;
  - SMEs: 7% to 45%.

Other sources confirm this diverging range of estimates. Forrester for example estimated based on the Business Technographics Global Infrastructure Survey conducted in 2014 that Germany was the top European adopter of Private cloud (33%), followed by France (32%) and the UK (24%)[120], whereas Eurostat estimated that Iceland, Demark, Finland, Italy and Sweden are the top countries in adoption of Private cloud (ranging from 13% to 18%). The Cloud Industry Forum (CIF) conducted a survey in the UK among 250 senior IT and business decision-makers from both the public and private sectors in 2015 and found out that the cloud adoption rate is 84% (as compared to the 24% in the Eurostat survey), of which 78% are using two or more cloud-based services and 70% expect their adoption to increase within the next 12 months as well as 12% not using cloud computing expect to do so within a year.[121] Similarly, according to EVault's Second Annual cloud -Connected Backup and Recovery Survey[122] to 650 respondents across five countries (the USA, UK, France, Germany and the Netherlands) 77% of organisation surveyed had already adopted cloud services in France. And according to BITKOM 44% of German companies were already using cloud computing in 2014.[123]

From an industry perspective, the information & communication sector is, by far, the sector in which the largest proportion of EU firms report the use cloud computing services (45%), followed by the sector

[119] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742
[120] Forrester, Adoption Profile: Private cloud In Europe, Q3 2014, March 2015
[121] UK cloud adoption rate climbs to 84%, finds new research from the cloud Industry Forum (2015). See: http://cloudindustryforum.org/news/827-uk-cloud-adoption-rate-climbs-to-84-finds-new-research-from-the-cloud-industry-forum
[122] France Leads Europe in cloud Adoption & BYOD But Security Remains a Concern (2013). See: http://www.evault.com/view-from-the-trenches/france-leads-europe-in-cloud-adoption-byod-but-security-remains-a-concern/
[123] cloud computing wird Basistechnologie in vielen Unternehmen (2015). See: https://www.bitkom.org/de/presse/8477_81706.aspx

covering professional, scientific and technical activities (27%), while the share ranged from 14% to 20% in all other economic sectors[124].

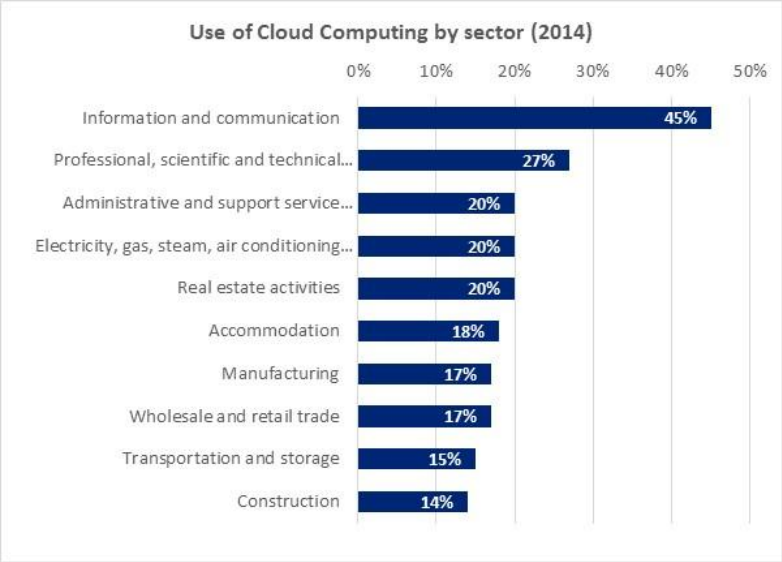


Figure 17 – Use of cloud computing by sector (Eurostat)

Also here, the vertical market survey estimated higher adoption rates across sectors and concluded that given "the high level of experience that business in all sectors have with regard to utilising Public cloud somewhere within their business" it is expected to see "limited levels of growth in this area through to 2015". [125] The sector with the highest adoption of Public cloud is the telecom/media sector (80%) followed by the finance sector (76%) and other service sectors (76%). These results include the finance sector and the public sector (government) that were not included in the Eurostat dataset. This is a relevant point to notice, which can help explain the very different take-up estimates in the Eurostat dataset, as take-up of cloud computing in public sector is estimated to be 60% for public cloud services and 50% for private cloud services.

[124] Eurostat News Release, 9 December 2014, ICT usage in enterprises in 2014 cloud computing services used by one out of every five enterprises in the EU28 Lack of knowledge main reason for not using cloud services.
[125] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742

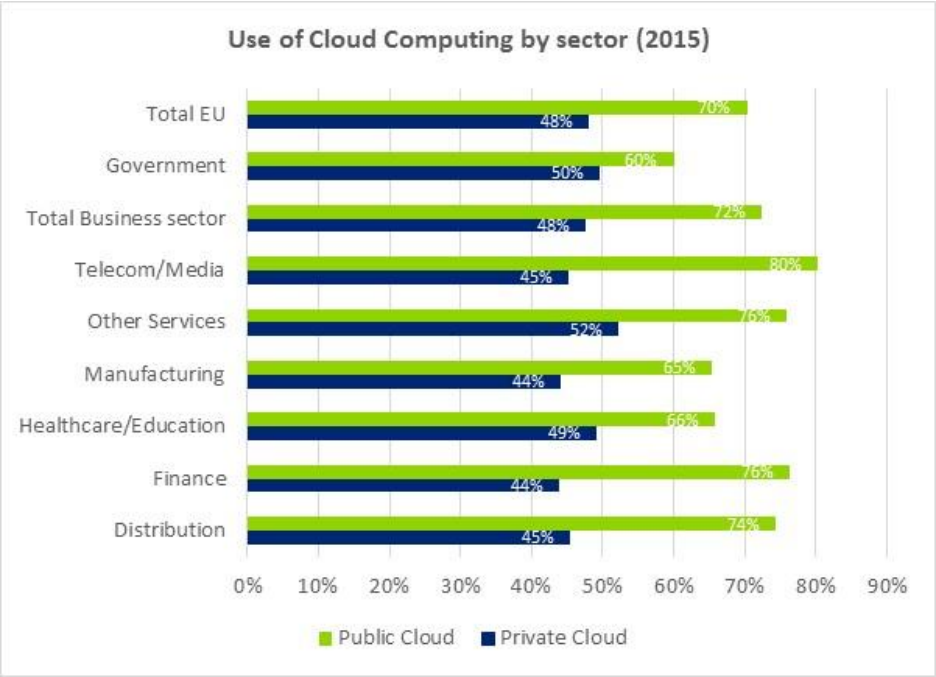


Figure 18 – Use of cloud computing by sector (IDC)

Concerning the types of cloud services used it is clear that across all enterprises both cloud-based e-mail services (12%) and file storage services (10%) are most commonly used followed by hosting of enterprise databases (7%). The use by enterprises of the remaining types of cloud services covered by the Eurostat survey, from office software to more specific applications (finance and accounting, customer relationship management (CRM)) as well as computing power, range from 3% to 6%. Overall, enterprises relied on a cloud solution mainly for their e-mail services (66%) and for file storage (53%) a further 39% used it to host their enterprise database, while 34% reported using it for office software (e.g. word processors, spreadsheets, etc.) (See Figure 19).[126]

The vertical market survey also estimated in 2013 the types of cloud services that professional users have adopted or intend to adopt. Office and collaboration software (including on-line productivity tools such as Office 365 and Google Apps as well as web conferencing apps such as WebEx) are mostly used (20%), followed by CRM (17%), storage (16.4%) and enterprise databases (16.2%). cloud services for security, unified computing (UC), and enterprise resource planning (ERP) ranged from 14.8% to 15.4% whereas other services are used by less than 10% of professional users in the EU (See Figure 19).

In terms of the amount of cloud solutions adopted, the recent study on cloud uptake provides insights as to the average number of solutions adopted by sector and for the EU as a whole in 2013 and projections for 2015. From this is clear that the finance sector makes most intensive use of cloud solutions with an average number of solutions adoption of 2.44 in 2013 and up to 4.36 in 2015 (both Public and Private cloud), followed by government (1.97 up to 4.02 in 2015) and the Telecom/media sector (1.73 up to 4.06 in 2015). Particular growth is estimated for the Healthcare/education sector with an average of 1.66 cloud services adopted in 2013 estimated to grow to 4.54 in 2015. Overall the average at the EU level was

[126] cloud computing - statistics on the use by enterprises (2014). See: **http://ec.europa.eu/eurostat/statistics-explained/index.php/Cloud_computing_-_statistics_on_the_use_by_enterprises**

estimated at 1.43 in 2013 and expected to increase to 3.57 in 2015, of which 1.19 (2013) up to 2.94 (2015) adoption of the number of Public cloud services and 0.24 (2013) up to 0.62 (2015) of Private cloud Services.[127] Overall, it is expected that the majority of firms in Europe (54%) is expected to retain the same deployment model in the next three years, whether it is private or public cloud[128].

Adoption of cloud computing services is slower in the EU than in other parts of the world, most notably North America. In addition, cloud adoption figures in the public sector are lower than private firms, according to a KPMG survey[129], although adoption of cloud services is expected to accelerate in the public sector in the near future. The public sector has more modest expectations from cloud computing than their private sector counterparts (only half of the survey respondents expect to have cost advantages, and even less expect to change their model for operations and/or their interaction with constituents).

[127] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742

[128] Gartner "Cloud Service Providers must understand deployment, adoption and buyer complexity to leverage cloud revenue opportunities" 13 January 2015

[129] See: https://www.kpmg.com/global/en/issuesandinsights/articlespublications/pages/exploring-cloud.aspx

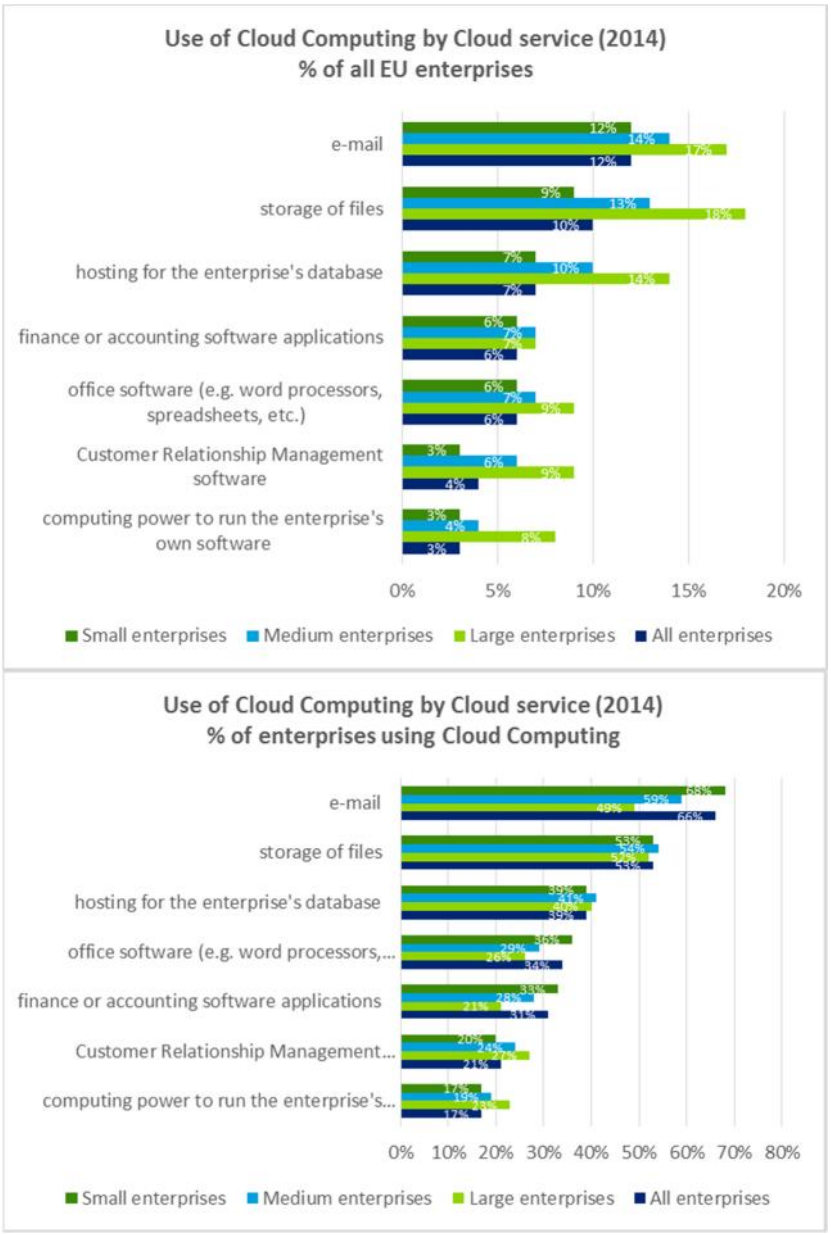


Figure 19 – Use of cloud computing by cloud service (Eurostat)

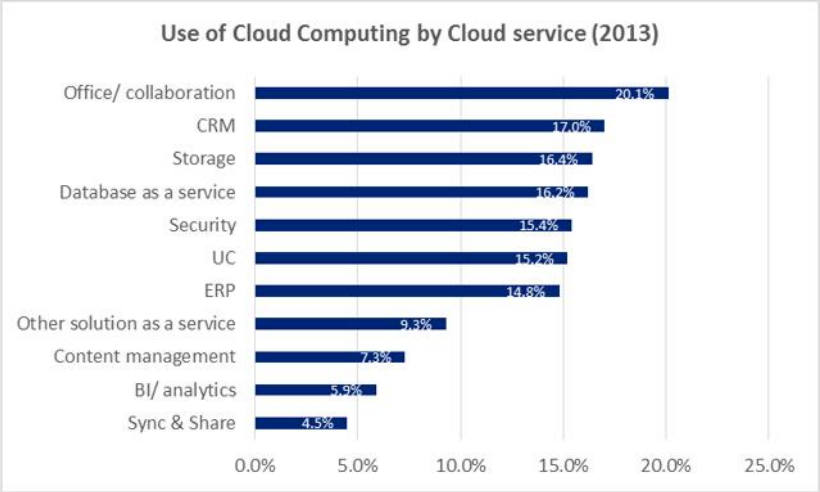


Figure 20 – Use of cloud computing by cloud service (IDC)

With regard to the preferences of professional cloud users, the cloud uptake study estimated that they select their cloud provider based on the service offering rather than the specific supplier or where it is based. The main factors influencing the choice of the cloud service provider as indicated by respondents are price/quality ratio (60%), price (50%), reputation of the supplier (47%) and the SLA or guaranteed uptime (38%). While one third of respondents indicated the availability of local implementation partners as relevant, the location of the supplier's headquarters and geographic location of the equipment providing the services are considered less important (29% and 26% respectively).

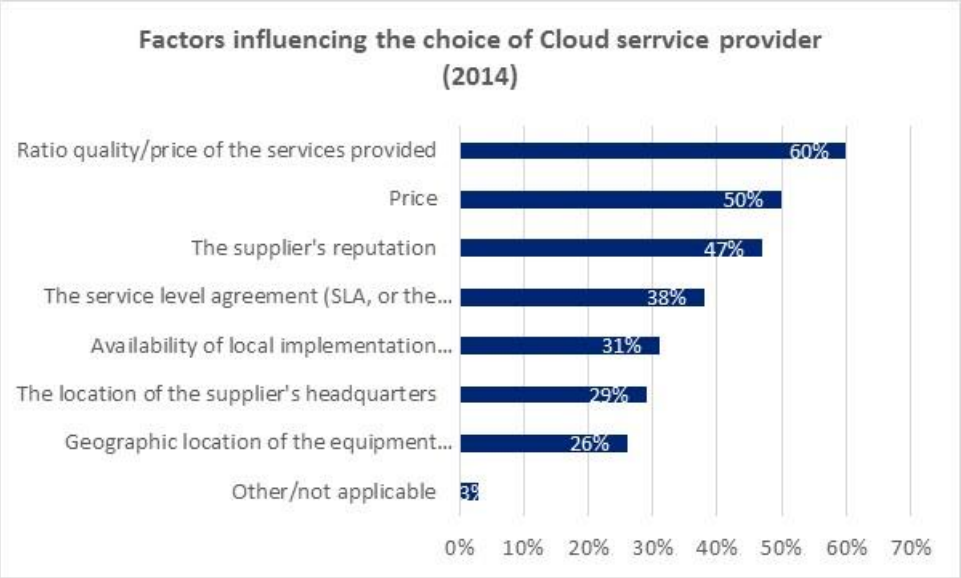


Figure 21 – Factors influencing the choice of cloud service provider (2014, IDC)

3.1.3 Cloud providers: key players in Europe

The European market for cloud computing Services is a fast emerging market as European adoption numbers are rising sharply, although European users tend to privilege 'easy' cloud applications such as email, security, back office and database rather than CRM, BI, PaaS and HRM/HCM.[130] Despite the fact that US based providers are dominating the European market, there are patterns suggesting that there are numerous promising EU Public cloud vendors that are working their way up in their home market.

The recent cloud uptake study provides figures on the key cloud providers in Europe.[131] Of the top 25 Public cloud vendors in the EU, 17 are headquartered in the US, seven are based in the EU and one (Visma) is based in Norway. The US companies have on average twice the revenue of the EU based providers, which are all applications vendors. The top five European-based Public cloud providers by European market share are:

- SAP (Germany): SAP's main cloud focus is on offering SaaS applications for CRM and ERM. Even though the company made a relatively early start in the SaaS market, it initially had disappointing results. However, since then the company has made acquisitions and improved its Public cloud offerings, and is now experiencing impressive growth, which is explained in further detail below and illustrated in figure 6. SAP is not only the leading European-based Public cloud provider on the EU market, but also the world's largest vendor of business management software, including enterprise resource management, customer relationship management, and supply chain management;
- T-Systems (Germany): In terms of its cloud services, T-Systems' main focus is on providing Private cloud services. Nevertheless, it also offers a virtual Private cloud (services based on a shared environment but with enhanced security and control compared to "standard" Public cloud offerings), which is Public cloud services according to IDC. T-Systems is a subsidiary of Deutsche Telekom, which has a long standing involvement in the European IT market;
- SmartFocus (France/UK): Smartfocus is a provider of SaaS services for email, social and mobile marketing. Founded in Paris in 1999 as Emailvision, the company acquired UK-based Smartfocus in 2013 and subsequently took the SmartFocus name for the combined company and moved its group headquarters to London;
- Unit 4 (Netherlands): Unit 4 is a business applications vendor based in the Netherlands. It offers its applications as multi-tenant applications but with isolated tenant databases. Coda, its leading financial management software suite, has a range of different solutions that can be hosted on its cloud infrastructure, and it has a number of data centers for cloud hosting in different European locations;
- Cegid (France): Cegid is a long-standing French vendor of business applications that also offers SaaS applications. It says it has 24,000 small companies using its SaaS accounting services, and over 650 mid-sized and large customers for its SaaS services.

In terms of market comparison of the top 25 Public cloud vendors by origin, the 17 US headquartered providers collectively generate 83% of the total revenue of the top 25 Public cloud vendors, while the seven

[130] The demand of cloud computing in Europe: drivers, barriers, market estimates. Research in Future cloud computing workshop (IDC 2012)
[131] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742

EU based providers generate only 14% as can be seen on the figure here-under. This is equivalent to a 2% share on average per EU based provider, whereas the US providers have a share of 4.9% per provider on average.

It is also worth noting that GXS (bought by Opentext) only recently relocated its headquarters to the US. This highlights another ongoing issue that faces EU based IT companies. They are often the target for acquisition by US based companies or investors, resulting in an inevitable 'westwards shift' in ownership. The NASDAQ stock market is also seen by many European IT business owners as being a more attractive option when looking to take their company public, again leading to EU businesses becoming foreign owned. Unfortunately, there is very little acquisition activity in reverse by EU based businesses taking over US owned companies.

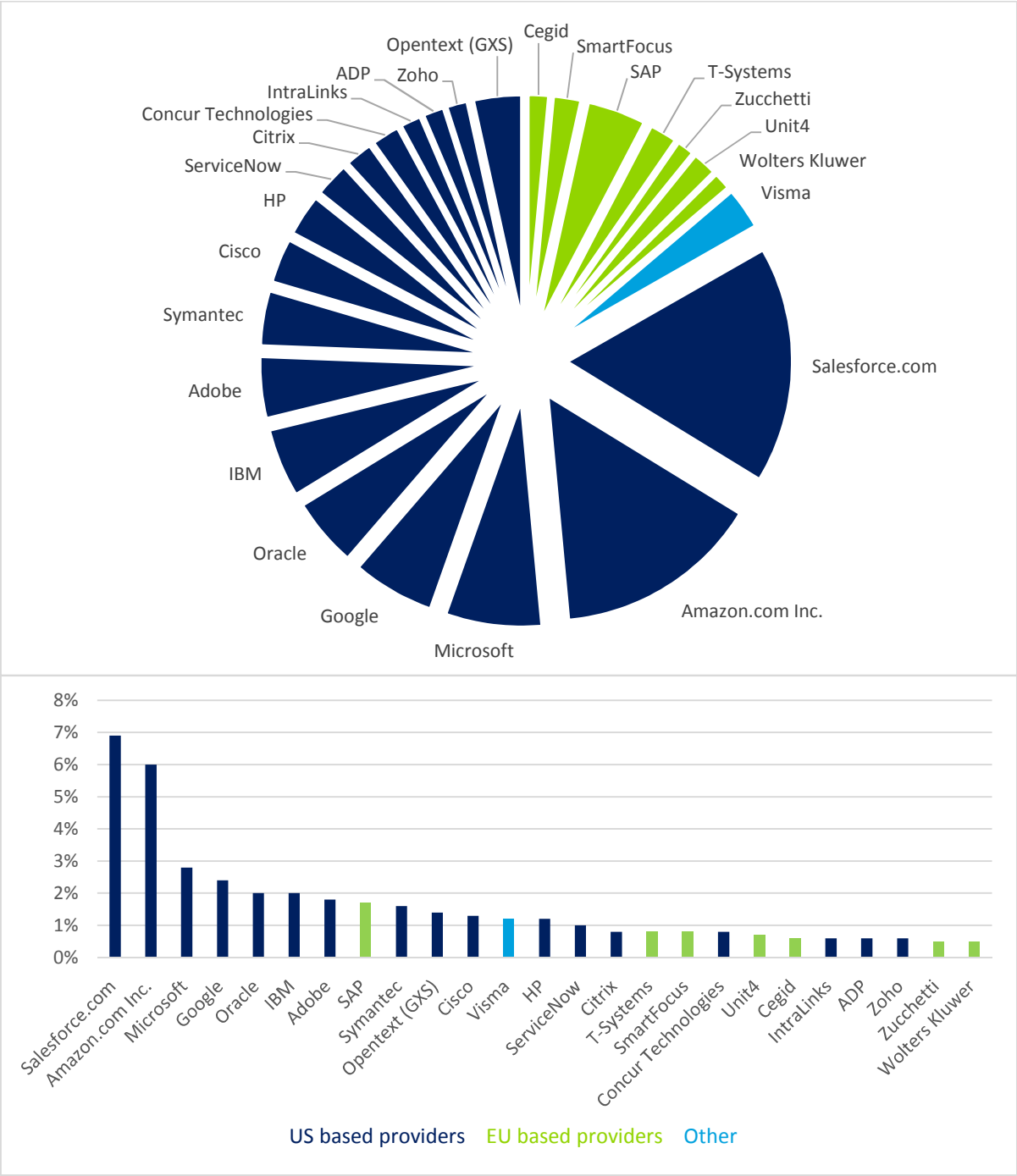


Figure 22 – Estimated EU Market Shares of the top 25 Public cloud services providers (IDC 2014)

There was great disparity between the top 25 Public cloud vendors' growth rates in EU in 2012-2013. The average growth rate was 192%, while the range was from 18% at Cisco to impressive 576% at SAP. The disparity in growth rates is mostly driven by the differences between the providers' cloud strategies. The growth rates of the seven EU based providers are illustrated in Figure 23 below.

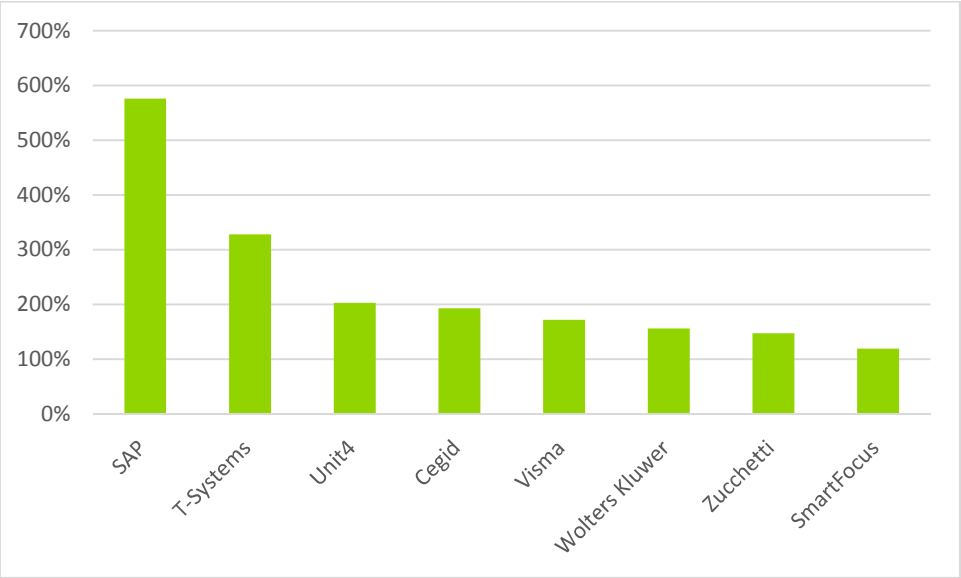


Figure 23 – Growth 2012–2013 of top 8 European Public cloud services providers in EU market

Clearly, SAP (Germany) stands out from the group with almost five times higher growth than SmartFocus which experience a growth rate of 119%. According to the recent study on cloud uptake, SAP's rapid growth is associated with a change in strategy from trying to get its customers to adopt a radical vision of cloud, centred on new and untried cloud offerings, to a far more pragmatic approach centred on maximising growth from its existing cloud offerings.

Expanding the focus to the top 100 Public cloud vendors in the EU, the numbers change and we can form a slightly different picture of the EU market. The top 100 providers collectively generate 56.6% of the total revenue of all cloud service providers in the EU. Looking more specifically at top 26-100 providers, 49 of these are US based and 23 are EU based. US headquartered companies still dominate the market with a 60.7% share of the total revenue of the top 26-100 Public cloud vendors, while European companies generate a 34.1% share of this. This is equivalent to a 1.48% share on average per EU based provider, whereas the US providers have a share of 1.24% per provider on average.

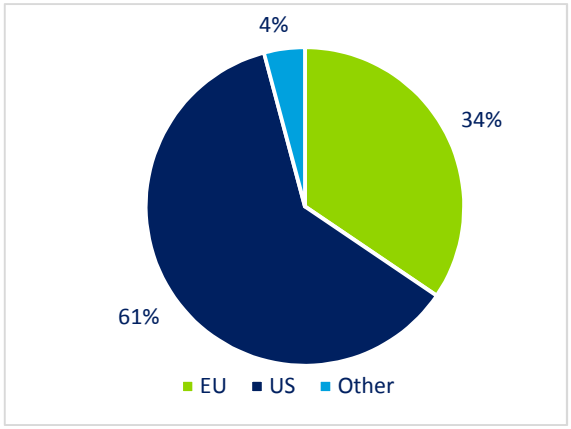


Figure 24 – Total Share of Revenue of Top 26–100 Public cloud vendors

The leading EU based Private cloud services providers by European market share are T-Systems (Germany), Atos (France), Capgemini, BT GS, and Orange BS. European vendors are the largest group amongst the vendors, and account for slightly under 50% of the overall revenue.[132]

European suppliers therefore have a strong presence in the Private cloud market. Figure 8 below shows the EU market share of the leading EU based Private cloud services providers. It is worth nothing that even if we were to include non-EU headquartered suppliers, T-Systems would still be the largest single provider of Private cloud services in the EU. Nevertheless, according to the article to Forrester, IBM was the top Private cloud services provider in 2013, but was overtaken in 2014, where VMware managed to become the leading Private cloud vendor in Europe.[133] The data from both sources should be interpreted with caution however, since vendors are reluctant to separate results for their traditional hosting business and Private cloud, so the estimates of revenues for these are not robust. Moreover, the data showing that T-Systems is the largest single provider of Private cloud Services in the EU is based on a separate analysis as Private cloud services are not included in IDC's tracker programme.

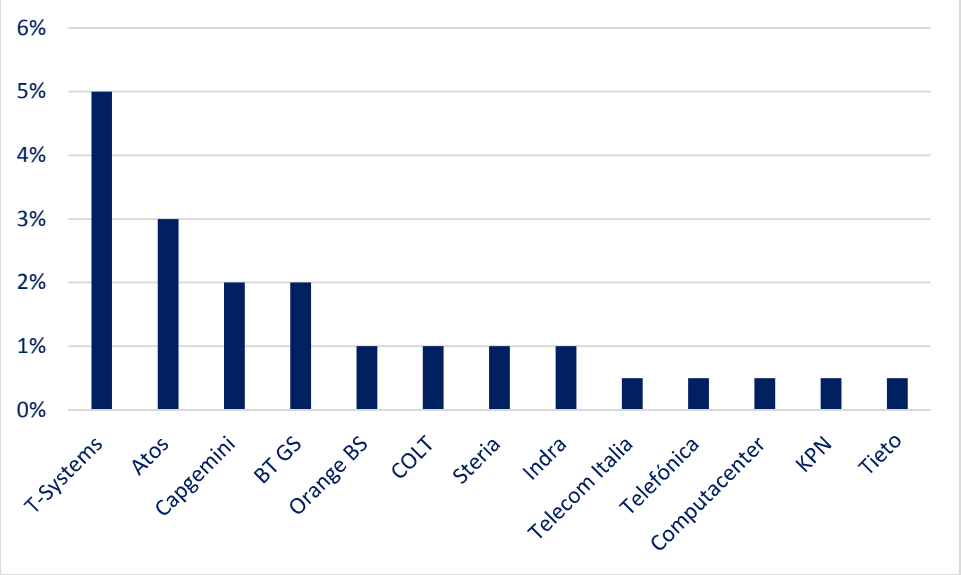


Figure 25 – EU Market Share of the leading European Private cloud services providers

3.2 Perceived barriers to the adoption of cloud computing

As mentioned above, several barriers still limit the pace of adoption of cloud computing in Europe. The Commission has put in place different measures to address these barriers and thereby unleash the potential that could be gained from cloud computing. It is clear that introducing measures to increase the adoption of cloud computing is likely to have an important impact not only on the cloud computing market in Europe (projected to be potentially double if current barriers would be addressed) but also wider impacts on a macroeconomic level (GDP growth by 2020 potentially ranging from EUR 65.4 billion to EUR 164.7 billion and additional job creation of 1 million to 2.5 million).

[132] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742
[133] Forrester, Adoption Profile: Private cloud In Europe, Q3 2014, March 2015

This study focusses on measures that tackle barriers to adoption of cloud computing for professional users (i.e. adoption of cloud computing by enterprises as well as governments in Europe) and the impact that specific measures could have on both the professional users and the companies providing cloud services in Europe (Cloud providers).

3.2.1 Available statistics and estimates

The Eurostat survey from 2014 provides insights into the factors that limit the adoption of cloud computing by enterprises. Figure 26 provides an overview of the percentages of enterprises that have indicated which factors are limiting their use of cloud computing (data refer to the total of enterprises included in the survey).

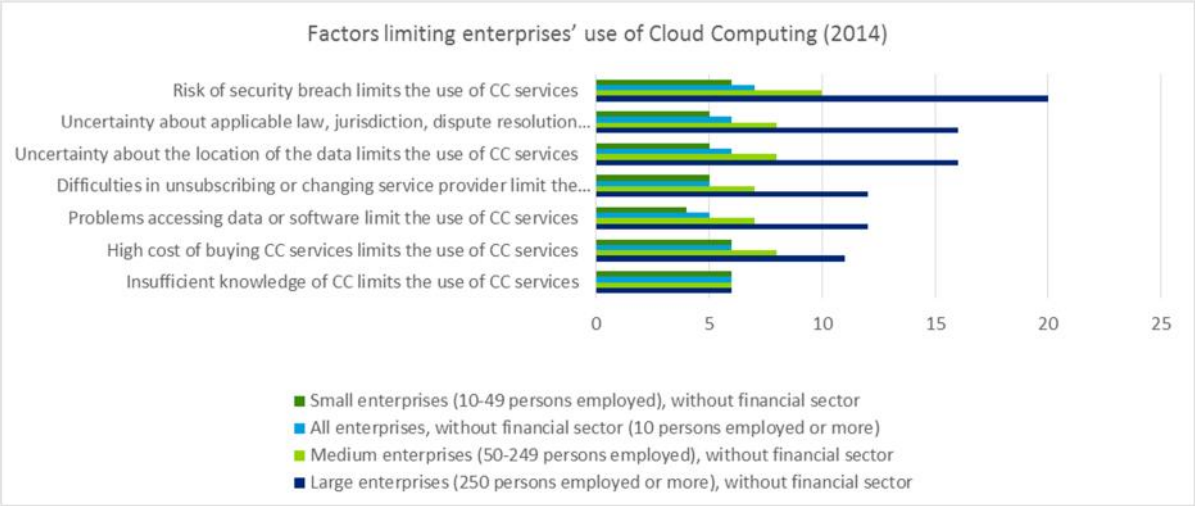


Figure 26 – Factors limiting enterprises' use of cloud computing (Eurostat, 2014)

The results differ when looking at large, medium-size and small enterprises[134]:

- **Large enterprises**: the main limiting factor indicated by large enterprises is the risk of security breach (20%) followed by uncertainties about the applicable law, jurisdiction and dispute resolution mechanism (16%) and the uncertainty about the location of the data (16%);
- **Medium-size enterprises**: also consider the risk of security breach the major limiting factor (10%) followed by uncertainties about the applicable law, jurisdiction and dispute resolution mechanism (8%) and the uncertainty about the location of the data (8%) as well as the high cost of buying cloud services (8%);
- **Small enterprises**: shows a less dispersed impression of the limiting factors, although interestingly the most indicated factors are insufficient knowledge of cloud services (6%), the high cost of buying cloud services (6%) and the risk of security breach (6%).

The 2014 Eurostat survey looked also at the factors preventing entirely enterprises from adopting cloud computing services (as opposed to those simply limiting a larger use). Figure 27 provides an overview of

[134] The data reported are calculated as a percentage of the total number of enterprises included in the Eurostat survey. When calculated on the number of enterprises that buy cloud computing services, the percentages are higher. For instance, the percentage of large enterprises reporting that the risk of security breach limits the use of cloud is 20% on the total of the enterprises covered, while it rises at 57% when considering the large enterprises that but cloud computing services already.

the percentages of enterprises that have indicated which factors are preventing their use of cloud computing (data refer to the total of enterprises included in the survey).

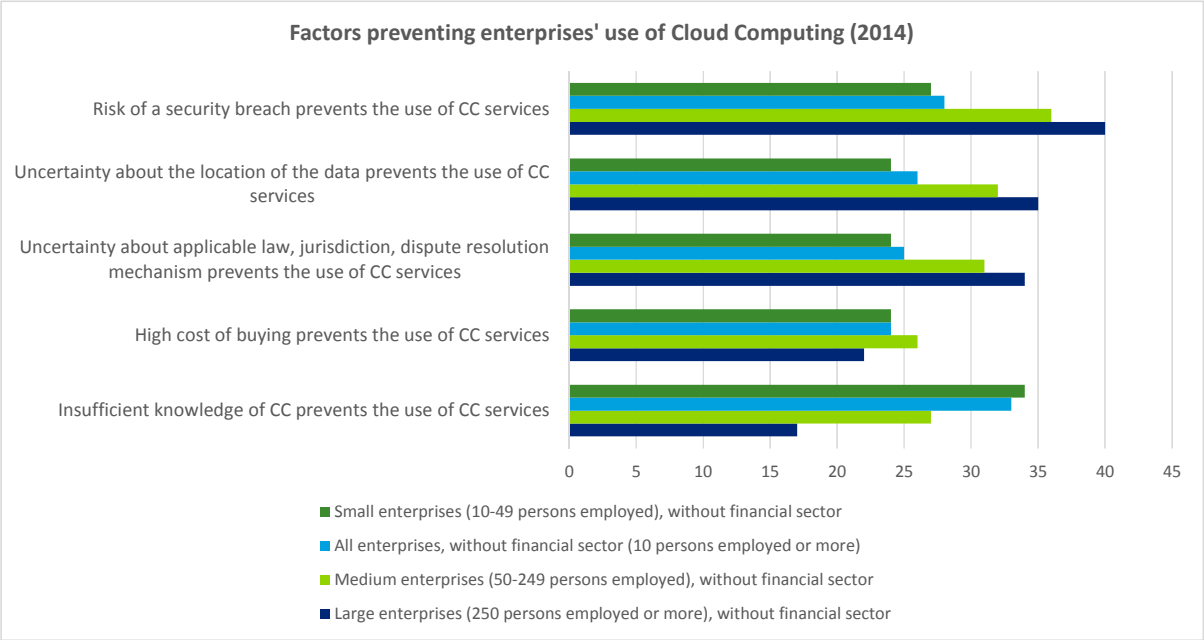


Figure 27 – Factors preventing enterprises' use of cloud computing (Eurostat, 2014)

Also in this case, the results differ when looking at large, medium-size and small enterprises:

- **Large enterprises**: consider risk of security breach the most important factor preventing them from using cloud services (40%) followed by uncertainty about the location of the data (35%) and uncertainties about the applicable law, jurisdiction and dispute resolution mechanism (34%);
- **Medium-size enterprises**: consider the same factors as most important as the large enterprises, namely risk of security breach (36%) uncertainty about the location of the data (32%) and uncertainties about the applicable law, jurisdiction and dispute resolution mechanism (31%);
- **Small enterprises**: show a more dispersed picture here which makes sense given that this group has the lowest take-up of cloud computing overall as shown in the previous section. The factors that prevent small enterprises from using cloud services are insufficient knowledge of cloud computing (34%), risk of security breach (27%) and high costs and uncertainties on law and data location (24%).

These results show a number of important trends. Enterprises tend not to trust the security of cloud services and be uncertain about the applicable laws, jurisdiction and dispute resolution mechanisms, which points to a lack of trust overall. For small enterprises in particular there is a clear lack of knowledge of cloud computing that is keeping them from adopting cloud services. This is particularly important given that 99% of all enterprises in the EU are in fact small and medium-sized enterprises.[135]

[135] Fact and figures about the EU´s Small and Medium Enterprise (SME). See: http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/index_en.htm

As stated in the final report of the European Cloud Partnership (ECP)[136], the requirements for the use of cloud differ case by case, depending on the sector in which cloud computing services could be/are used and in particular depending on the type of data (e.g. highly sensitive data), the use of the data (e.g. data protected by Intellectual property rights and/or requiring a license) and the need for enforcement (e.g. data requiring strict controls, such as financial data). The ECP report provides an overview the related barriers per sector (based on several cross-border use cases), from which it is clear that the most common barriers (across sectors) relate to data protection compliance, information security, and jurisdiction/enforcement.

Table 10 – Overview of priority issues by sector

Barrier: / **Sector / use case:**	Data protection	Intellectual property rights	Confidential information	Outdated legacy laws	Information security concerns	Supervision and inspection	National sovereignty	National security	Jurisdiction/ enforceability	Procurement rules
Public sector in general	✓		✓	✓	✓	✓	✓	✓	✓	✓
Taxation and social security	✓		✓		✓	✓	✓	✓	✓	
Healthcare and legal services	✓		✓		✓	✓		✓	✓	
Media and entertainment	✓	✓	✓	✓	✓	✓			✓	
Financial services	✓		✓	✓	✓	✓		✓	✓	
National archiving	✓						✓		✓	
Manufacturing/consumer		✓			✓					

Barriers to the uptake of cloud computing were also assessed in a study on uptake of cloud computing in 2012. The relevance of these barriers was assessed for EU enterprises, both large and small, through a survey.

3.2.2 Barriers to adoption of cloud computing in Europe

Although the impact of barriers varies by type of cloud service users, these barriers and obstacles can be grouped into five main clusters, as follows:

[136] Establishing a Trusted cloud Europe - A policy vision document by the Steering Board of the European cloud Partnership (2014). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=4935

- **Legal jurisdiction and data location**, covering concerns about where data reside and which jurisdiction would apply in case of dispute;
- **Security, data protection and trust**: covering aspects of data security, data protection and overall reliability of cloud vendors;
- **Data access, data portability and Technology Transparency and change Control**: encompassing aspects related to the portability of data, business process, portability from one vendor to another and onto companies' own IT systems, fears of losing control over software changes and lack of transparency over ownership of customisation of cloud solutions;
- **Business case:** encompassing aspects such as enterprises' evaluation and understanding of cloud services, their useful and the type and quality of local support given to users, including concerns of language of provision of services; and
- **Infrastructural/industrial policy**: covering issues that go beyond the specific of cloud computing market, such as broadband coverage and speed of internet connection, energy market, and system of tax incentives (e.g. a system promoting investments in hardware would discourage investments in cloud computing).[137]

The figure below shows a ranking of these barriers based on responses of EU companies and their perceptions on the importance of the different barriers in the adoption of cloud computing technologies.

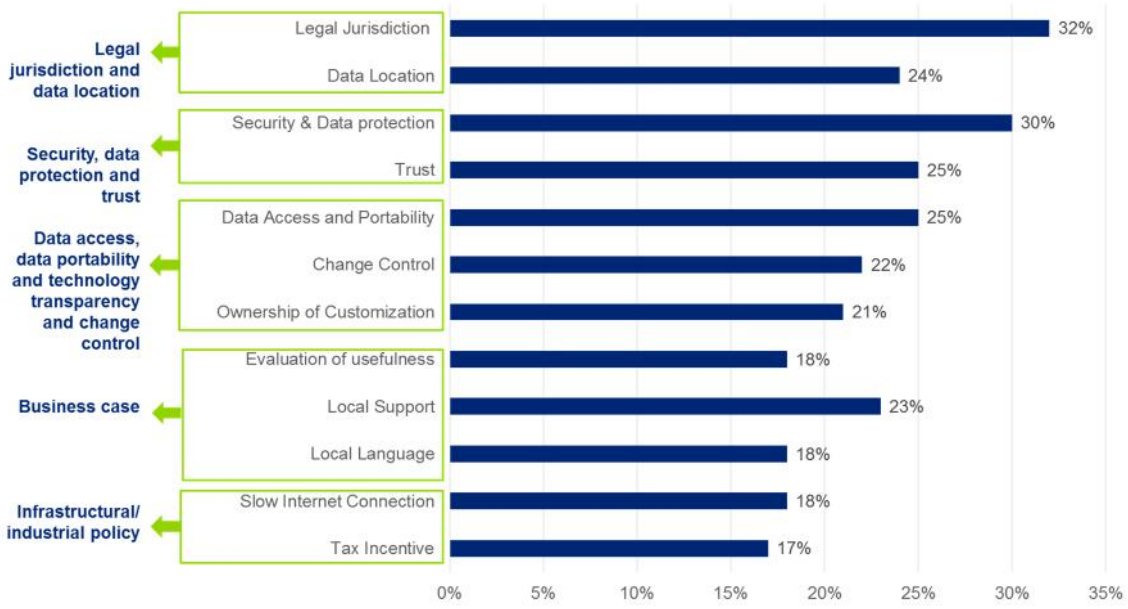


Figure 28 – Cloud computing barriers (Source: IDC 2011)

Also in the IDC study, the applicable law/legal jurisdiction and security and data protection concerns are perceived as the most significant barriers, with close to a third of respondents identifying both of these as significant barriers to cloud uptake. Next, concerns about the access to data and its portability is raised as an important barrier by a quarter of enterprises. Finally, the business case and more structural factors such as speed of the internet connection and tax incentives are marked as relevant by around a fifth of

[137] Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC

enterprises. This demonstrates that the barriers to the update of cloud computing services are quite diverse and interventions to tackle these barriers should be far-reaching.

Legal jurisdiction and data location

The issues of applicable law/legal jurisdiction and data location are closely linked. EU companies are concerned about the uncertainty and lack of control over the storage location of their data when relying on cloud services. Barriers concern the legal aspects of cloud computing, and encompass aspects such as differing legal frameworks between EU Member States and uncertainties over applicable law, unclear legal jurisdiction and data location issues, complex security and data protection regulations, small trust in suppliers, and lack of guaranteed data access and portability between cloud systems. When companies outsource their elements of their IT infrastructure and services to the cloud, a loss of control occurs to a certain degree.[138]

Legal jurisdiction and regulatory barriers are also a barrier from the perspective of the cloud computing service providers at both national and EU level. The identification and promotion of best practices by industry in respect of applicable laws, technical standardisation and operational assurances are also issues to be tackled in order for providers to deliver cloud services to European customers, without hindrance from national regulatory barriers[139].

Security, data protection and trust

Uncertainties about the way legal and security issues are managed in the cloud environment are strongly correlated with uncertainties about the relationship with and the trustworthiness of cloud providers. In particular, as mentioned, among EU enterprises using cloud services the risk of a security breach is reported as the main factor limiting a larger use of the cloud.[140] Among public sector users, fears of fragmented legal jurisdictions, security issues and data protection, and data location are also prevalent and explain the lower adoption rates compared to the private sector due to higher regulatory barriers. In 2012, a third of cloud users mentioned that issues related to legal jurisdiction were, at the time, largely restricting their adoption of cloud computing services. Security and data protection barriers were the second most important barrier, with 30.5% users considering it as a strong barrier and close to 10% of users indicating that his issue completely restricted their use of cloud computing services.[141] Issues of data protection came particularly to the forefront in 2013 with the revelations of breach of data protection by national agencies[142].

Data access, data portability and Technology Transparency and change Control

Data access and portability barriers are less relevant in the short term, but are expected to become more relevant in time for all stakeholders, as intensity of cloud usage increases. Legal barriers appear to be

[138] OECD, cloud computing: The Concept, Impacts and the Role of Government Policy, 2014

[139] FINAL REPORT Prepared for the European Commission DG Communications Networks, Content & Technology, 2013

[140] Eurostat News Release, 9 December 2014, ICT usage in enterprises in 2014 cloud computing services used by one out of every five enterprises in the EU28 Lack of knowledge main reason for not using cloud services.

[141] Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC

[142] Ibid

important for both private and public sector organisations, but seem to affect more cloud computing adoption in the public sector.[143]

Technology transparency and control barriers would probably lessen over time, as the market matures and the interaction between players becomes clearer. Particularly, concerns about the control of software and services changes and updates should lessen in time, as companies benefit from automated software upgrades with no extra cost.

Business case

The perceived lack of a clear business case for cloud computing is an obstacle for the public sector and for SMEs, while large enterprises seem to have a clearer awareness of cloud benefits. On the other hand, large enterprises (>250 employees) and vertical markets with the strongest cloud penetration (finance and telecommunications) are most concerned about cloud issues, since they are most aware of their practical impact. EU firms not using cloud services mention that insufficient knowledge of cloud computing was considered as the main blocking factor for cloud adoption[144]. Indeed, EU enterprises tend to undervalue the relevance that some business issues have on their cloud uptake and short-term plans of adoption. IDC analysis of cloud impact indicators shows that evaluation of usefulness (particularly in SMEs), the need for local language support, and uncertainty about the ownership of customisation (particularly among large companies) have hampered adoption and short-term plans, and are at least equally as important as regulatory barriers.

Infrastructural/industrial policy

Despite ranking lower than other barriers in EU companies' assessment of barriers to cloud uptake as well as having had so far little impact on cloud adoption and short-term plans, it is expected that tax incentive on capital spending will have more and more of an impact on demand in regulated sectors that benefit from such incentives.

Slow connectivity emerged as a constraint to cloud adoption mainly for SMEs. Clearly, eliminating the coverage gaps of broadband networks across Europe and insuring high-speed networks diffusion is a key requirement for a cloud -friendly environment.

In addition, although the predicted growth in cloud services spending and adoption presents significant revenue opportunity for providers of cloud computing services, the opportunities this growth presents can only be leveraged if service providers understand deployment model variations, are able to reach new buyers and respond to customer-driven investment timing.[145]

In particular, evidence demonstrated that cloud users' strategies for cloud deployment vary geographically (at regional and national levels) and over time (typically over three years).[146] It is therefore paramount for service providers to adapt to multiple patterns and models of cloud adoption across regions and countries and respond more precisely to a dynamic demand. A Gartner survey for 2014 shows that globally 49% of

[143] See KPMG (2012), Exploring the cloud . A Global Survey of Governments' Adoption of cloud
[144] Eurostat News Release, 9 December 2014, ICT usage in enterprises in 2014 cloud computing services used by one out of every five enterprises in the EU28 Lack of knowledge main reason for not using cloud services.
[145] Gartner "Cloud Service Providers must understand deployment, adoption and buyer complexity to leverage cloud revenue opportunities" 13 January 2015
[146] Ibid.

cloud users indicate they will use one cloud deployment model now and in the future (three years) while 29% will switch models between now and sometime over the next three years, including within a single firm. Service providers must thus identify consumers' intentions for their cloud computing strategies while providing them the right solutions adapted to their market, (whether it be geographic or sectorial) at present.

Findings from stakeholders' consultation

Based on the interviews and results from the online survey carried out as part of the study, it is clear that professional cloud users and providers of cloud computing services consider some barriers particularly important.

The figure below provides an overview of the main barriers mentioned by professional users and provides of cloud computing services during interviews and via the online survey.

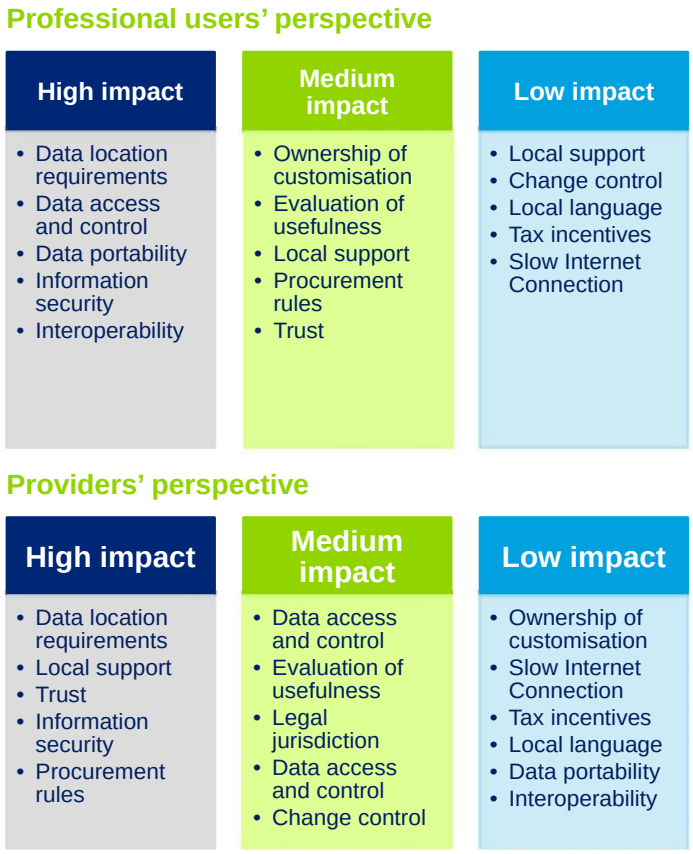


Figure 29 – Barriers to cloud computing from stakeholders' consultation

For professional users, the barriers identified reduce the likelihood to adopt cloud computing services, and those identified as 'high impact' are more likely to impose costs to businesses, often in order to understand and compare offers. Such costs include the time of internal staff to understand and compare the different offers, and in some cases, external advisory fees to have additional guidance before being able to choose the most viable offer.

For providers, the barriers mentioned are likely to reduce their sales/turnover in their domestic market, while the impacts on cross-border sales/turnover are less clear, as small providers (like those that answered the survey) tend to focus on domestic markets.

Barriers identified by stakeholders include data location requirements, security of data and data protection and, linked to that, SLAs and legal requirements, many of which confirm the analysis of earlier studies and surveys.

In addition, the relevance of increasing awareness and education among current and perspective users of cloud computing services was repeatedly mentioned by stakeholders interviewed, both by providers and by business representative organisations.

Both professional users and providers of cloud computing services identified data location requirements as a high-impact barrier, limiting the adoption of cloud computing services by users and reducing sales/turnover for providers. Indeed, data location requirements limit the choice of available offers for users, that may be prevented from adopting cloud computing services due to their costs (as the most economically efficient offer may not be available). On the other hand, providers may face higher costs for providing cloud computing services, as they may be force to establish in locations with higher production costs.

Legal requirements on data protection and privacy are often mentioned as a crucial barrier to the wide adoption of cloud computing, especially as they are especially strict in the EU, and in some Member States in particular. However, according to some of the stakeholders interviewed (and especially by regulators and small providers), the rigid EU requirements can be in fact a competitive advantage for European businesses, as potential customers from third countries appreciate the higher standards offered by European providers.

In addition, some stakeholders reported that, as an effect of the higher requirements imposed by European laws, clients of cloud computing services are starting to migrate towards European cloud providers and intermediaries. However, they commented, the European supply of cloud computing services is still quite fragmented: a closer cooperation of providers to promote their products together (and offer scalability and a higher number of solutions to current and perspective clients) could help overcoming this obstacle. In addition, a list of European cloud computing providers and intermediaries (a sort of G-Cloud with EU28 scope) was suggested by some of the stakeholders interviewed.

Linked to this point, the importance of certification schemes has been highlighted by many stakeholders (mostly by regulators and providers). In particular, in order to address the issue of access by foreign authorities (such as national security or tax authorities) to data in the cloud, some stakeholders considered positively the idea of having security aspects (such as encryption schemes) as part of the certifications schemes (as it is already happening for privacy and data protection issues). Third-party certification schemes are still perceived as more reliable, while more expensive. Some stakeholders (on the regulators' side, for the most part) envisaged the possibility of a system with different level of certification, depending on the different levels of criticality of the data. For instance, a self-assessment certification scheme, easier and less expensive to administer, could be chosen for less critical data, while third-party certification schemes and schemes based on continuous monitoring (more complex and expensive to administer) could be used for highly critical data. Such a scheme would require cloud users to identify the different levels of criticality of their data, and to choose the most appropriate certification accordingly. Stakeholders commented that this would ask for a better education and awareness of cloud users.

The need for more awareness and education among current and perspective users on the key characteristics of cloud computing services, on how they can respond to their needs was mentioned frequently by the stakeholders interviewed, with no distinction of typology (i.e. including regulators, business representative organisations and large and small providers). Based on their experience, they observed that often customers are not entirely aware of their needs, and therefore tend to buy cloud computing services from the large providers because they recognize the value of the brands. In addition, stakeholders reported, often current and potential users are not able to fully understand the characteristics and the potential benefits of cloud computing, so they might under-estimate its potential, and exploit the existing applications less than what they could. It is crucial that (prospective) purchasers of cloud computing services *'do their homework'* before engaging in negotiations with (prospective) providers, stakeholders commented (both from the regulators' and the providers' side), according to the regulators and providers (large and smaller ones) interviewed.

4 Assessing the costs and benefits of cloud computing in Europe

This section describes the the key costs and benefits from cloud computing at both macro-economic (such as on GDP and employment) and micro-economic level (on businesses' performance) as identified by literature. It also describes the approach undertaken by our study to estimate the costs and benefits from cloud computing, and the sources used for such estimates.

4.1 Cost and benefits of cloud computing

The massive adoption of cloud computing is expected to generate significant benefits not only for EU companies and organisations but also for the European economy at large, ranging from economic and cost-saving benefits to environmental impacts. Obstacles and barriers nonetheless persist, as discussed in the previous chapter, limiting the adoption of this technology and thus currently hampering the full realisation of these expected benefits.

Identifying and estimating the benefits of cloud computing represents a first crucial step to take relevant actions for removing barriers.

Benefits of cloud computing have been identified at the level of users as well as for society at large. While the benefits for the economy at large (such as impacts on GDP and employment) have been quantified by several studies, benefits at company level have proven more challenging to quantify accurately. An overview of the main benefits of cloud computing and their available quantitative estimates is provided below.

4.1.1 Benefits for society as a whole

There is an increasing body of literature that provides an indication of the quantifiable benefits cloud computing is expected to have on the economy, including aspects such as **GDP and macro-economic performance, through both increased revenues and business creation, as well as employment** and **public finance accounts**[147].

[147] See among others: CEBR (2010), The cloud dividend – The economic benefits of cloud computing to business and the wider EMEA economy, Etro F. (2011); The economics of cloud computing, available at: http://www.intertic.org/Policy%20Papers/Report.pdf; Forrester, Adoption Profile: Private cloud In Europe, Q3 2014, March 2015; Gartner "Cloud Service Providers must understand deployment, adoption and buyer complexity to leverage cloud revenue opportunities" 13 January 2015; Gartner, Forecast: Public cloud Services, 2012 – 2018, Q3 2014 update; Liebenau J.,et al (2012), Modelling the cloud . Employment effects in two exemplary sectors in the United States, the United Kingdom, Germany and Italy, LSE Enterprise; McKinsey, Disruptive technologies: Advances that will transform life, business, and the global economy (2013). See: http://www.mckinsey.com/insights/business_technology/disruptive_technologies; OECD, cloud computing: The Concept, Impacts and the Role of Government Policy, 2014

Estimates regarding the impact of cloud computing adoption to the macro-economic performance of the EU (including impact on GDP) vary. All of them, however, agree in identifying a positive impact.

It is estimated that **over the next five years**, cloud computing could add a **cumulative total revenue of EUR 449 billion to the EU28 GDP** (including in the public sector), of which EUR 57.7 billion and EUR 103.2 billion would be net new GDP generated in the years 2016 and 2020 respectively, representing a share of 0.4 and 0.71% of total EU GDP respectively[148]. It is estimated that in 2013, the adoption of cloud computing contributed EUR 27.9 billion to EU GDP, making up 0.2% of total EU GDP[149].

Looking back at the past five years, between 2010 and 2015, cloud computing could have generated over EUR 763 billion or 1.57% of GDP cumulative growth across the five largest EU economies (i.e. UK, Germany, France, Italy and Spain)[150]. During that period, cloud computing was estimated to contribute to annual growth of GDP in Europe by a rate between 0.1% per year in the short term under slow adoption assumption, reaching 0.4% in the medium term under the assumption of fast adoption[151]. By the year 2020, according to the baseline scenario, the net new impact of cloud on the EU GDP is expected to grow to EUR 103.2 billion representing a share of 0.71% of the total, more than 3 times of the share represented in 2013. This includes both the private and public sectors[152]. However, these estimates grow dramatically in case of removal of (part of) the barriers to cloud adoption. For instance, a study on the cloud computing uptake identifies a 'policy-intervention scenario', in which EU intervention addressing and relenting some of the most pressing issues around cloud is taken on. Under this policy intervention scenario, the public cloud spending is estimated at 38.3% compound rate (about EUR 80 billion), generating a contribution of up to EUR 250 billion to EU GDP in 2020, corresponding to an increase of EUR 162 billion with respect to the previous scenario, where no specific intervention to remove the key barriers to cloud computing is considered.

Furthermore, all analyses agree on the **positive impact of cloud computing on job creation and employment**. Estimates for job creation vary widely between sources and scenarios: between 300 000 and 2.5 million jobs have been created through cloud computing for the 2012 – 2015 period. According to study on the cloud computing uptake, the cumulative impact on employment is expected to reach 1.6 million jobs created between 2008 and 2020 (2.5 million according to the optimistic scenario and slightly over 1 million in the pessimistic scenario)[153]. CERB finds that widespread cloud computing adoption has the potential to support significant direct and indirect job creation, amounting to 2.3 million new jobs across the five countries analysed over the 2010-2015 period. In his paper, Etro suggests that impact on employment is of 300 000 new jobs under the slow adoption scenario and of more than 1 million jobs under the fast adoption scenario in the short-run (i.e. in the first two years after the adoption). The positive contribution to employment would be reduced in the following years, with a range between 70 000 and 700 000 new jobs created in the fifth year of the adoption process. About two thirds of job creation is expected to occur in the six largest countries (United Kingdom, Germany, France, Poland, Italy and Spain), but each country could

[148]Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC
[149]Ibid
[150] Ibid.
[151] See: Etro (2011, ibid.)
[152] Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC
[153] IDC, Ibid.

enjoy an increase in the work force. The positive contribution of cloud computing to the net creation of new jobs can be translated in a quicker reduction of the unemployment rate. The study estimates a reduction of the unemployment rate in the European countries due to the introduction of cloud computing between 0.1% and 0.3% in the short run and between 0.05 % and 0.2 % in the medium run. A study from the LSE[154] focuses on the impact of cloud computing on employment. It concurs in identifying a positive impact, and clarifies that the availability of skills to develop cloud computing technology will be crucial to achieve the full potential of this technology. Considering only the potential of creation of new jobs, a study on the uptake of cloud computing estimates that in the 'Policy-driven' scenario cloud -related workers could exceed 3.8 million, against some 1.3 million in the 'No Intervention' scenario. Importantly, all these studies agree that the job reduction due to jobs that would be lost or the workers displaced by cloud -related re-organisation of business processes and productivity increases would be overcome by job creation effects. Under all estimates above, **cloud computing emerges as a driver of net creation on employment.**

In terms of business creation, approximately 303 000 new businesses, in particular SMEs, could be created between 2015 and 2020 through the development and deployment of cloud computing[155]. Such estimate refers to the baseline scenario; figures range from about to 800 000 under the more optimistic scenario to about 96 000 under the pessimistic scenario in the same time period[156].

In addition, Etro quantifies the impact of cloud computing on public finance accounts via direct cost savings (e.g. reducing the public expenditure for IT) and indirect effects from new business creation, additional employment and additional income from taxation (which all contribute to GDP increase). In the short-term, the impact is estimated in a reduction of the deficit/GDP ratio of about 0.1% in the slow adoption scenario and of 0.2% in the fast adoption scenario across Europe.

The table below summarises the key economic benefits arising from cloud computing, the mechanism through which cloud computing produces the different types of benefit, and the key quantitative estimates available.

Table 11 – Summary of economic benefits of cloud computing

Benefit	Definition	Quantitative estimates
Business creation and macro-economic performance	The shifting of CAPEX into OPEX reduces entry barriers, especially for SMES, helping the creation of hundred thousand new companies in Europe, with substantial effects on GDP.	> A cumulative total revenue of EUR 449 billion to the EU28 GDP over 2010 – 2015. > Approximately 303,000 new businesses created, in particular SMEs, could be created between 2015 and 2020
Employment	Direct employment effects derive from the new companies entering the market and hiring workers. Indirect employment effects are associated with the suppliers to cloud service firms, such as telecommunication	Between 300 000 and 2.5 million jobs would be created through cloud

[154] Liebenau J.,et al (2012), Modelling the cloud . Employment effects in two exemplary sectors in the United States, the United Kingdom, Germany and Italy, LSE Enterprise
[155] Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC
[156] Ibid.

Benefit	Definition	Quantitative estimates
	energy, construction and maintenance firms. Inducted employment effects account for the added spending in the economy and the associated network effects of growing business activity beyond the direct effect on the using firms and the indirect effects on their suppliers.	computing for the 2012 – 2015 period.
Public finance accounts	Cloud computing improves public finance accounts through the direct impact on the public sector spending and the indirect one on the tax revenues.	Reduction of the deficit/GDP ratio of about 0.1% in the slow adoption scenario and of 0.2% in the fast adoption scenario across Europe

4.1.2 Benefits for professional users of cloud computing

Certain benefits for users of cloud computing have already been identified. A number of studies and analyses have estimated these and unanimously point to positive benefits, while the quantitative estimations of such benefits vary greatly. Below we provide an overview of the main benefits for professional users and their available estimates.

The main benefits of cloud computing for professional users, i.e. businesses and public sector organisations using cloud computing services, from cloud computing adoption have been identified and can be categorised along the following main elements:

- Reduction of ICT costs;
- Shift of IT costs from capital expenditure to operating expenses;
- Scalability and adaptability;
- Time to market;
- Management time.

Different studies have estimated that the adoption of cloud **computing services allow firms to reduce IT costs ranging from a 20% to 50% reduction** and to **shift IT costs from capital expenditure (CAPEX) to operating expenses (OPEX)**[157]. Additional cost savings for businesses adopting cloud computing services come from IT labour costs and from IT power and cooling costs. In the case of savings from IT labour costs, by outsourcing IT services, firms can reduce their IT headcount and/or redeploy staff into more productive IT areas such as application developments. In the case of savings from IT power and cooling costs, firms can reduce their energy bills by eliminating the need to power and cool servers and data centres[158].

The combined effect of costs savings and of the shift from CAPEX to OPEX triggers a mechanism that allows businesses to switch available resources from IT to other activities, such as R&D, investments in other areas, etc. This allows firms to invest more in innovation and productivity, freeing resources and improving the way of working (e.g. reducing development time and time to market). In addition, the shift

[157] Final Report of the study "SMART 2013/0043 - Uptake of cloud in Europe" Uptake of cloud in Europe Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, IDC
[158] CEBR (2010), The cloud dividend – The economic benefits of cloud computing to business and the wider EMEA economy.

from CAPEX to OPEX reduces the entry barriers, stimulating business creation and development opportunities[159]. These effects are deemed as particularly relevant for SMEs, which face the largest barriers to find financial instruments to finance their investments and thus the largest barriers to increase their productivity and innovation. The net IT cost savings were estimated to EUR 140.7 billion between 2010 and 2015 in across the UK, Germany, France, Italy and Spain[160], with IT CAPEX savings of EUR 154.7 billion and IT OPEX savings of over EUR 130 billion (73.829 billion related to FTE/productivity and EUR 56.349 billion related to power and cooling). The impacts of cloud on IT costs differ across countries and sectors, depending on several factors, such as the prevalence of SMEs and structural characteristics (e.g. broadband coverage, ICT adoption, etc.) as well as the rate of adoption of cloud computing.

The largest impact was expected to occur in the sectors of distribution and retail and of banking and finance, which are characterised by large adoption rates of cloud computing services, and can achieve large productivity gains through better management of seasonal peaks, faster time-to-market and IT scalability[161]. Across the five larger EU economies, the estimates are of net cost savings of EUR 85.354 million between 2011 and 2015 for the distribution and retail sector, and of EUR 40.405 million for the banking and finance sector.[162]

The efficiency of businesses is also a key element for the quantification of benefits from cloud computing services, together with high adoption rates and the structural characteristics of the different sectors of economic activities. Efficiency of business process is particularly relevant in the case of SMEs, which represent 99.7% of European businesses. Countries that combine the highest rates of cloud computing adoption with more efficient SMEs, are expected to higher levels of business creation, while countries with large but less efficient SMEs sector are expected to achieve less benefits in terms of business creation[163]. Across the largest economies in the EU, Germany is expected to have the largest benefits from cloud computing (as they combine large adoption rates with more efficient SMEs)[164].

Other effects of cloud computing adoption on firms (such as the increased adaptability and scalability, the new managerial practices and the reduced time to market) have been identified, but not quantified:

- **Scalability and adaptability**: grid computing provides cloud with elastic scalability, i.e. the ability to add and remove computing capacity on demand. This has a significant advantage in applications with a highly variable workload (such as seasonal peaks) or unpredictable growth, or for temporary applications. This benefit is directly related to the IT costs savings and the shift from CAPEX to OPEX, and allow businesses to adjust to seasonal peaks more efficiently. In addition, cloud computing minimises or eliminates planned and unplanned downtime, improving user service levels and business continuity.
- **Time to market**: application deployment is greatly accelerated as cloud computing shorten the product deployment cycle, improve the quality and availability of applications and maximize resources. Companies can rely on a ready-to-use infrastructure, easily customisable. This reduces the time needed to launch a new product/service on the market.

[159] CEBR (2010), ibid.)
160 CEBR (2010), ibid
[161] CEBR (2010), The cloud dividend: Part two– The economic benefits of cloud computing to business and the wider EMEA economy.
[162] CEBR (2010), The cloud dividend – The economic benefits of cloud computing to business and the wider EMEA economy.
[163] Ibid.
[164] Ibid.

- **Management time**: with IT management and computing processes on cloud computing, managers can re-shape the use of their time and dedicate more time and energy to strategy and innovation.

The reduction of IT costs, and the easy and quick deployment of solutions and the flexibility due to scaling services up or down have been acknowledged as main benefits by the businesses using cloud services. The Eurostat module on cloud computing reports that, out of the 151 000 of the 1.5 million enterprises in the EU-28 surveyed, more than half of them report to have experienced all or some of the benefits mentioned above, with peaks of more than 85%[165]. These results are consistent across business' size, sectors and type of cloud deployment model adopted (i.e. Public, Private or Hybrid cloud).

The table below summarises the main benefits for professional users arising from cloud computing, the mechanisms for those benefits to manifest, and the quantitative estimates available.

Table 12 – Summary of benefits of cloud computing for companies/users

Benefit	Definition	Quantitative estimates
Costs savings	The largest and most identifiable economic benefit of cloud computing is the direct cost savings from changes within the organisation (such as from reduced IT infrastructural investment and maintenance)	- Reduction of total IT costs between 20% and 50% - Overall savings in IT costs of EUR 140.74 million between 2010 and 2015 in across the UK, Germany, France, Italy and Spain
Operating expenses	Cloud computing costs lowers the operating expenses of firms (OPEX). This allows firms to have more capital available for other investments (CAPEX) fostering productivity and growth.	- IT OPEX savings of over EUR 130 million between 2010 and 2015 in across the UK, Germany, France, Italy and Spain (73.829 million related to FTE/productivity and EUR 56.349 billion related to power and cooling) - IT CAPEX savings of EUR 154, 7 million between 2010 and 2015 in across the UK, Germany, France, Italy and Spain (73.829 million related to FTE/productivity and EUR 56.349 million related to power and cooling)
Scalability and Adaptability	Grid computing provides cloud with elastic scalability, i.e. the ability to add and remove computing capacity on demand. This has a significant advantage in applications with a highly variable workload (such as seasonal peaks) or unpredictable growth, or for temporary applications. In addition, cloud computing minimises or eliminates planned and unplanned	N/A

[165] See: http://ec.europa.eu/eurostat/statistics-explained/index.php/Cloud_computing_-_statistics_on_the_use_by_enterprises

Benefit	Definition	Quantitative estimates
	downtime, improving user service levels and business continuity.	
Time to market	Application deployment is greatly accelerated as cloud computing shorten the product deployment cycle, improve the quality and availability of applications and maximize resources. Companies can rely on a ready-to-use infrastructure, easily customisable. This reduces the time needed to launch a new product/service on the market.	N/A
Management time	With IT management and computing processes on cloud computing, managers can re-shape the use of their time and dedicate more time and energy to strategy and innovation.	N/A

4.1.3 Environmental benefits

Other types of benefits identified concern mostly the **environmental aspects of the cloud computing technology**.

Cloud computing firms are investing into energy efficiency and progressively improving their performances in this respect. The widespread adoption of cloud computing technology can represent an important push towards more energy-efficient technology.

Several factors enable cloud computing to lower energy use and carbon emissions from IT, namely[166]:

- Dynamic Provisioning: Reducing wasted computing resources through better matching of server capacity with actual demand;
- Multi-Tenancy: Flattening relative peak loads by serving large numbers of organisations and users on shared infrastructure;
- Server Utilization: Operating servers at higher utilisation rates.
- Data Centre Efficiency: adopting advanced data centre infrastructure designs that reduce power loss through improved cooling, power conditioning, etc.

While large organizations can lower energy use and emissions by addressing some of these factors in their own data centres, providers of public cloud infrastructure are best positioned to reduce the environmental impact of IT because of their scale. As much as 8% to 9%of electricity used for cloud computing is lost just transferring energy to the servers themselves[167]. This means that energy cost and energy efficiency are important aspects in data centre management. Many cloud computing providers are focusing on harnessing technology to help reduce their data centre's **power usage effectiveness (PUE)**, which is an energy efficiency metric for data centres. A PUE value of 1.0 means that the data centre is completely

[166] Cloud Computing and the Sustainability: The Environmental Benefit of moving to the cloud (2010), Accenture, WSP and Microsoft
[167] R.H. Katz, (2009), Tech titans building boom, IEEE Spectrum (February), at http://www.spectrum.ieee.org/feb09/7327 accessed 23 February 2009.

optimal and losses almost no energy in either cooling systems or in the distribution of electricity. Currently most data centres average a PUE value of 2.0 or more). To help reduce their PUE, data centres often look to green technology or even their surrounding location to harness the local environment as a mechanism for either improved distribution or cooling[168].

Several strategies to save energy in an efficient way are under consideration, which include both hardware and software solutions. Energy saving strategy for compiling technology, of application software power, of Virtual Machine Manager, of Hardware Temperature Control, server consolidation and use of renewable energy sources are some of these strategies[169].

Studies[170] estimate that **cloud computing reduces carbon emissions of 30% for large, already efficient companies and up to 90% for the smallest and less efficient businesses**. Clearly, provisions such as data location requirements can hamper this type of benefits. For instance, where data location requirements oblige providers to duplicate their data centres in several locations, can reduce (up to cancel) the positive environmental impacts of cloud computing.

The table below summarises key externalities from the adoption of cloud computing, and the quantitative estimates available.

Table 13 – Summary of other benefits of cloud computing

Benefit	Definition	Quantitative estimates
Environmental impacts	Substantial positive externalities are expected from a massive adoption of cloud computing because of energy savings: the improvement of energy consumption and efficiency can lead to a substantial reduction of carbon emissions.	Reduction of carbon emission: 30% for large, companies and up to 90% for the smallest and less efficient businesses.

4.2 Modelling costs and benefits of cloud computing in Europe

The final objective of the cost-benefit analysis is to quantify the net impacts of the policy measures considered within the study to remove existing barriers to the uptake of cloud computing. For this, a model able to include the relevant variables and their inter-relationships needs to be designed.

4.2.1 Model for cost-benefit analysis of cloud computing in Europe

The analysis is based on a model for Cost-Benefit Analysis (CBA) that builds on the key parameters identified in literature and described above.

[168] Ibid.
[169] Borah A.M., Muchahary D., Singh S.K., and Borah J. (2015), Power Saving Strategies in Green cloud computing Systems, in International Journal of Grid Distribution Computing, Vol.8, No.1, pp.299-306, available at: http://dx.doi.org/10.14257/ijgdc.2015.8.1.28, accessed June 2015
[170] cloud computing and the Sustainability: The Environmental Benefit of moving to the cloud (2010), Accenture, WSP and Microsoft and http://www.scientificamerican.com/article/cloud-computing-saves-energy/

In order to achieve the objective mentioned above, the cost-benefit analysis first outlines the **baseline scenario**, capturing the status quo of uptake of cloud computing, as well as the benefits and costs for different stakeholders.

As a second step, the **impacts of the various policy initiatives** will be assessed in terms of their effect on cloud uptake, benefits and costs for involved stakeholders. The overall framework of the CBA is detailed in the figure below.

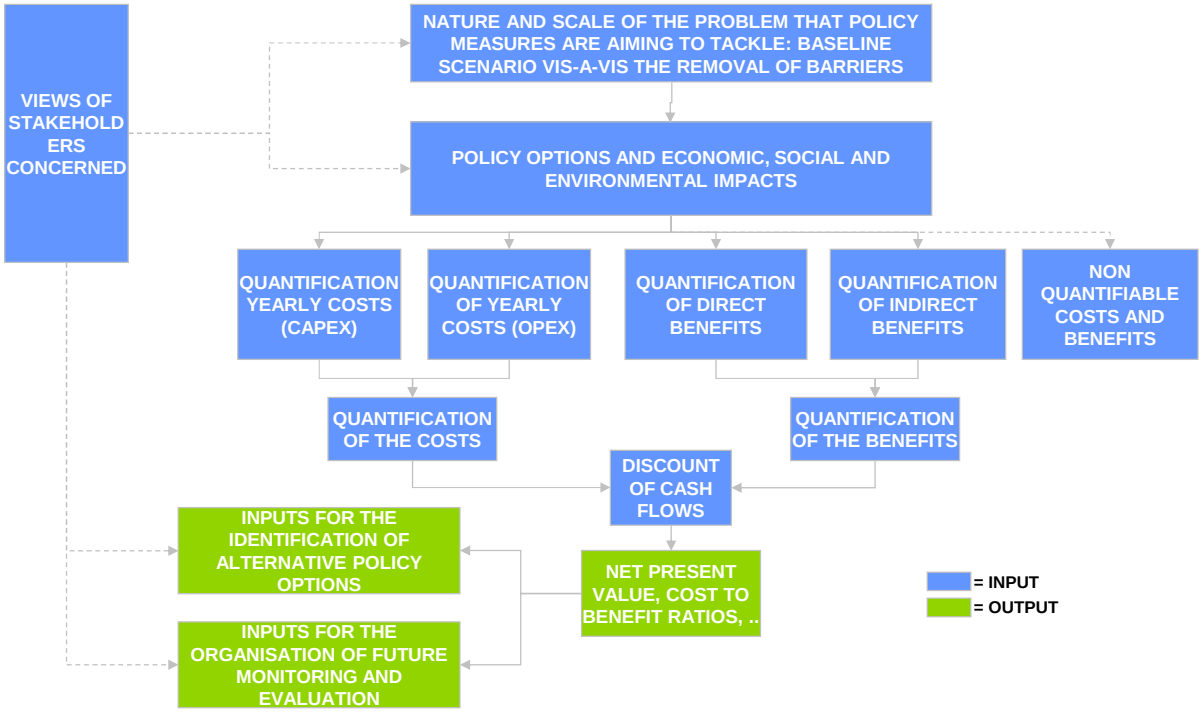


Figure 30 – Overall framework of the CBA

The first step of the assessment, which is described in detail in the next section, is the creation of the baseline scenario. The generation of impacts by cloud computing for key involved stakeholders is summarised in the figure below.

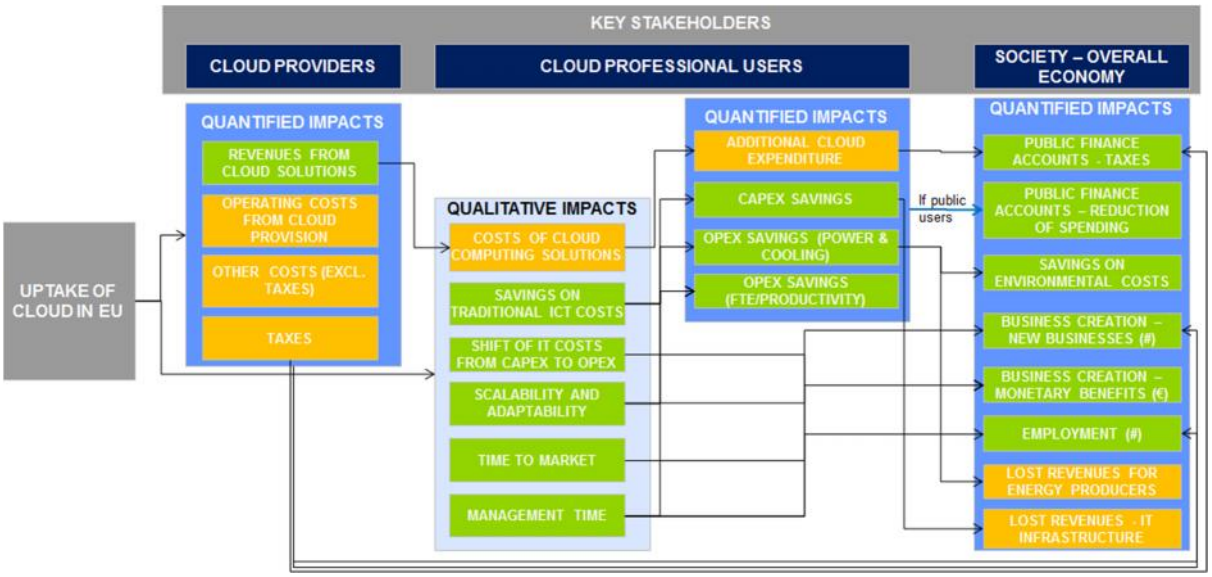


Figure 31 -Framework of the baseline scenario

The **uptake of cloud computing** services (SaaS, PaaS and IaaS) in EU is the "engine" of the model, since it represents the key enabler of business generation for cloud **providers**, benefits from use (as well as additional cloud expenditure) for **professional users**, as well as a range of impact for the **wider economy and the society**.

Looking first at the impacts on cloud **providers**, the provision of cloud computing services generates benefits in the form of **revenues** which can be quantified as the overall EU expenditure for cloud services. Associated to these revenues are the **costs** related to the provision of cloud services. In order to support the next phases of the assignment, it is appropriate to isolate **operating costs** of cloud providers, since this dimension is expected to be impacted by different policy measures considered in the study. **Other costs** (e.g. R&D costs, IT investment costs, etc.) sum up to operating costs and enable to arrive at the pre-tax results. Finally, taxation (representing a cost for providers and a benefit for public finance) is the last element to be subtracted in order to estimate **profits** for cloud providers, which represent the net benefits for this stakeholder category.

The provision of cloud services to **(professional) cloud users** generates a series of effects, which are described in the next section of this chapter. Along with the **cost** of purchasing cloud solutions, a series of positive effects are achieved (as identified by literature), namely:

- Reduction of ICT costs;
- Shift of IT costs from capital expenditure to operating expenses;
- Scalability and adaptability;
- Time to market [acceleration];
- Management time [reallocation].

Based on the outcomes of the desk research and available data, these drivers of costs and benefits can be quantified based on the following dimensions:

- Additional cloud expenditure (cost), as an effect of purchasing cloud solutions;
- CAPEX savings (benefit) due to the shift of IT costs from capital expenditure to operating expenses;
- OPEX savings – power and cooling costs (benefit) as an effect of the reduced IT infrastructure due to the shift to cloud ;
- OPEX savings – productivity related (benefit) as an effect of the reallocation of resources (IT, management) enabled by cloud ;

In case the users are in the public sphere, the different drivers of savings generate also a positive impact on **public finance accounts** through the direct impact on the public sector spending and the indirect one on the tax revenue (see also section 4.1.1).

In addition, cloud users would also experience benefits in terms of higher scalability and adaptability, faster time to market and shift of IT costs from capital expenditure to operating expenses. All of these would in turn result in **business development opportunities** and **business creation**.

The **wider economy and society** would experience benefits in terms of higher **employment**, resulting from the growth of existing enterprises, as well as market entry of new enterprises. Positive impacts under these dimensions are also expected to be generated by the growth in number of cloud providers, as an effect of the increase of the cloud market (considering employment, available literature estimates the net effect on employment (new jobs generated by cloud vs. disruption of existing businesses) as being positive.

The reduction of power and cooling costs will also generate positive externalities in terms of **reduced environmental footprint**, due to the overall reduction of energy consumption. It is worth underlining that the savings achieved by users in terms of reduced power and cooling costs are foreseen to be **counterbalanced** by **lost revenues** for energy producers. This effect should be taken into consideration, even if energy producers are not the primary focus of the analysis.

The “compensation effect” above is not the only one: additional effects that are considered in the model include:

- Saving on CAPEX expenses by users lead to a reduction of revenues for providers of “traditional” IT infrastructure solutions;
- The provision of cloud services will generate taxation costs for both providers and users, which will be counterbalanced by the positive impact on public finance accounts

In addition, multiplier effects are generated by the combination of business creation enabled by cloud adoption, combined with the benefits it offers to companies in terms of CAPEX and OPEX savings. Existing literature[171] recognises and quantifies this effect, which is visualised in the figure below, as an additional **benefit** of cloud computing for the wider economy.

[171] See e.g. CEBR, cloud Dividend Report, 2011

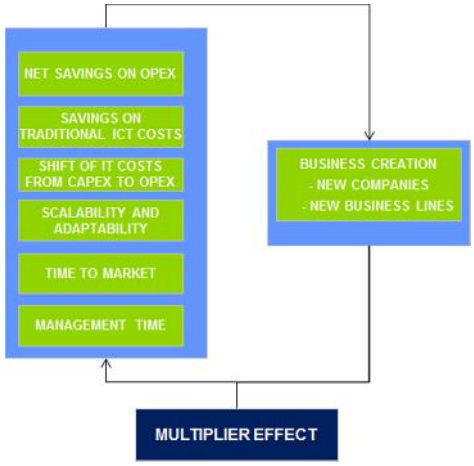


Figure 32 – Illustrative logic behind the multiplier effect

All drivers of costs and benefits, along with the results of data gathering activities, are explained in detail in the next sections.

4.2.2 Gathering insights on costs and benefits – data sources

Secondary data

The cost-benefit analysis model uses a set of secondary data sources. These are summarised in the figure below and described in more detail in the next section.

Table 14 – Cost-benefit analysis data sources

Model element	Data source
Uptake of cloud computing	IDC (2014), Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up
Total expenditure on cloud computing	IDC (2014), Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up
Cloud providers' cost and profit structure	Orbis database
Benefits to professional cloud users	CEBR (2010), The cloud dividend – The economic benefits of cloud computing to business and the wider EMEA economy.
Electricity costs and electricity production costs	Eurostat Energy Price Statistics European Environment Agency external costs of electricity production data

Stakeholders consultations

The study collected additional inputs (both quantitative and qualitative) from stakeholders' consultation via interviews[172], online surveys (a cloud computing professional users' survey[173] and a cloud computing providers' survey[174]) and ad-hoc sessions at two C-SIG plenary meetings (one held on October 29 2015 and the second on June 27 2016).

The stakeholders' consultations provided relevant inputs in the modelling of the baseline scenario. In particular:

- for **professional users**: on level of take-up and drivers, level of IT expenditure, barriers and cost of adoption;
- for **providers/intermediaries**, on annual turnover, FTE, types of service and deployment models, geographical markets, types of customers (B2B, B2C, B2G) and sectors;

For the **demand side**, questions aim at understanding their current adoption of cloud computing services or plans to adopt, which types of services they are using (or considering to use), and what are the benefits they have experienced (or expect to have). The typology of benefits included is consistent with the findings from literature, and include the shift of IT expenditure from CAPEX to OPEX and the reduction of IT expenditure.

Similarly for the **supply side**, providers are asked to what extent cloud computing services are a relevant part of their turnover, which types of customers they serve (i.e. active in which sector or sectors of economic activity), which markets they are engaged in (e.g. domestic only or in one or more EU Member States or third countries).

Both users and providers of cloud computing services were asked the main barriers to the wider adoption of cloud computing services, linked to those identified via desk research and strategic interviews, and summarised in section 3.2 of this report. The purpose of these questions was to validate the list of the relevant barriers, and to assess which of them were reported as more relevant by the stakeholders engaged.

[172] The list of interviews carried out is available in annex D.
[173] The cloud computing professional users' survey is available online at: https://www.surveymonkey.com/r/8KLNBLN. Please see also annex B
[174] The cloud computing providers' survey is available online at https://www.surveymonkey.com/r/8XP85LK. Please see also annex C

5 Baseline scenario of costs and benefits of cloud comptuting in Europe

This section presents the results of our model on the costs and benefits of cloud computing to the baseline scenario for measuring the economic impact of cloud computing in Europe.

Based on the market trends identified in section 3, the aim is to develop a model that can be used to estimate the baseline scenario and later the potential impacts in terms of costs and benefits that may result from the policy scenarios as defined in section 2. It reflects the baseline scenario of cloud computing in Europe, and answers to the question '*how will the market for cloud computing evolve in absence of further policy measures?'*

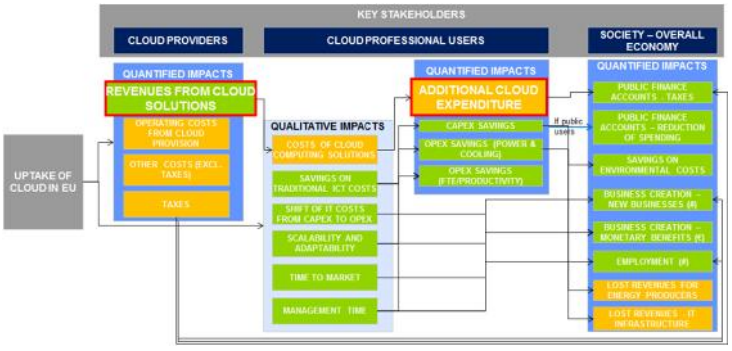
The following sections outline the key findings on the development and impact of cloud computing in Europe and how they are used to populate the baseline model (Section 5.2), as well as explaining how the baseline scenario will support the assessment of costs and benefits of the proposed measures (Section 5.3).

5.1 Development of cloud computing in Europe

5.1.1 External parameters for the baseline scenario

EU Expenditure on cloud Services

Data on EU expenditure on cloud solutions is used, in the frame of the model, to estimate the **additional cloud expenditure** by professional end users, as well as the **revenues for cloud providers.**



EU expenditure on cloud services is the area of investigation with the highest coverage of sources. Among

considered sources, IDC[175] and Gartner[176] are the ones with the most suitable geographical coverage (respectively EU28 and Eastern plus Western Europe) and higher availability of future projections (time span up to respectively 2020 and 2018)[177].

The figures provided for Public cloud expenditure, when considering overall numbers are significantly different, with Gartner estimating an overall expenditure higher than the one of IDC by a factor of between 3 and 4[178].

Gartner figures, however, include additional services to SaaS, PaaS and IaaS (namely BPaaS and cloud Advertising). After removing the data on expenditure on these services, IDC (baseline scenario) and Gartner estimates show very similar results, as shown in the figure below.

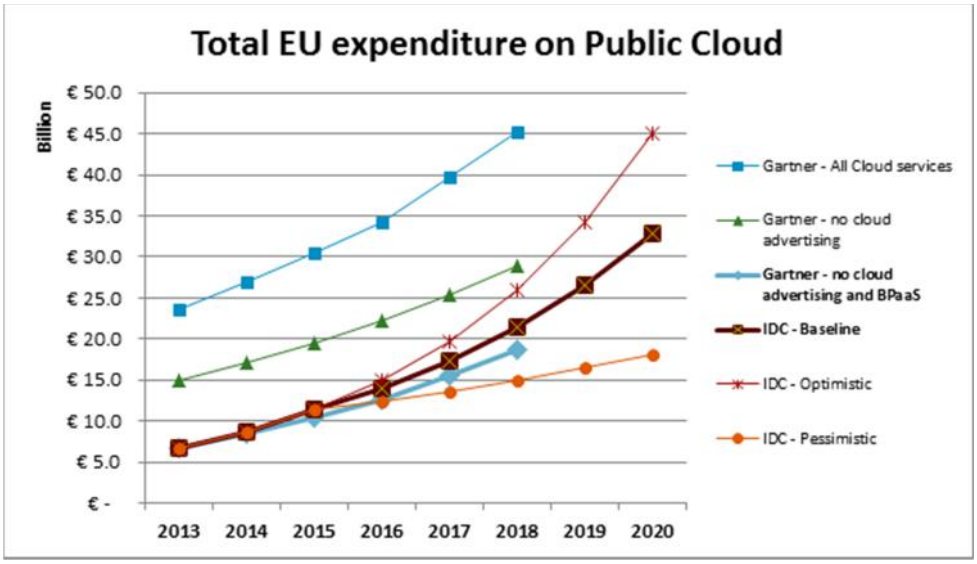


Figure 33 – Estimates of EU expenditure on Public cloud services

The following table shows Public cloud expenditure data in more detail (figures in EUR million):

Table 15 – Public cloud expenditure estimates by Gartner and IDC

Total EU expenditure on Public cloud	2013	2014	2015	2016	2017	2018
Gartner - no cloud Advertising and BPaaS	EUR 6.740	EUR 8.397	EUR 10.433	EUR 12.673	EUR 15.446	EUR 18,.674
IDC - Baseline	EUR 6.699	EUR 8.709	EUR 11,317	EUR 13.999	EUR 17.317	EUR 21.421
% Difference	0.61%	3.58%	7.81%	9.48%	10.81%	12.82%

[175] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up
[176] Gartner - Forecast: Public cloud Services, Worldwide, 2012-2018, 3Q14 Update
[177] Data of expenditure on cloud computing services already include public sector expenditure.
[178] Gartner data are in US dollars and have been converted in Euro by using figures provided by Gartner itself on expected future exchange rates, which are in line with the average exchange rate of the last 5 years.

These figures are homogeneous, and future differences are perfectly in the range of possible fluctuations in the EUR/USD exchange rate, which is a significant variable as Gartner estimates are provided in Dollars.

In the baseline scenario of this study, we thus refer to the baseline figures provided by IDC, since:

- Figures are provided in the Euro currency, protecting estimates from future fluctuations in the exchange rate;
- Data is available for a longer timespan (2020 vs. 2018);
- IDC also provides data on Private cloud expenditure, as outlined in the next section.

IDC also provides an estimate of EU expenditure for Private cloud services, which is expected to grow by a factor of 4 over 8 years in the baseline scenario (from less than EUR 3 billion in 2013 to EUR 12 billion in 2020).

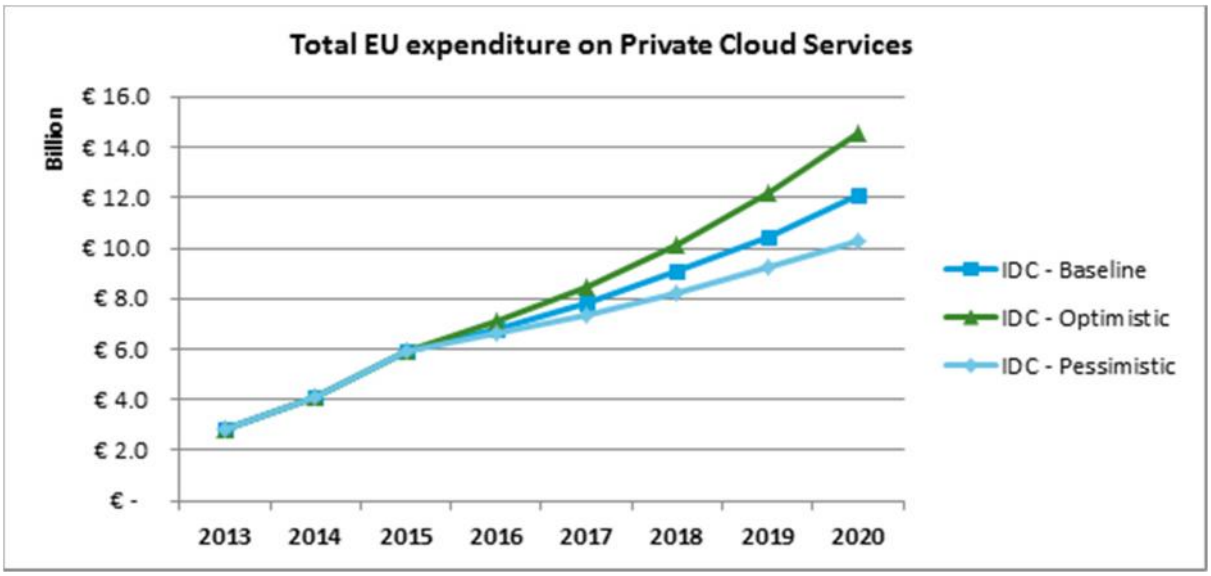


Figure 34 – IDC estimates of EU expenditure on Private cloud services

As in the case of Public cloud, in the baseline scenario of this study, we use the estimates provided by IDC. The total cloud market in the EU by 2020 is expected to be worth EUR 44.8 billion in the absence of new measures, out of which Public and Private cloud services in EU for all 28 Member States are estimated to account for EUR 32.7 billion and EUR 12.06 billion respectively.

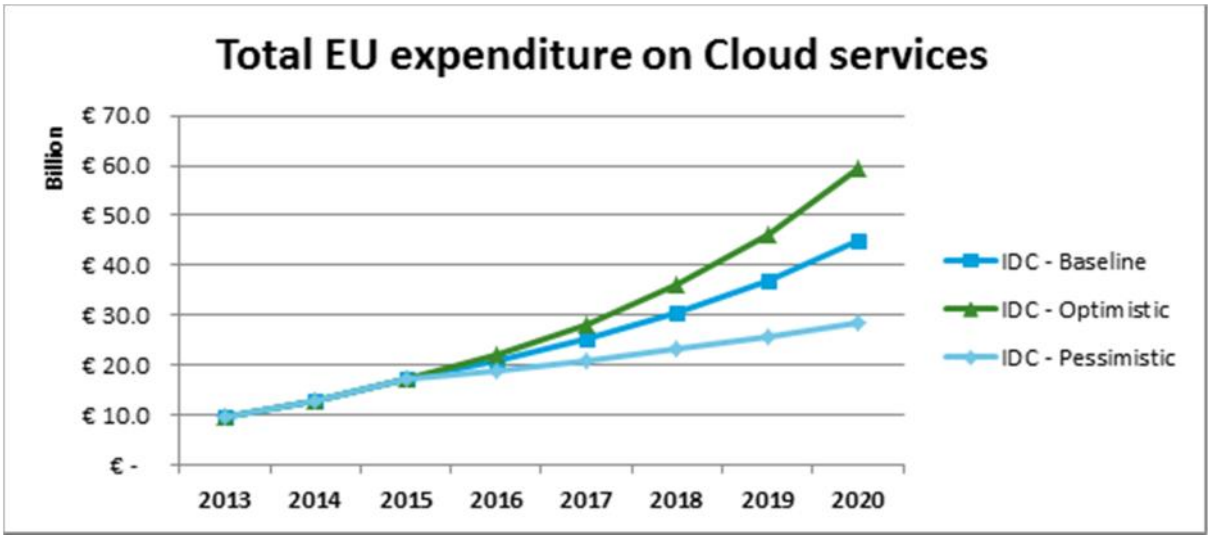
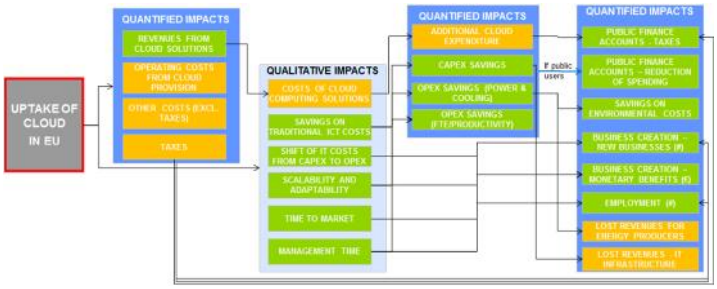


Figure 35 – Baseline scenario – estimated EU expenditure on cloud services

While the baseline scenario uses the realistic/baseline IDC figures, the optimistic and pessimistic projections are also valuable. On one hand, the pessimistic figures can serve as an illustration of a baseline scenario under an assumption that on-going policy developments (other than the options assessed in this study) actually slow down cloud adoption.

On the other hand, the figures provided by IDC for the optimistic scenario can be used as a reference to perform "sanity checks" on the estimated impact of considered policy measures. As noted in the IDC study, "*The policy driven scenario* [included in the study] *might be considered as partially similar to the optimistic scenario of this study, insofar they both assume a fast growth of the market. However, macroeconomic perspectives of growth and development in Europe are today much more pessimistic than a few years ago, and this has resulted in more cautious predictions of growth to 2020.*"

Uptake of cloud computing in Europe



As mentioned in section three, there are very different estimates for the **uptake of cloud computing**. According to a recent survey from Eurostat, only a fifth (19%) of EU companies used cloud computing services in 2014. The results are significantly lower than the outcomes of other surveys on the same topic. However, these data are the most reliable due to the very large sample of companies covered by the survey.

Alternative sources are much more optimistic in terms of cloud uptake estimation. The IDC vertical markets survey[179] estimated that of companies adopting cloud computing in the EU about 72% indicated to expect

[179] Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014). See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742

to use at least one Public cloud service in 2015 while 48% indicated the use of at least one Private cloud service.

Aside from the differences in data among available sources, two additional elements of complexity in the estimation of cloud uptake are:

- The differences in existing categorization of services;
- The different intensity of usage of the same service, e.g. in terms of workload shift from traditional IT solutions;
- The potentially high number of different cloud services used at the same time within the same organization.

At the same time, however, estimating the uptake of cloud computing is a key element to assess the impact of the investigated measures. We thus propose, as an actionable indicator of the increase in adoption of cloud computing, to link uptake to the increase in cloud expenditure by users[180]. By using IDC figures, a proxy indicator can be developed: This is illustrated below using 2013 as a starting year with an index value of 1.00.

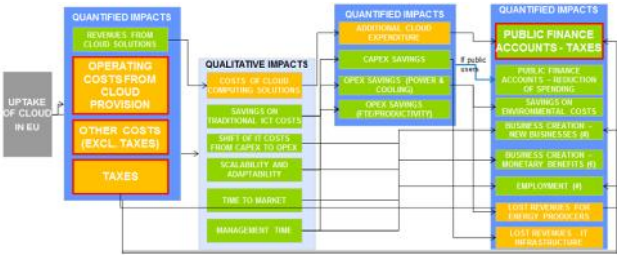
Table 16 – Illustration of proxy indicators suggested for cloud uptake

	2013	2014	2015	2016	2017	2018	2019	2020
Uptake of Public cloud in EU	0.70	0.91	1.19	1.47	1.81	2.24	2.78	3.43
Uptake of Private cloud in EU	0.30	0.43	0.62	0.71	0.82	0.95	1.10	1.26
Total uptake of cloud in EU	**1.00**	1.34	1.80	2.18	2.64	3.19	3.87	4.70

Although the indicator does not capture a precise quantification of the number of cloud services in use, or of the number of companies using at least one cloud service, it is capable of taking into account expected changes in both market penetration and usage intensity.

5.1.2 Cost and benefit parameters for key players in the baseline scenario

Cost elements for cloud providers



Revenues for cloud providers are an important indicator of the value of cloud computing market in Europe, but are not the best indicator of the **net benefits** for the industry. These can be best captured by estimating the **profits** generated from the provision of cloud services. Profits can be quantified through a top-down approach, starting from identified revenues and by subtracting the estimate of the key cost components (e.g. operating

[180] Thus formulating the strong assumption that price levels will remain stable over the time.

costs, other costs, taxes) based on the average of the sector. To calculate this average, we have extracted financial data for the top 100 cloud providers in the EU[181] from the Orbis database, using the market shares to determine the different weights of the various cost components for companies with different importance on the market.

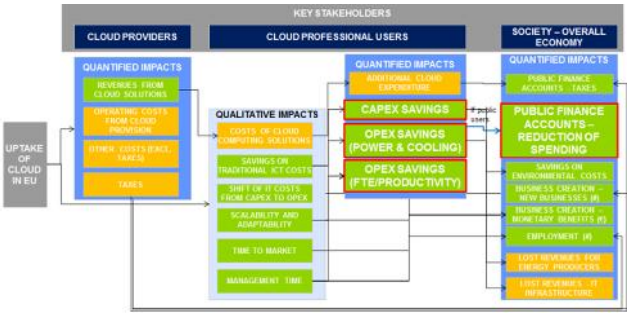
Table 17 – Cloud providers' cost structure

	2010	2011	2012	2013	2014	2010-2014
Operating profit/loss (%)	19.98%	18.78%	20.95%	19.43%	19.70%	19.75%
Operating cost (%)	80.02%	81.22%	79.05%	80.57%	80.30%	80.25%
Net income (%)	14.95%	13.68%	15.16%	15.43%	12.33%	14.31%

The costs of taxation in the model represents a cost for companies and a source of benefit for the society by generating a positive impact on the public finance accounts.

Benefits for professional end users

The implementation of cloud computing by professional end users is driven by a series of advantages which can be achieved thanks to the adoption of the services. In the Cloud Dividend Reports 1 and 2, CEBR provides an estimation of these benefits, by distinguishing three categories of benefits:



- **IT CapEx savings:** IT CapEx and asset maintenance – the elimination of server and storage costs and their replacement with utility-type cloud computing capabilities
- **IT OpEx savings (FTEs / productivity):** IT operations – the reduction of IT headcount, through the effective outsourcing of IT services, and their re-deployment in more productive areas of IT (such as applications development);
- **IT OpEx savings (power & cooling):** the reduction of IT power & cooling costs and the resulting savings on energy bills

The studies provide the estimations of cumulative benefits and cost dimensions in the 5 largest EU economies between 2010 and 2015 as shown in the table below.

[181] See Uptake of cloud in Europe, Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up, Annex A

Table 18 – *Cumulative costs and benefits of cloud computing – Source: Cloud Dividend reports*

Costs and benefits (EUR Million)	France	Germany	Italy	Spain	UK	TOTAL
Business development opportunities	**24 599**	**32 642**	**23 995**	**16 866**	**29 555**	**127 657**
Business creation	**51 377**	**69 507**	**43 305**	**30 939**	**20 026**	**215 153**
Net total cost savings of which:	**26 323**	**37 740**	**28 463**	**22 008**	**26 206**	**140 740**
-IT CapEx savings	28 653	36 378	30 461	23 013	36 176	154 682
-IT OpEx savings	13 818	18 139	14 533	10 396	16 943	73 829
-IT OpEx savings (power and cooling)	11 107	14 345	11 821	8 510	10 566	56 349
-Additional cloud expenditure (PAYG)	-27 255	-31 122	-28 353	-19 910	-37 481	-144 120
Indirect GVA	**60 450**	**81 351**	**55 007**	**40 737**	**42 202**	**279 747**
Total Economic Benefit	**162 749**	**221 239**	**150 770**	**110 550**	**117 989**	**763 297**
Direct and indirect employment (000s)	**469**	**789**	**456**	**392**	**289**	**2 396**

By taking into account the assumptions performed by CEBR on cloud adoption and uptake, the figures can be extrapolated for the year 2015 assuming maximum adoption of cloud.

Table 19 – *Costs and benefits for users in 2015 – full cloud uptake – Source: Cloud Dividend reports*

Costs and benefits (EUR)	France	Germany	Italy	Spain	UK	TOTAL
-IT CapEx savings	13 865 380 587	18 777 131 051	13 873 208 491	10 481 078 986	15 004 981 023	**72 001 780 139**
-IT OpEx savings	6 686 623 703	9 62 757 165	6 618 933 686	4 734 771 527	7 027 570 585	**34 430 656 665**
-IT OpEx savings (power and cooling)	5 374 752 458	7 404 418 740	5 383 775 896	3 875 808 551	4 382 536 198	**26 421 291 843**
-Additional cloud expenditure (PAYG)	-13,188,878,928	-16 064 156 154	-12 913 137 466	-9 067 843 507	-15 546 265 306	**-66, 80 281 361**

Although the data refers only to a selection of countries and the amount of costs and benefits in the EU cannot be extrapolated directly, CEBR data enables to calculate benefit-cost ratios for end users. The adoption of cloud computing is therefore foreseen to have a benefit-cost ratio (BCR) of 2, meaning that every Euro spend by a potential user in cloud technology is foreseen to generate almost 2 Euros from savings, more precisely EUR 1.08 in IT CapEx savings, EUR 0.52 thanks to IT OpEx savings and EUR 0.40 due to IT OpEx savings related to power and cooling.

Applying the BCR to the yearly expenditure on cloud enables to estimate the total savings for users. These represent benefits for businesses and for public finance accounts, in case users are public entities.

The BCR figures used in the cost-benefit model, expressed as percentages, are shown below.

Table 20 – *BCR for users in 2015 – full cloud uptake – Source: Cloud Dividend reports*

BCR	All sectors	Finance & Business services	Government, education & health	Distribution, Retail & Hotels	Manufacturing	Other sectors
Business development opportunities	89%	122%	69%	81%	79%	99%
Business creation	154%	234%	242%	56%	122%	363%
IT CapEx savings	108%	62%	95%	140%	84%	129%
IT OpEx savings	52%	41%	48%	58%	47%	60%
IT OpEx savings (power and cooling)	40%	33%	39%	48%	33%	32%

Additional impacts for the wider economy and the society

In addition to those impacts, the team also investigated broader impacts for the wider economy and society, including:

- Lost revenues for traditional IT suppliers;
- Lost revenues for energy producers;
- The environmental impact of power and cooling CapEx savings, thanks to the reduced energy consumption.

It is worth noting that from the point of view of the economy as a whole, lost revenues to particular economic operators (IT producers or IT suppliers) are offset by savings to the professional cloud users and can therefore be seen as transfers from one group to another, bringing no net benefit on the level of the economy as a whole. Therefore, these impacts have been excluded from the model, with the impact on society focusing on the environmental impact resulting from reduced energy consumption, as well as benefits to the government in terms of tax revenue (VAT and income tax).

5.2 Costs and benefits under the baseline scenario

The following sections outline the outcomes of the cost-benefit analysis carried out for the baseline scenario.

5.2.1 Net benefit to users, providers and wider economy and society

The cost-benefit analysis based on the aforementioned secondary sources and driven by the baseline projections of cloud uptake developed by IDC allows to estimate the costs and benefits to users, providers, and the economy as a whole in the period up to 2020.

The following table outlines the costs and benefits to **professional cloud users** aggregated on EU28 level.

Table 21 – *Costs and benefits to cloud users – baseline scenario*

Costs and benefits (EUR Million)	2015	2016	2017	2018	2019	2020
Monetized benefit 1: business development opportunities	15 372	18 616	22 543	27 300	33 061	40 019
Monetized benefit 2: business creation	26 520	32 116	38 892	47 099	57 037	69 042
Monetized benefit 3: reduction of CAPEX	18 564	22 481	27 225	32 969	39 926	48 330
Monetized benefit 4: reduction of OPEX	8 877	10 750	13 019	15 766	19 092	23 111
Monetized benefit 5: reduction of OPEX (power and cooling)	6 812	8 250	9 990	12 098	14 651	17 735
Monetized cost 1: VAT	-3 720	-4 505	-5 456	-6 607	-8 001	-9 685
Monetized cost 2: cost of cloud services	-13 498	-16 346	-19 795	-23 971	-29 029	-35 140
Net Benefit:	**58 928**	**71 362**	**86 419**	**104 654**	**126 736**	**153 412**

As can be seen in the figure above, under the baseline scenario, the users would experience a considerable net benefit across all years, with the overall benefit growing together with cloud uptake to exceed EUR 150 billion by 2020. This evolution is shown in the figure below.

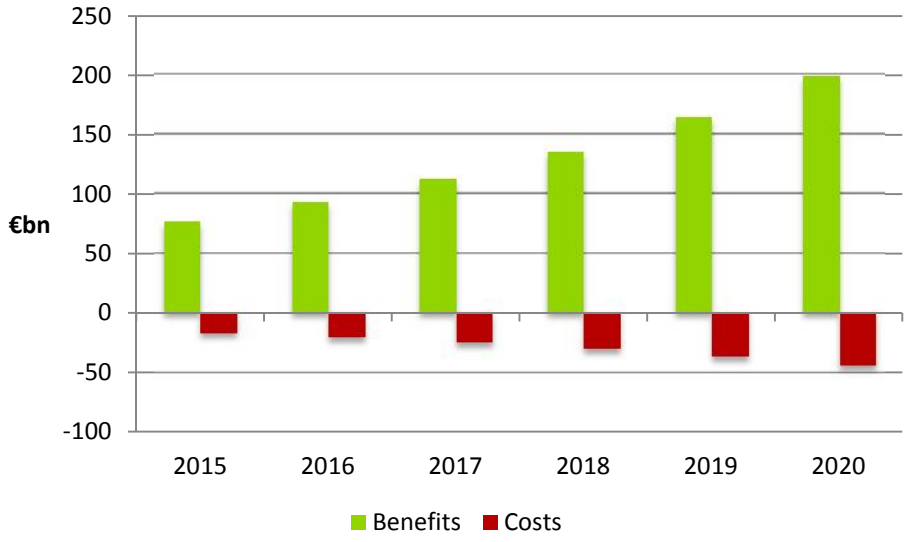


Figure 36– *Costs and benefits to cloud users – baseline scenario*

Cloud providers are also projected to experience a net benefit under the baseline scenario, although the overall magnitude of that net benefit aggregated across the EU28 is considerably lower.

Table 22 – *Costs and benefits to cloud providers – baseline scenario*

Costs and benefits (EUR Million)	2015	2016	2017	2018	2019	2020
Revenues from cloud services	17 218	20 851	25 251	30 578	37 030	44 825
Operating costs from cloud services	-13 817	-16 733	-20 263	-24 539	-29 717	-35 972
Monetized benefit 1: net profits from cloud services	2 464	2 984	3 614	4 376	5 300	6 415
Monetized cost 1: Income tax	-696	-843	-1 021	-1 237	-1 498	-1 813
Net Benefit:	**1 768**	**2 141**	**2 593**	**3 140**	**3 802**	**4 602**

As in the case of net benefit to cloud users, the net benefit to providers is projected to grow to 2020, driven by accelerating cloud uptake.

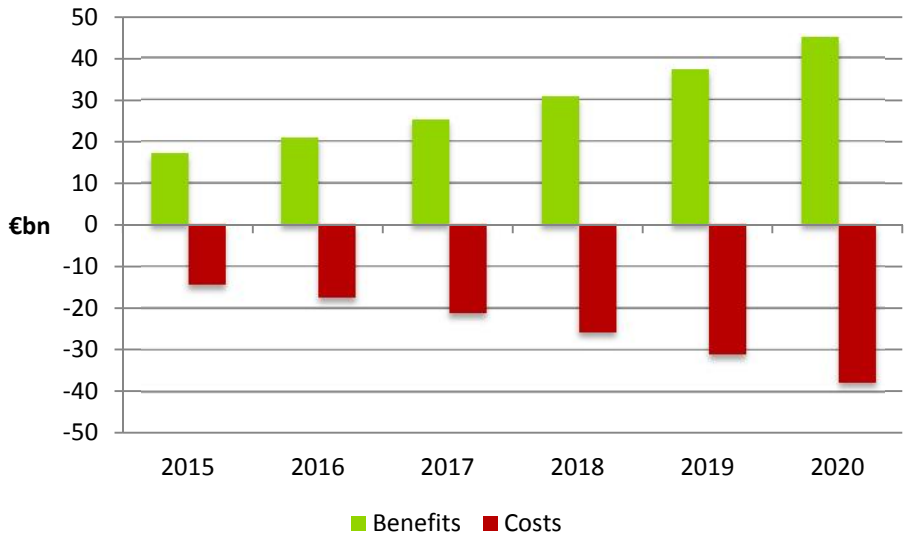


Figure 37 – *Costs and benefits to cloud providers – baseline scenario*

Finally, from the point of view of **the wider economy and society** the baseline scenario envisages a range of benefits, as shown below.

Table 23 – *Costs and benefits to the wider economy and society – baseline scenario*

Costs and benefits (EUR Million)	2015	2016	2017	2018	2019	2020
Monetized benefit 1: VAT	3 720	4 505	5 456	6 607	8 001	9 685
Monetized benefit 2: Income tax	696	843	1 021	1 237	1 498	1 813
Monetised benefit 3: reduced costs of environmental impact due to cloud	1 831	2 218	2 685	3 252	3 938	4 767
Net Benefit:	**6 248**	**7 566**	**9 163**	**11 096**	**13 437**	**16 266**

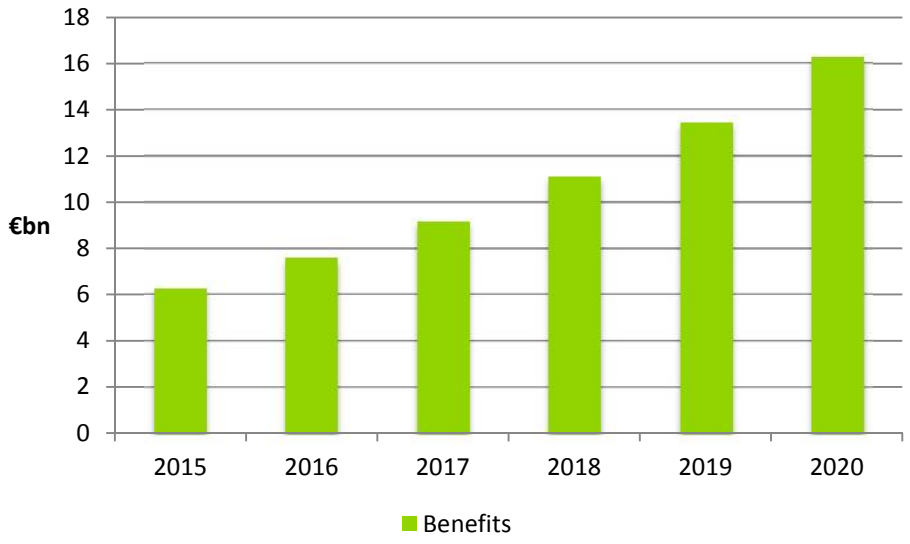


Figure 38– *Costs and benefits to the wider economy and society – baseline scenario*

Comparing the **net benefits** to cloud users, cloud providers, and the wider economy and society, it is clear that the overall net benefit is primarily driven by the benefits to users, as shown in the figure below.

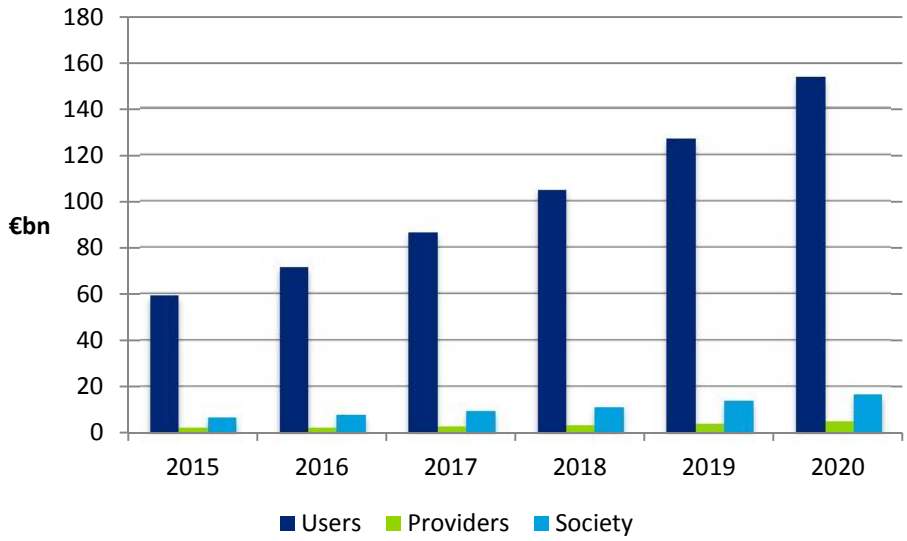


Figure 39- *Net benefits under the baseline scenario*

5.2.2 Net benefit across sectors

The data from Cloud Dividend reports allows for examining the **distribution of costs and benefits of cloud services to cloud users across sectors**. As can be seen below, the highest benefit from cloud services can be observed by cloud users in the Distribution, Retail & Hotels sectors, followed by Finance & Business services sectors. These two groups of sectors account for, respectively, 34% and 24% of the overall net benefit to cloud users. Government, Education & Health sector account for 14% of the net benefits, and Manufacturing for 13%.

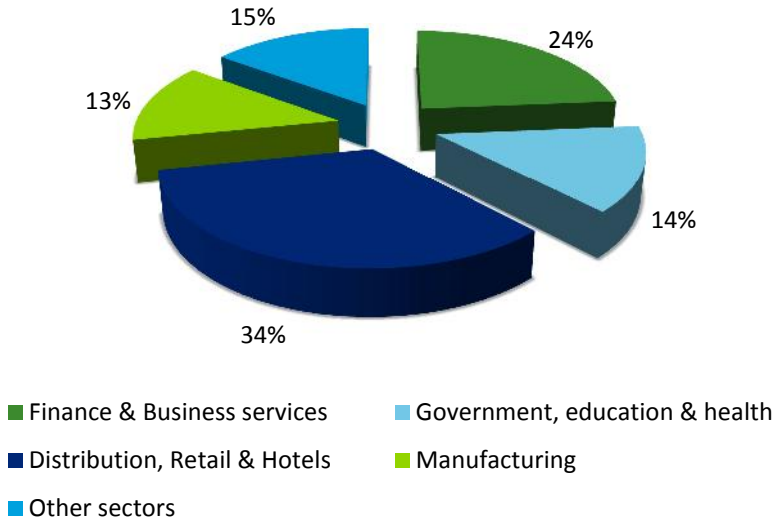


Figure 40- *Distribution of net benefits to users across sectors (as % of NPV in 2015)*

5.2.3 Baseline scenario using alternative uptake projections

While in the above sections the baseline scenario used a "realistic" uptake projection, it is conceivable that the development of cloud services faces potential obstacles, slowing down its adoption. In order to model such a scenario, the **cost-benefit analysis has been replicated using "pessimistic" IDC figures**. Under the pessimistic scenario, considerable growth in cloud uptake is still expected and the net benefits are still expected to rise for users, providers and wider economy and society, although this growth would be more modest. In the case of net benefits to users, which drive the overall benefits of cloud services, the net benefit under the pessimistic scenario would reach EUR 97 billion compared to over EUR 150 billion under the realistic baseline scenario, as shown in the figure below.

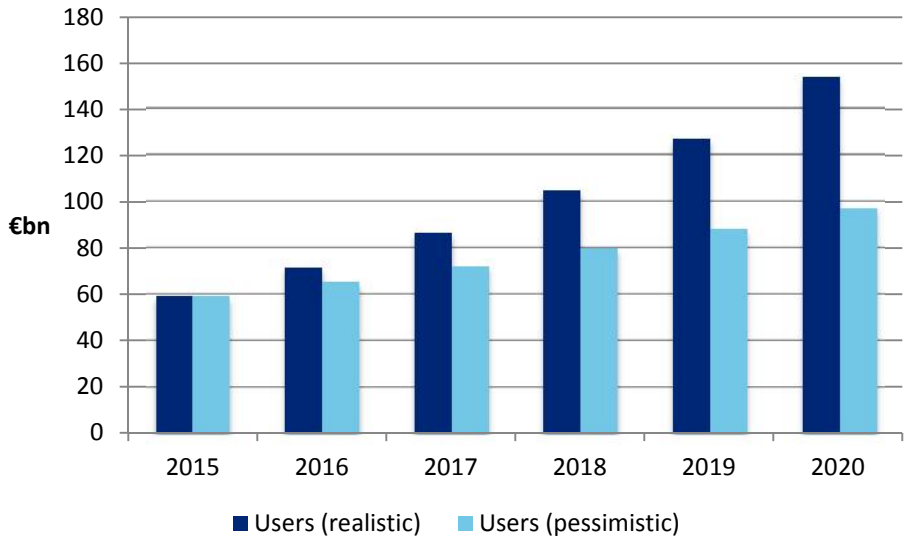


Figure 41 – *Net benefits to users – baseline and pessimistic scenario*

This pattern holds also for net benefits to providers and wider economy and society.

Additional sensitivity analysis for the baseline scenario is presented in annex E.

5.3 Approach to the assessment of the impact of measures

The policy options outlined in section 2.3 by tackling existing barriers to the adoption of cloud computing, will generate a series of impacts on involved stakeholders. In the stakeholder survey, the proposed options have been submitted to respondents in order to receive a feedback on their impact on:

- Providers:
  - Sales increase;
  - Operating cost reduction;
  - Other cost reduction;

- Professional users:
  - Increased adoption;
  - overall IT expenditure (CapEx and OpEx);

As all drivers of costs and benefits are ultimately linked to cloud uptake (and sales and uptake are tied in the model), when a measure will impact cloud uptake (for a service, a sector or overall) it will produce a change across all the elements in the model, as depicted in the figure below. It is worth underlining that overall revenues and costs will increase here not because of changes in (sales) values, but rather in volumes.

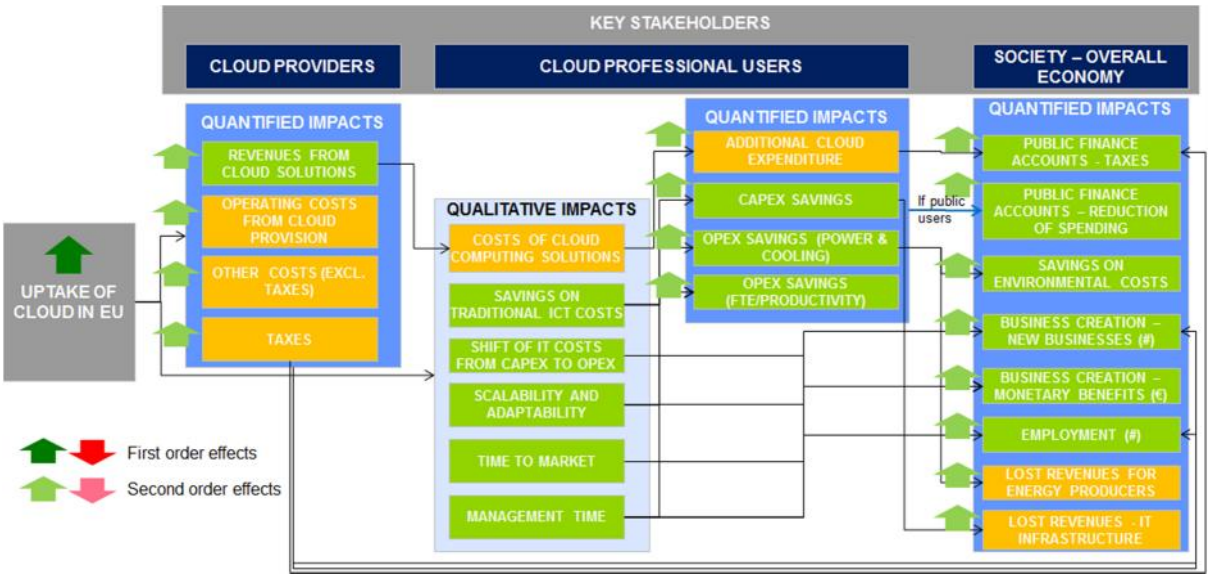


Figure 42 – Impacts on the model of increased cloud sales/adoption

When a measure will result in operating costs reduction for cloud providers, based on the survey results and stakeholders' interviews the team will investigate two possible second order effects:

- Benefits are internalized by cloud providers, leading to no change in cloud uptake and increased net benefits for cloud providers;
- Benefits are passed on (partially or fully) downstream in the value chain, meaning that reduced costs translate into lower prices, with positive impacts on cloud uptake and negative impacts on (unitary) revenues for cloud providers. This situation will be particularly interesting for investigation because both unitary costs and revenues will decrease for cloud providers while volumes will increase, with total net effects depending on the price elasticity of users. Likewise, overall cloud expenditure by users and the impact on public finance accounts from taxes will depend from the same dynamic. This second hypothesis is visualized in the figure below, assuming that the reduction applies to the operating costs.

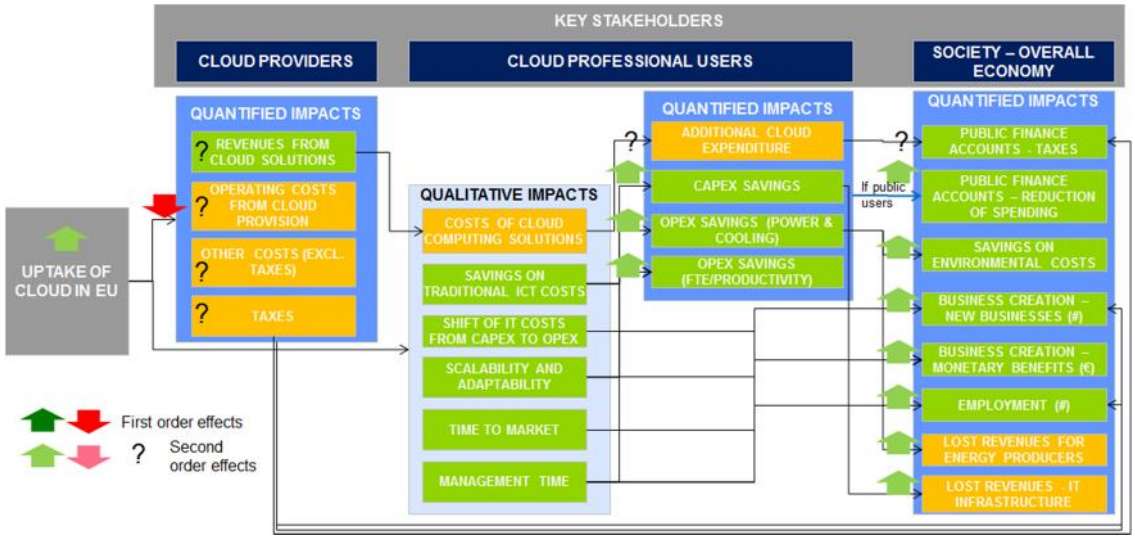


Figure 43 – Impacts on the model of reduced costs for cloud providers if cost reduction is passed on to users

In case a policy option will reduce costs for users (e.g. higher standardization reducing transition costs from one cloud solution to another), the BCR for users will improve, increasing benefits for users. Moreover, improvements in terms of scalability and adaptability will results in additional business creation and employment.

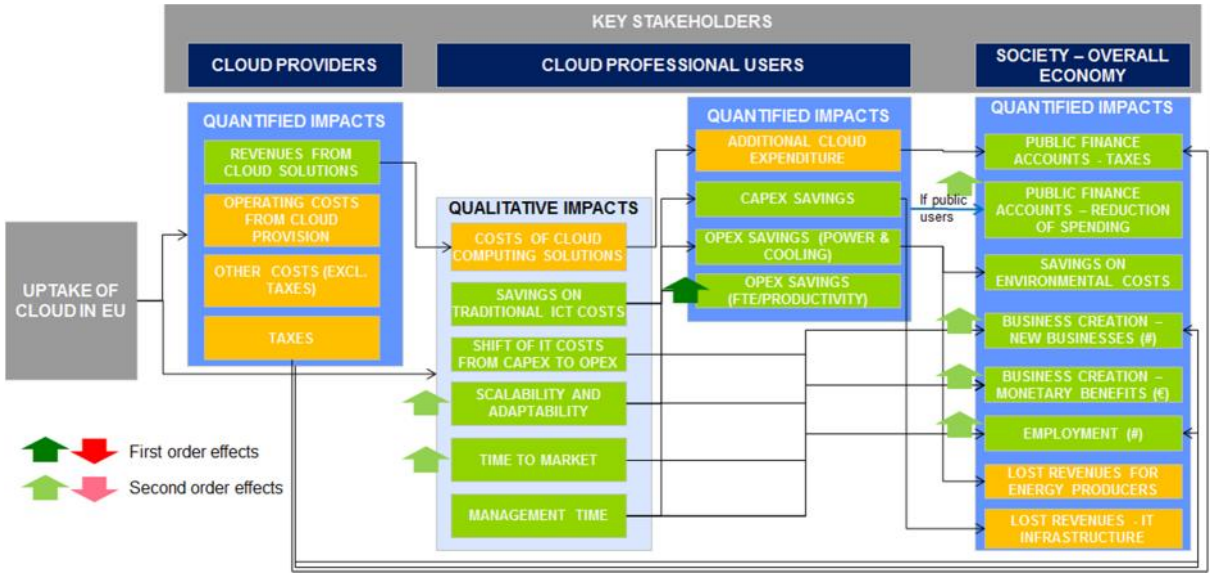


Figure 44 – Impacts on the model of reduced OpEx for cloud users

The results of the assessment of policy options might reveal more complex effects. As an example, in the case of Figure 39, improved BCR for cloud users might increase the appeal of cloud and drive cloud adoption, leading in turn to the situation described in Figure 37. The effects will be further explored on a case to case basis, based on the results of the assessment and on the feedback of stakeholders.

6 Policy initiatives for cloud computing in Europe

This section presents the policy measures on cloud computing implemented at EU level supporting the free flow of data initiative and the approach adopted to estimate their impacts on costs and benefits of cloud computing.

The policy measures to be considered for the cost-benefits analysis have been divided in three groups. The first two groups include measures that have already been taken and can be further developed to support the free flow of data, i.e. measures on Standards and schemes, certification, and trust and on Safe and fair contractual terms for cloud computing. The third group includes measures to remove data location requirements, which directly relate to the Free Flow of Data Initiative (FFDI) recently launched by the Commission.

6.1 Policy initiatives supporting the free flow of data Safe and fair contractual terms for cloud computing

In the context of the European Cloud Computing Strategy, as well as in the current Digital Single Market Strategy for Europe, different measures have been initiated or planned at European level to 'unleash the potential of cloud computing in Europe' and 'support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology". These have been discussed in section 2.1 above, including their current status.

These measures also support the realisation of the Digital Single Market Strategy, and specifically the free flow of data initiative. The latter initiative aims explicitly "to remove legal and technical barriers to the free flow of data and data services in the EU", including those encountered in the context of cloud computing services. As confirmed by the results of the Commission's public consultation on the regulatory environment for platforms, online intermediaries, data and cloud computing and the collaborative economy[182], a "large majority of respondents think that the location of data affects their strategy in doing business both at individual and business level", and support the economic benefits of interoperability of cloud services and data portability of data between different providers of cloud services.

The measures that have already been taken – and which can be developed further in order to support the free flow of data - can be grouped around three main topics:

- Standards and schemes, certification, and trust;
- Safe and fair contractual terms for cloud computing; and

[182] See https://ec.europa.eu/digital-single-market/en/news/first-brief-results-public-consultation-regulatory-environment-platforms-online-intermediaries

- Removing data location requirement and other regulatory barriers to the free flow of data.

In the sections below, for each group of measures we briefly describe:

- **Content of the measure**: what does the measure consist of?
- **Expected result(s)**: what are the objective(s) the measure aims to achieve against the broader backdrop of the free flow of data and the goal of removing barriers?
- **Stakeholders involved**: who contributes to the execution of the measure and to achieving the expected results?
- **Possible impacts**: what impacts could be expected at a high level from supply/demand side?

6.1.1 Standards and schemes, certification, and trust

This group of measures has three separate components that interact and can reinforce each other. Each of these will be discussed separately below.

Identifying and promoting standards and schemes for trusted and reliable cloud offerings

- **The measure consists of**: ensuring that there is a clear set of standards for cloud computing providers to use, e.g. in relation to information security, privacy, terminology and so forth; and ensuring that available schemes are known and used in practice. This is done by identifying and mapping relevant standards and schemes, and promoting these towards cloud stakeholders. This ensures that cloud services can be described and assessed on equal terms, which is important to ensure fair competition to cloud providers and to improve transparency for cloud users. This measure is entirely industry driven: while there is support and funding from government in order to achieve the objectives, neither the standards nor the schemes have any form of public sector endorsement.
- **The expected result is:** To reduce ambiguities and incompatibilities in current cloud services. These initiatives make it easier to know precisely which standards are adhered to and which assurances are being provided, in a manner that supports the comparability of competing cloud services. Functionally, it also helps cloud users to ensure the security of data in the cloud, to support interoperability, and to allow data to move more easily between cloud s (data portability), so that users would be more easily able to change providers. This measure therefore has a direct beneficial impact on the free flow of data, since it addresses technical and functional barriers that can currently cause vendor lock-in, and allows users to make informed choices between competing providers. For cloud providers, the measure is also beneficial as it gives them more transparency and predictability with respect to reasonable expectations in relation to interoperability, portability, and competition.
- **Stakeholders involved:** As discussed in greater detail in section 2.1.1., work streams have been initiated with respect to standardisation efforts and with respect to certification schemes (which often rely at least to some extent on standards):
  - ETSI is leading the standards mapping initiative through the Cloud Standards Coordination initiative[183]; a number of cloud computing companies and other organisations are involved, specifically through interactions with other standardisation bodies.

[183] See http://csc.etsi.org/

- ENISA is leading the certification mapping initiative though the ENISA Cloud Certification Schemes List (CCSL) and the Certification Schemes Metaframework (CCSM)[184]. A number of cloud computing companies and industry groups are involved, including notably via the C-SIG.

- **Expected impact(s)**:
  - At the supply side, compliance with standards and requirements of certification scheme is likely to have a cost for most cloud providers. This can be mitigated to some extent by the fact that the initiatives focus on the mapping of existing standards and schemes (i.e. they avoid the introduction of entirely new compliance obligations), but since not all companies adhere to these, the cost can be significant, especially for SMEs.
  - At the demand side, cloud uptake might initially become costlier due to compliance costs being passed on to the user. However, quality of services is likely to improve, and competition is strengthened if customers can select more easily from comparable services.
  - Competition at the international level may improve if the selected standards and schemes are internationally recognized.
  - It could also lead to more take-up of higher quality cloud services that adhere to specific standards or rely on specific schemes, but this requires awareness, since customers must first be capable of determining the value of standards and schemes.

Moving from self-regulation to co-regulation through EU trustmarks

- **The measure consists of:** strengthening and formalising cooperation between industry and the public sector, specifically through cooperation with regulators or supervisors in regulated professions or industries, or with respect to specific data types that are subject to legal protection measures (e.g. data protection authorities, financial supervisors, health care professionals, bar associations, etc.). This particular measure interacts with and builds on the work on standards and certification as described above. Standards and certification as such are self-regulatory initiatives: industries establish relevant norms and apply them, possibly through specific certification schemes which are private sector operated. However, these do not inherently benefit from any specific public sector recognition that allows customers to attach specific value to them (i.e. a customer cannot accept a cloud service as being legally adequate as a result of its adherence to a specific standard or scheme). The present measure would change this by applying a co-regulatory approach through one or more EU trustmarks. The measure is thus not purely industry managed, and relies on the involvement of a public sector third party that might be perceived as more neutral or credible than a purely industry driven scheme. Note that the measure is not necessarily a 'one-size-fits-all' approach that relies on a single trust mark at the EU level, since multiple trustmarks could be developed at the sector specific or data specific level. This

[184] See https://www.enisa.europa.eu/news/enisa-news/enisa-cloud-certification-schemes-metaframework

would allow sectors which are already strongly harmonised or which already have comparable competent regulators across the EU to move more rapidly.

- **The expected result is:** to make it easier for cloud users to rely on standards and schemes that have been given a specific legal recognition, and for cloud providers to demonstrate easily across the EU that they meet applicable legal requirements for their customers, thus opening access to EU level markets without having to adjust their service on a country per country basis. This allows comparison and completion on a fair and equal footing; and to benefit from the greater neutrality that an EU trustmark might provide. Again, this measure directly creates a beneficial impact on the free flow of data, since regulators and supervisors can play a decisive role – both positively and negatively – on which (cloud) service providers are seen as acceptable or appropriate in a given industry or for given data types. By better harmonising the positions of such supervisors and regulators, common and rational positions can be created at the EU level, as well as cooperation mechanisms between supervisors and regulators, thus ensuring that the Digital Single Market can operate as effectively as possible.
- **Stakeholders involved:** The measure would require the involvement of the cloud industry as described in the prior sections (since standards and certification schemes remain crucial to develop and apply this option), but also of public sector organisations or non-profit associations with a formal mandate (such as professional bodies, orders, federations etc.) that can assign a certain recognition or value to such standards or schemes, as a basis for the allocation of trustmarks. A key example of this policy measure in action is the cloud computing Code of Conduct for data protection[185]. In other policy areas (other than data protection) similar activities could be undertaken, e.g. in the financial services industry and for legal professions, for which competent supervisors already exist at the national level that already interact at the EU level. In these too, supervisors or regulators could be encouraged to adopt common positions as to the requirements for the permissible use of cloud providers across the EU.
- **Expected impact(s) and timeframe**:
  - The impact on business is similar to the impact of certification schemes in terms of effort for cloud providers (at the supply side). The cost impact is also likely to be similar.
  - However, the involvement of a more neutral party (a regulator or supervisor) is likely to create more trust with end users, thus also unlocking a greater market and accelerating cloud adoption.
  - The effect on competition and thus indirectly on quality of service and pricing can be beneficial, but only if trustmarking is sufficiently inclusive. I.e. if only a small number of market players is trustmarked, this can lead to exclusion, lock-out of competition, smaller competition and thus pricing increases and/or quality decreases.

Enhancing trust in cloud computing services through legislative recognition

- **The measure consists of:** recognising standards, schemes or technical specifications through secondary legislation (such as implementing acts) as being suitable to ensure compliance with

[185] See https://ec.europa.eu/digital-single-market/en/cloud-select-industry-group-code-conduct

specific laws. Principal examples would include the legal recognition of standards, schemes or specifications (e.g. ISO/IEC 27018:2014 for the protection of personal data in cloud computing), e.g. under the recently adopted GDPR and/or the NIS Directive. This could improve transparency and predictability, since cloud providers and cloud users can more easily determine which specifications (e.g. in relation to security, privacy, service levels, data formats/portability etc.) have obtained some form of formal legal recognition, making it more likely that they are appropriate for their own activities. The policy measure differs from the two above due to the fact that it is regulatory rather than co- or self-regulatory, i.e. it emanates from the public sector without industry support and serves to demonstrate compliance with specific legislation.

- **The expected result is**: to help make it easier for cloud users to select an appropriate cloud provider on the basis of legally recognised specifications, and for providers to know that they are using standards that are legally recognised as being safe, reliable and of good quality. The measure would thus eliminate some of the uncertainty around this issue that currently still exists, and thereby also one of the barriers to the free flow of data: an EU level legal recognition of relevant standards would reduce or eliminate any need for national standard setting or geographic divergences that lack a rational justification.
- **Stakeholders involved:** The initiative would need to be driven by European standardisation bodies such as ETSI, CEN and CENELEC, with a mandate from the European Commission, and including appropriate liaisons to international standardisation organisations (such as ISO) to avoid overlaps, and with close involvement of the cloud industry. Ultimately the measure culminates in legislative action, preferable from the legislator at the EU level.
- **Expected impact(s)**:
  - Would increase legal certainty, thereby strengthening faith in cloud services and thus stimulating cloud adoption.
  - Would also provide a strong incentive to align with legally recognised standards, thus reducing the range of potentially relevant standards and supporting the free flow of data. This could reduce costs of compliance both at the supply side and at the demand side, since there is no longer a drive to consider multiple standards.
  - Inversely however, ignoring a legally recognised standard may eventually become economically unviable, since compliance with a legally recognised standard may be perceived by the market as being mandatory.
  - Innovation may suffer if new services are not able to comply with existing legally recognised standards.

6.1.2 Safe and fair contractual terms for cloud computing

Develop, maintain and promote contractual terms for cloud computing

- **The measure consists of:** developing, maintaining and promoting standardised contractual clauses that can be re-used and applied in a variety of cloud services. This can be done either generally (draft contractual clauses for general services agreements) or for specific contract types (e.g. model terms for service level agreements (SLAs – which include elements like scope of the service, availability and uptime guarantees, response times to support requests, etc. – what you get -, the quality and responsibilities), data processing agreements, data security agreements, and so forth). Similarly, model provisions could be drafted that are specific to cloud provisioning types (e.g. SaaS, PaaS, IaaS, etc.), or which distinguish between contracting contexts (e.g. B2B, B2C, B2A, etc.). This allows providers to describe their service levels on equal terms, and makes it easier for customers to know that the SLAs have appropriate and balanced clauses in place.
- **The expected result is:** a set of standard terms that will make it easier for cloud users to know what service will be provided when procuring a cloud solution, thereby making it easier not only to ensure getting what is needed, but also to compare the offerings of different cloud providers, which again supports the free flow of data by removing a legal barrier – i.e. national divergences – that might exist between cloud providers in different Member States based on their national laws or legal traditions. The measure helps to overcome some of the knowledge gap that often exists between providers and buyers (especially for SMEs; note that SMEs might be cloud providers or cloud customers; either way they may have less resources than optimal to create appropriate contractual clauses).
- **Stakeholders involved:** Several actions have already been undertaken on this point as described in section 2.1.2.:
  - The C-SIG has produced a set of Cloud Service Level Agreement Standardisation Guidelines, which have been published in 2014[186].
  - The European Commission has conducted a study resulting in the production and publication of a standardised modular cloud SLA agreement[187].
  - EU research activities working around cloud SLAs (SPECS, SLALOM, A4Cloud, etc.) continue.
  - The Expert Group on cloud computing contracts has organised a series of meetings and working sessions resulting in the publication of a series of recommendations on cloud contracting terms[188].
- **Expected impact(s):**
  - Cloud providers can use these terms in their own agreements, thus (slightly) driving down some of their costs and allowing them to promote their services as complying with EU good practices. This facilitates market access, especially to SME providers, and can increase adoption of cloud services.
  - Cloud buyers can use these terms as a condition of procurement (i.e. requiring that providers apply them or adhere to them), or as a yardstick for assessing the adequacy and

[186] See https://ec.europa.eu/digital-single-market/en/news/cloud-service-level-agreement-standardisation-guidelines
[187] See http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=10860
[188] See http://ec.europa.eu/justice/contract/cloud-computing/expert-group/index_en.htm

appropriateness of cloud services. This provides greater certainty in relation to available legal assurances and compliance with best practices, resulting in better procurement decisions and better market access (thus favouring the free flow of data).

- As a positive externality, greater legal certainty could reduce (costs of) litigation and disputes, which is a saving for society in general.

6.1.3 Removal of data location requirement and other regulatory barriers to the free flow of data

- **The measure consists of:** identifying any national requirements (whether through law, administrative practice or policy) in relation to data location or data processing, identifying the rationale behind the requirements, and assessing if and how cloud services could satisfy the requirements. This would allow the requirements to be rationalised, ensuring that barriers are not introduced (or are removed) that hamper cloud computing services when the same result could be obtained through objective requirements on security, accessibility, response times, etc. that could also be satisfied in a cloud setting. This would open new markets to providers, and would allow users to procure cloud services in a more efficient way. A secondary option for implementing this measure (either in isolation or in combination with the rationalisation effort) would be to provide further legislative support to the emerging right to data portability, i.e. the right to retrieve a copy of one's data in a usable format and to obtain support in moving it to a competing service. A narrowly focused version of this right has been integrated in the GDPR (specifically Article 20), but this provision only grants a right to a data subject, in relation to personal data that they have provided themselves to a data controller. Thus, it could not be exercised by a company, nor in relation to non-personal data, nor in relation to data that was hosted by a data processor; as such, it does not provide comprehensive recourse. A broader approach is taken by the recently proposed Directive on certain aspects concerning contracts for the supply of digital content (Digital Content Contracts Directive or DCCD)[189]; Articles 13 and 16 of this proposal detail the consequences in case of termination of contracts for the supply of digital content to consumers and include a specific right to data portability. Again, the scope is restricted, since the concept of digital data is not all-encompassing and since the proposal only targets consumers (again excluding B2B contexts), but none the less it illustrates how the free flow of data could be supported by legislative action.
- **The expected result is:** a rationalisation of current regulatory requirements, ensuring that geographic data location requirements are not needlessly maintained, and/or introduction of data portability rights that allow cloud customers to move their data more easily to a competing services.
- **Stakeholders involved:** The initiative should be led by the Commission, with support from the Member States and from key industry groups that commonly face data location requirements (e.g. financial services, health care, legal services, etc.) in order to identify regulatory barriers and to seek constructive rational alternatives to such barriers. At a second stage, legislative action may be needed at the EU or national level, in conjunction with consultation with supervisors or

[189] See http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1450431933547&uri=CELEX:52015PC0634

regulators that interpret and apply norms at the sector specific level, in order to rationalise regulatory requirements.

- **Expected impact(s) and timeframe:**
  - Impacts depend largely on the outcome of studies and follow-up actions; this is linked to the broader Free Flow of Data initiative.
  - Generally, the measure should strengthen accessibility of the market for cloud providers, since they would not be excluded from certain markets on the basis of rationally unjustifiable requirements, and it should strengthen competition.
  - The measure should have a beneficial impact on the costs of cloud providers, since they would more rarely be confronted with a need to create and maintain local infrastructure for pure compliance purposes without any additional objective benefit.
  - This benefits cloud buyers too, since they can use a broader range of competing cloud providers.

6.2 Modelling costs and benefits of policy initiatives for cloud computing in Europe

6.2.1 Follow-up of ongoing measures

The first two groups include measures considered in this section are measures that have already been taken and can be further developed to support the free flow of data, i.e. measures on Standards and schemes, certification, and trust and on Safe and fair contractual terms for cloud computing

Such measures can be summarised as follows:

- Self-regulatory measures including the identification of relevant standards and certification schemes, and the drafting of standardised contractual clauses (including SLAs). Further work could be done to fine-tune and elaborate this work – through further standardisation, more context-specific contractual clauses, maintaining and expanding the list of identified standards and schemes, and promoting all of these initiatives – without substantively impairing its inherently self-regulatory nature.
- Co-regulatory measures that involve public sector endorsement (including via regulators and supervisors or other bodies acting under a public sector mandate) of self-regulatory initiatives. The only current example at the EU level is the data protection code of conduct as its approval is being sought by data protection authorities (specifically the article 29 Working Party). This effort is however not yet complete, and more could be done to engage other regulators or supervisors in other contexts.
- Full regulatory measures that focus on rationalising data location requirements or on strengthening data portability rights. Data location requirements are presently still under examination, but with respect to data portability some progress has already been made through the adoption of the GDPR and through the proposed DCCD. None of these comprehensively cover the issue of data portability, but both support the growing policy emphasis on data portability rights as a tool for enhancing competition.

At the horizontal level (across all three tiers of initiatives) the intended impacts on the free flow of data are comparable. On the one hand, the objective is to remove **practical** barriers to the free flow of data by eliminating or at least mitigating functional problems: standardisation (both technical standardisation and legal standardisation through model contract provisions) makes it easier for cloud users to compare providers and to move data from one location to the next. On the other hand, the objective is to remove **legal and policy** barriers to the free flow of data by ensuring that **legislation** does not needlessly impose restrictions and (equally importantly) by ensuring that **regulators and supervisors** do not needlessly interpret or apply legal frameworks in a way that discourages the free flow of data. Collectively, and in combination with appropriate awareness raising initiatives towards all relevant stakeholders, this can lead to an environment which is conducive to free data flows across Member States and across comparable cloud providers.

These measures affect stakeholders in various ways, creating new benefits and opportunities, but sometimes also risks and costs. More specifically:

- **For cloud providers (supply side)**:
  - They can **benefit** from these measures principally because they will remove barriers to market access, allowing them to more easily reach a broad customer base without being confronted with needlessly diverging legal and policy expectations. They can also benefit from the self- and co-regulatory approaches as they provide good practices that they can align too, which are recognizable to their customers and thus have a clear market value. Thus, the **cost of compliance can be lowered,** and **revenue can be increased**.
  - However, there are also **risks** to be managed. Specifically, if specific standards or requirements are made legally mandatory or are perceived as such by the market, this can create **needless compliance costs**, or **harm innovation** by imposing requirements that exclude new and more effective solutions. Furthermore, increased competition and market access is not necessarily beneficial to all providers: SME providers in particular can be protected in practice against foreign competition due to national legislative requirements. Harmonising and rationalising this may lead to **crowding out effects** if SME providers are unable to provide added value that allows them to compete in the market. This may actually lower competition, thus ultimately raising prices and/or lowering quality.
- **For cloud customers (demand side):**
  - They can **benefit** from stronger competition: by gaining access to new cloud providers, their market options will increase, which should **lower costs and/or improve quality** of their cloud services. Furthermore, their **costs of compliance and costs of data/service migration** will decrease, due to less ambiguity on which providers satisfy legal requirements, and greater technical ease with which migration is practically possible. This is particularly true for **regulated professions and industries**, who are subject to supervisory and regulatory expectations that are often unclear and where the interpretation can vary irrationally from country to country or from context to context. Depending on the customer and on the cloud usage context, the measures may also **increase innovation**, since cloud adoption will allow

customers to focus on providing better services in their core activities rather than on operational IT concerns. Especially for SMEs, there can also be a beneficial impact on **ICT security**, given that cloud environments will typically offer a range of protection measures that will exceed the capabilities of what an average SME would be able to implement itself.

- Here too however, there are also **risks** to be managed. cloud customers must be made appropriately aware through awareness raising actions that cloud computing does not eliminate the need for an accurate **allocation of responsibilities**: selecting a cloud provider – even one that complies with relevant norms, and/or which is trust marked – does not imply that the customer can abdicate all responsibilities itself, including in relation to privacy and information security.

- **For regulators and supervisors:**

  - The approach will have a **benefit** by **reducing costs and efforts of compliance monitoring and enforcement.** By moving towards a shared understanding and application of justified requirements in their respective industries, regulators and supervisors do not have to duplicate each other's activities (by individually determining norms, assessing which service providers comply, taking enforcement actions, etc.), allowing them to focus on their core activities of monitoring specific industries or sectors. It will also allow **greater professionalization**, since some regulators and supervisors may currently struggle to ensure access to the required skills and expertise to assess cloud computing solutions. Coordinating efforts at the EU level will allow them to pool resources and make optimally informed decisions.
  - The principal **risks** to be managed relate firstly to the **costs and efforts of organising efficient interactions at the EU level**, both for initially determining appropriate requirements, and for coordinating any assessments of cloud providers (i.e. ensuring that a cloud provider which is considered as appropriate for sector X in Member State A is also recognised as such in Member State B). This is not a trivial cost or effort, and may offset some of the cost/effort reduction benefits to be gained by eliminating duplication of efforts. The second principal risk relates to **forum shopping:** it must be ensured that requirements are not only defined homogeneously, but also that they are interpreted and applied consistently; otherwise, cloud providers will be inclined to seek out the most cloud friendly regulators and supervisors, undercutting the credibility of the system.

As the summary above shows, the current policy measures can be effective in supporting the free flow of data. However, consistency and effectiveness of the implementation of each measure is key to avoiding negative side effects.

Section 6.3.1 describes to what extent and how such measures (or some of them) have been included in the model developed by this study to assess costs and benefits of cloud computing in Europe.

6.2.2 Removal of data location restrictions

The removal of data location restrictions is expected to have impacts on three main groups, namely:

- Large providers of cloud computing services;
- Small providers of cloud computing services;
- Professional users of cloud computing services.

With regard to the impacts on **large-scale providers** of cloud computing services, the removal of data location restrictions implies that they are free to select the most suitable place(s) within the EU to set their own data centres. Decisions on the optimal location of such data centres will take into account for both the capital expenditure necessary to build the data centres, and the operating costs for their daily operations. Among the factors that influence the **construction costs** of data centres, it is possible to consider real estate costs, construction costs, permits and legal framework. Among the factors influencing the **running costs** of data centres, the following will also be taken into account[190]:

- cost of energy;
- cooling costs (in free cooling and in modern data centre cooling systems, related to average external temperature and variation);
- cost of networking interconnectivity (external to the data centre);
- taxation (of profits, labour, etc.);
- personnel (e.g. legal framework for contracts, skills, etc.).

Overall, the **capital expenditure** for building data centres do not differ dramatically among countries. Available analysis quantifies the average cost for rented industrial warehouses at USD 92/sqm/year, ranging from USD 65/sqm/year to USD 102/sqm/year (the only significant outlier being London, with a cost on USD 223/sqm/year)[191]. Construction costs are largely independent from location, considering the free movement of workers and of services across the EU, so that much of the country-related variations are *de facto* equalised over time. Similarly, there are no very large variations in terms of permits and legal issues for building the data centres (the time to obtain a permit is the element with the highest variance across country, but it relates to the pre-building phase).

Operating costs for running data centres are a more relevant variable in the decision on the optimal location for a data centre. Indeed, the cost of energy varies widely across Member States, with the EU28 average (including taxes) of about 0.14 EUR /kWh, ranging from 0.07 EUR /kWh to 0.18 EUR /kWh. Cooling costs present an even wider variation, as they also depend on the technological advancements in the field (overall, more sophisticated cooling systems have higher investment costs, but lower operating costs).

Such costs influence to a good extent the TCO of the data centres. Considering the TCO partitioning of a 'standard' data centre (i.e. 3 years servers, 10 years' amortisation of data centres building costs), energy costs represent 13.5% of the monthly TCO, while the costs of the colluding system represent 18% of the

[190] Hardware costs are independent from the location of the data centre, as hardware is usually procured at large scale and delivered directly at the data centre location.
[191] Jones Lang LaSalle

monthly TCO, and servers 4%[192]. These costs lead to maximum theoretical savings on TCO of 14% (of which, 7% on energy costs, 6% on costs for cooling systems, and 1% on other costs).

Such estimation however rests on a set of assumptions (such as the perfect removal on data location restrictions, the absence of externalities leading the choices of providers, etc.) that are not entirely realistic. In fact, available data show that data centres tend to be concentrated in those countries with already a higher density of data centres compared to economic activity[193].

Overall, considering more realistic estimates on the operating costs for data centres (i.e. not taking the extreme values in the ranges presented earlier), the removal of data location restriction can lead to a 9% reduction of the TCO for data centres. Such reduction in TCO is likely to be passed to the professional users of cloud computing services to some extent (a 100% pass-through rate being only possible in perfect competition). As cloud computing costs are decreasing much slower than Moore costs, with the standard price dropping only of 2% in 9 months[194], a reduction of the costs for cloud computing services is likely to lead to a reduction of prices for professional users between 3% to 5%.

The possible impacts of the removal of data location restrictions on **small providers** of cloud computing services are more uncertain. For those small-scale providers that do not benefit from the competitive advantage of data location restrictions, an overall reduction of the TCO similar to the mechanism describe above for large-scale providers is likely to happen. On the other hand, many small-scale providers benefit from data location restrictions, which act as entry barriers to the local market for large competitors. In these cases, the removal of data location restrictions is likely eliminate such entry barrier, and leave small-scale providers to face the competitive pressure of larger providers which compete on lower prices due to economies of scale. While those small-scale providers that use a direct link from a data centre to customers (usually for disaster recovery services) may not be affected by this competition on prices, they only represent a small minority of the market. Overall, it is likely that the removal of data location restrictions will have large negative impacts for small-scale providers of cloud computing services, potentially leading to the disappearance of the majority of such businesses in the sector.

With regard to the impact of removing data location restrictions on professional users of cloud computing services, the sectors more likely to be affected are those of legal services, banking, insurance, healthcare, and public sector at both national and local level. Those sectors together represent about 44% of expenditure on cloud computing services[195]. With the removal of data location restrictions, it is likely to expect such users to move to the more competitive providers and benefit from the 3% to 5% reduction in prices described earlier. As IT expenditure is overall constant across years (usually variations are below 2%), it is possible to assume that the reduction in price is compensated by an increase in IT expenditure, part of which will be for cloud computing services. The actual increase in IT expenditure for cloud computing is likely to be negligible. Total public cloud spending in 2015 was about USD 70 billion, compared to an overall IT spending for the same year of USD 3.5 trillion. Of this, EU spending in cloud computing is about 17%, which means that EU public cloud spending is below 1%. Even considering a 5% price reduction for professional users as an effect of removing data location restrictions (even if a 100% pass-through rate is

[192] See: Amazon VP for cloud , http://perspectives.mvdirona.com/2010/09/overall-data-center-costs/
[193] See for instance data from TeleGeography, available at: (http://www.telecomspricing.com/product.cfm?prod=11724&dept=5744
[194] See: https://451research.com/cloud-price-index-overview
[195] See data presented in section 3.1

unlikely), it will lead to an increase in spending for new cloud services ranging from 1% to 5% (a negligible amount overall).

Overall, the removal of data location restrictions is likely to produce a small (but measurable) reduction in TCO for data centres, which will benefit large-scale providers of cloud computing services and those small-scale providers that do not benefit from a competitive advantage due to the current restrictions. The impacts are likely to be negative for those small-scale providers that benefit from a competitive advantage due to the current restrictions on data locations. While professional end users are likely to experience a (limited) reduction in prices and a (limited) increase in adoption rates of cloud computing services.

The above detailed scenario is estimated to take place starting not earlier than 2018 after the completion of studies investigating the effects of the removal of the data location requirement and taking into account the legislative initiatives and timeline from the Commission's side. This timeframe is visualised in the figure below.

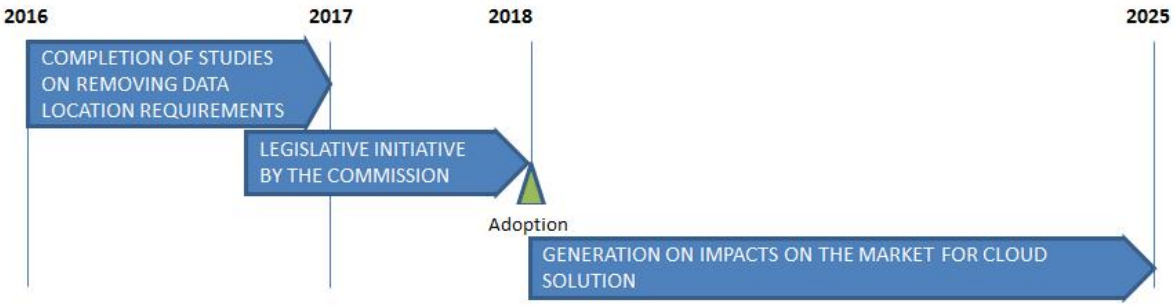


Figure 45 – General overview of the timeframe envisioned to adopt the removal of the data location requirements.

Section 6.3.2 provides more detail on how the impacts of such policy measure are included in the model developed for this study.

6.3 Calculating costs and benefits of policy initiatives for cloud computing in Europe

6.3.1 Follow-up of ongoing measures

The first two groups of policy initiatives considered in the analysis include measures that have already been taken and can be further developed to support the free flow of data, i.e. measures on Standards and schemes, certification, and trust and on Safe and fair contractual terms for cloud computing

However, not all of these measures can be included in the model for cost-benefit analysis of cloud computing in Europe developed for the study. In many cases, lack of data from available literature and

datasets makes it impossible to build reasonable assumptions for the analysis. This is the case of policy initiatives on standards and schemes, and on safe and fair contractual terms for cloud computing.

The only set of measures that have some evidence of impact (while very limited) are those on security certifications.

Promotion of existing certifications and standards

Available data point to a very limited if not null impact of certification on adoption of cloud computing.

Statistics on AWS certification (e.g. ISO 27001 and ISO 9001) for the US, where the adoption of cloud computing by professional users is larger than in the EU, point to little or no change to cloud adoption before and after the introduction of the certification.

The figure below shows the revenues and revenue forecast for AWS from 2006 to 2026 (logarithmic scale).

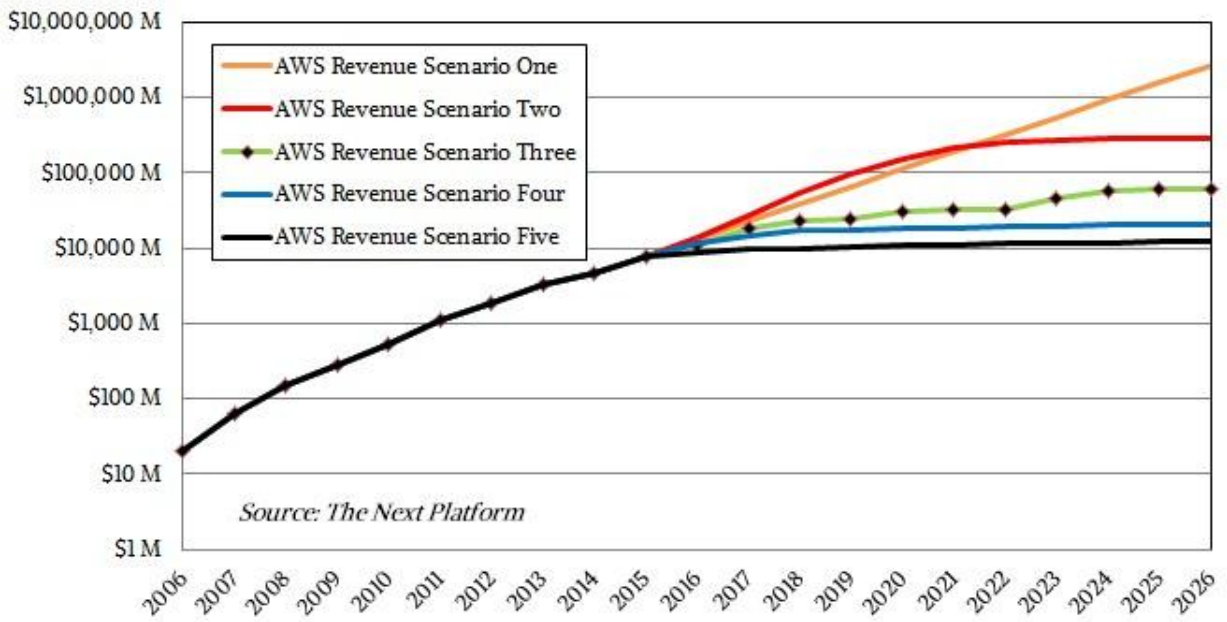


Figure 46 – (Expected) revenue growth for AWS certification[196]

The figure shows a modest decrease in the revenue growth in 2008 (with the start of the financial crisis), but no changes in years such as 2010 or 2014, where important ISO certifications for cloud computing were introduced. The figure still shows a growing revenue graph, with growth slowing over time.

Within the context of the study, we modelled some impacts of the introduction of certifications on adoption of cloud computing, while limited.

The option of introducing cloud certifications for cloud service providers in 2017 will add additional costs for these providers. The costs of these certifications can range from EUR 500 to EUR 12 000 and even up to EUR 25 000 and more in the case of ISO certifications, based on current estimations.

[196] See: http://www.nextplatform.com/2016/02/01/how-long-can-aws-keep-climbing-its-steep-growth-curve/

To reflect these costs, overall, an increase of 0.5% in costs for the cloud providers is included in the model.

As an effect of the price increase, the model incorporates an expected minor price increase of 0.5% following the increase in operating costs for the providers. A further effect linked to the introduction of these certifications is the additional uptake they will generate amongst the users. These certifications are likely to have a mild effect on attracting new users. The reasoning behind this is the fact that users will be more willing to move towards the cloud if they are reassured by the level of safety of the cloud service. These certifications could provide this reassurance. The intensity of use expressed in the uptake index will be adopted with an additional user uptake ranging between 0% (pessimistic scenario) and 2% (optimistic scenario). The realistic scenario used for the estimation of the impact of this measure is set at 1%.

The figure below describes the first and second order effects of the scenario in which the service providers transfers these additional costs to the cloud users by increasing the price with 0.5%.

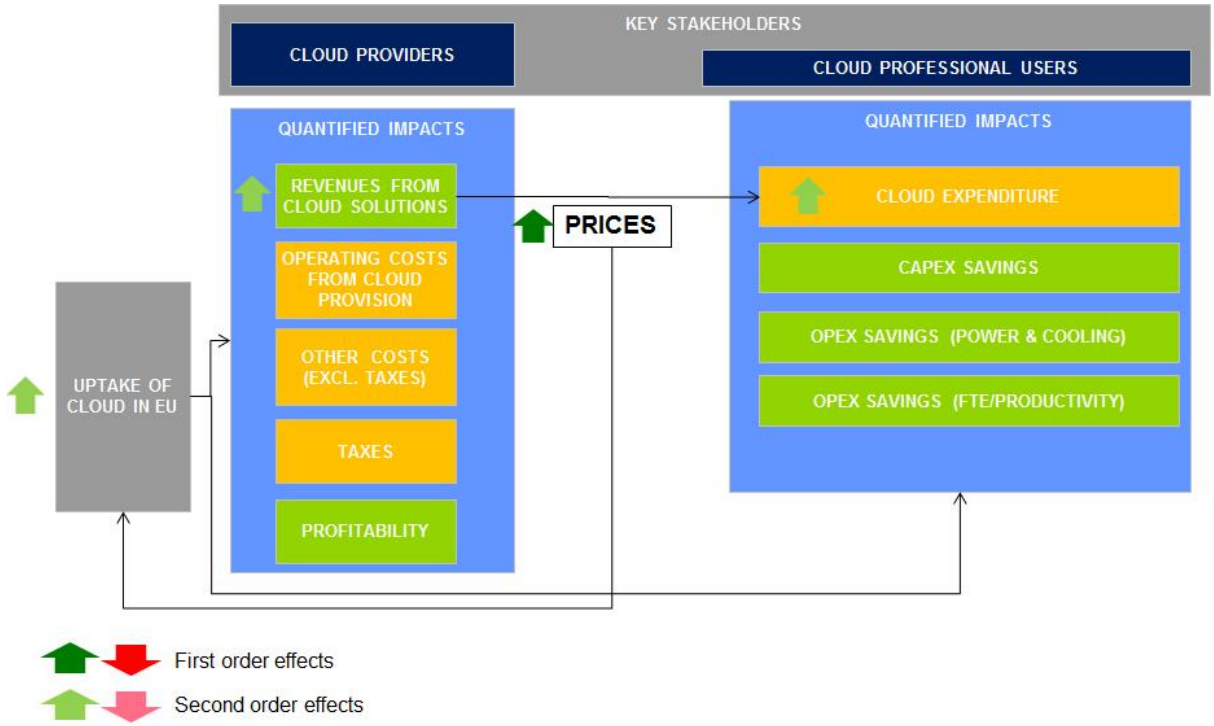


Figure 47 – Impacts on the model if certifications increase the price paid by cloud users for cloud services

6.3.2 Removal of data location restrictions

As outlined under section 6.2.2, the **removal of the data location requirement** would result in the decrease of the operating costs for the cloud providers. This reduction in operating costs can have a significant effect on the use and uptake of cloud services in the EU as explained under section 6.2.2. A conservative approach has been used to model the impact of the decision to remove the data location requirement. The following scenario estimates a drop in total operating costs for cloud service providers of around 9% and this starting from 2018. The figure below describes the first and second order effects of the scenario.

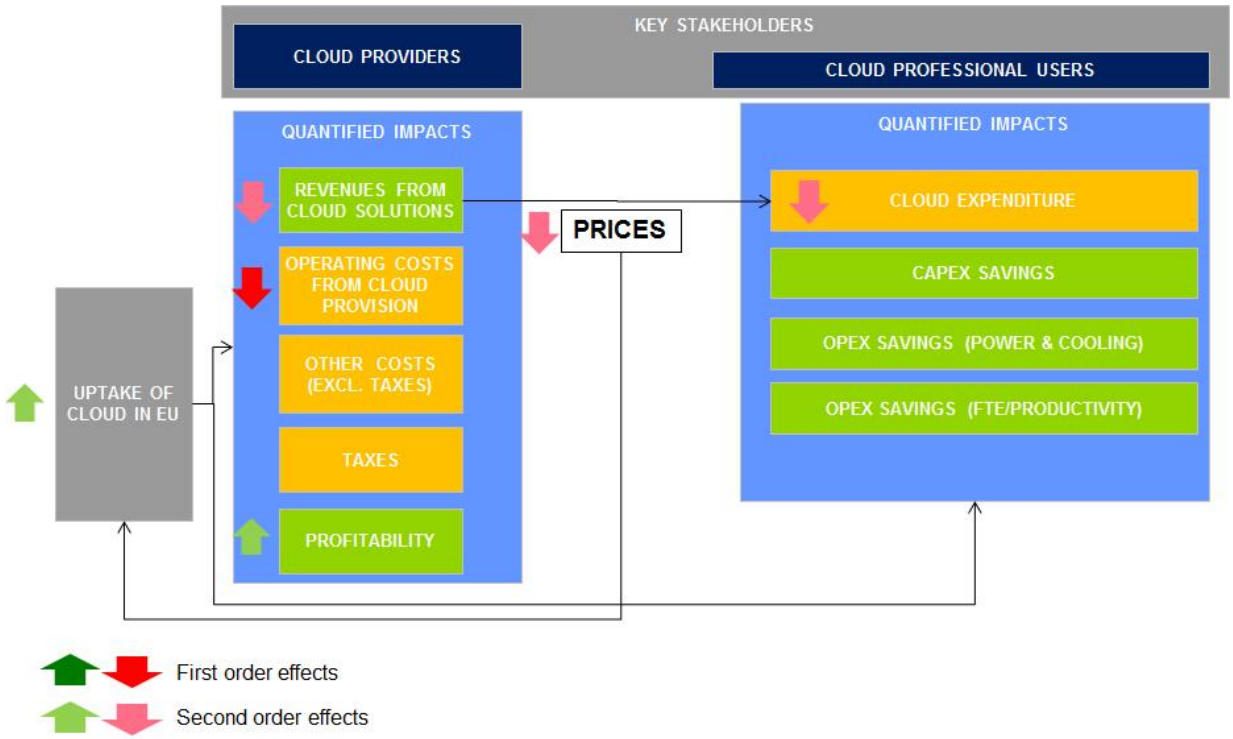


Figure 48 – Impacts on the model of reduced costs for cloud providers if cost reduction is passed on to users

As an effect of reduced operating costs for the cloud providers by 9%, their profitability, *ceteris paribus*, will increase, leaving providers with the option to reduce service prices to gain market shares.

The table below provides an overview of the "first order effect" change in net income for the cloud providers as an effect of reduced operating costs.

Table 24 – Change in net income for cloud providers due to a decrease in their operating costs

Description	Baseline scenario	Removal of data location requirement
Operating cost	**80.25%**	**73.03%**
Operating P/L as % of Revenue	19.75%	26.97%
Other P/L	1.39%	1.39%
Earnings before taxes %	18.36%	25.58%
Tax rate %	4.04%	5.64%
Net income %	14.31%	19.94%
Change in Net income %	N/A	5.63%

In the light of the effect outlined above, we assumed that a reduction of the operating costs by 9% would lead to a maximum price drop of 4% (i.e. part of the benefits will be internalised by cloud providers).

This price drop will lead (ceteris paribus) in the reduction of total expenditure on cloud services, as the users will need to pay a lower price. As an additional effect, as explained under section 6.2.2, part of the savings will be reinvested in the same IT field, increasing the "intensity of use" of cloud services. Since cloud expenditure represents 1% of total IT expenditure, the model foresees a reinvestment in cloud computing services by 4% of this 1%, or an increase of user uptake by 0.04%.

The price reduction could also trigger an additional user uptake as a lower price is likely to increase the demand for cloud services. As the costs of cloud services are only one of the several barriers and elements limiting the use and uptake of cloud computing, the model assumes an additional user uptake of 1%, resulting. A sensitivity analysis included in the model also evaluates an uptake increase of 0% (pessimistic scenario) and 5% (optimistic scenario).

6.3.3 Combination of both policy measures

As described above under each specific policy option, net benefits are expected to be generated. Both under the option to remove the data location requirement and under the option to promote certifications and standards an additional user uptake is considered of 1%. Albeit the cause of this additional uptake is different in each case (lower price vs. feeling of reassurance), the combination of both policy measures will have a cumulative effect, generating additional net benefits greater than the ones generated under the implementation of a single policy measure.

If both policy options are selected, the first impact on the baseline model will take place in 2017 with the large adoption of certifications and standards. In 2018, the implementation of the removal of the data location requirement will cause additional impacts.

In 2017, the certifications and standards will create an additional cost for cloud service providers. In the light of these additional costs, the providers are expected to increase the cloud service prices with 0.5% to transfer the extra costs directly upon the cloud users. Following the wider promotion of certification and standards, the assumption is made that this will actually increase the user uptake, due to the fact that these certifications and standards will provide a certain level of reassurance that using the cloud is safe, ranging from 0% to 2%. The realistic scenario follows the modest increase of 1%, whereas sensitivity analyses included in the model assess the case of pessimistic (0%) and optimistic (+2%) uptake.

In 2018, the removal of the data location requirement is expected to lower the total operating costs of cloud service provider by 9%. As this influences the Profit/Loss of the service provider, this lower cost will, *ceteris paribus*, increase the profitability of the service providers. Under the assumption that this increased profitability triggers a price reduction, the model assumes a reduction in prices of 4%. As explained above, as a direct effect of this price drop, there will be a reinvestment in cloud services equal to 1% of this 4%, being 0.04%. On top of that, it is expected that a drop in prices will generate additional demand and thus an increase of the user uptake index ranging between 0% and 5%. Under the realistic scenario, an increase of 1% is considered, whereas sensitivity analyses included in the model assess the case of pessimistic (0%) and optimistic (+5%) uptake.

7 Costs and benefits of policy initiatives for cloud computing in Europe

This section presents the results of the analysis of the costs and benefits of policy measures on cloud computing implemented at EU level. The impact of security certifications and standards are described first, followed by the estimated impacts of removing data location restrictions. Finally, the estimated combined impacts of these two different policy initiatives are presented.

7.1 Promotion of existing certifications and standards

7.1.1 Net benefit to users, providers and wider economy and society

As certifications and standards increase confidence in cloud users that the service is safe and reliable, an additional user uptake is expected of 1%. The results of the Cost-benefit analysis on the measure to promote existing certifications and standards for cloud providers indicate that **all the stakeholders** under consideration, namely cloud service providers, cloud users and society as a whole are likely to **benefit** from this policy option, although the additional benefits to the overall value chain are mild (less than 1%).

The table below offers an overview of the impact of the measure on the discounted NPVs for the period 2015-2020 for the affected stakeholders.

Table 25 – Changes in NPV across all three stakeholders after promotion of existing certifications and standards

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 538.4 billion	0.64%
Cloud providers	EUR 16.2 billion	0.94%
Society	EUR 57.3 billion	1.02%
Total additional NPV	**EUR 4.2 billion**	**0.70%**

The graph below outlines the changes in the net benefits generated over the period 2015-2020 for **cloud professional users** compared with the baseline scenario.

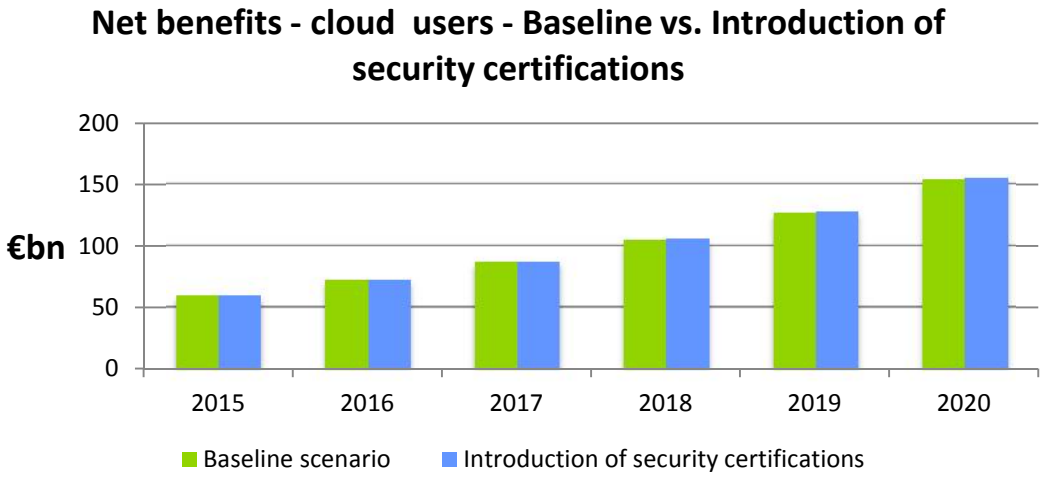


Figure 49 – Comparison between the net benefits for the cloud users generated in the baseline scenario vs. the promotion of existing certifications and standards

As previously mentioned in Table 25, **cloud users** are expected to experience an additional NPV creation of 0.64%, which corresponds to around EUR 3.5 billion in the case certifications and standards are widely promoted and adopted in the cloud sector compared with the baseline scenario. This is due to the additional user uptake generated by these certifications and standards and the reassurance they provide that these cloud services can be considered safe and reliable.

C**loud service providers** are the category of stakeholders directly targeted by this policy measure. Facing additional costs associated with acquiring certifications, they increase the service price by 0.5%. Overall, the profitability of the cloud providers remains the same, but they generate additional revenues due to the additional user uptake of +1% linked with the promotion (and adoption) of certifications and standards. The figure below shows the mild impact of the policy measure on cloud service providers. Over the period 2015-2020, an additional EUR 184 million NPV value is generated, equal to an increase of 0.94% compared to the baseline scenario.

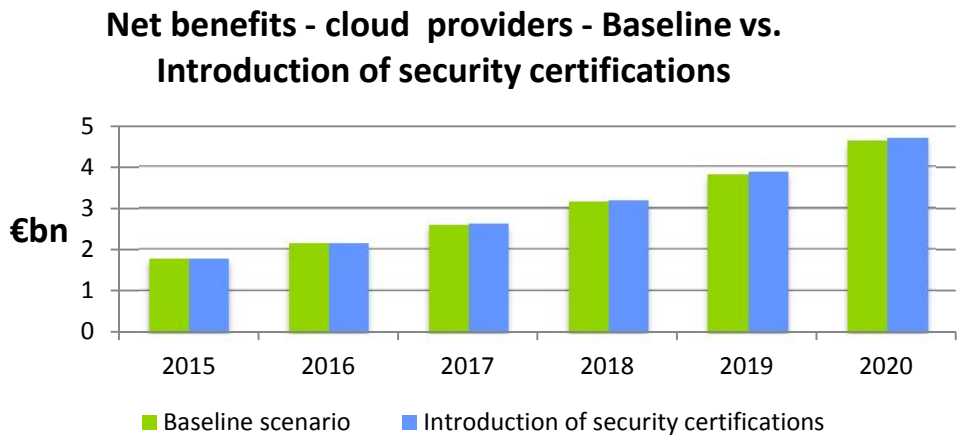


Figure 50 – Comparison between the net benefits for the cloud providers generated in the baseline scenario vs. the promotion of existing certifications and standards

Finally, **economy and society** as a whole experience a similar impact as effect of this policy measure. A graphical representation is given in the figure below. The additional net benefits generated on behalf of the economy and society are linked to a higher VAT income and additional net income taxes associated with the higher price and thus the higher expenditure and the higher uptake of cloud services in the EU. Overall, an additional EUR 586 million (+1.02%) of discounted NPV is generated over the period 2015-2020.

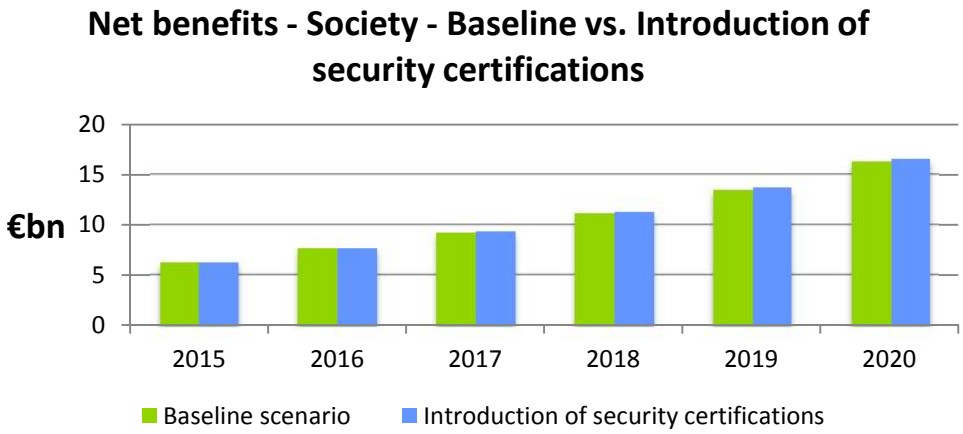


Figure 51 – Comparison between the net benefits for economy and society as a whole generated in the baseline scenario vs. the promotion of existing certifications and standards

The figures described above for cloud professional users, providers and society as a whole refer to a realistic set of assumptions on the impact of the promotion of existing certifications and standards on uptake of cloud computing by users and on prices charged by providers.

Additional hypothesis (a more optimistic and a more pessimistic scenario) are presented below, as a sensitivity analysis. Additional scenarios are presented in Annex E.

Optimistic scenario of significant increase in users' uptake

In the optimistic case that an additional 2% of user uptake is generated due to the promotion of existing certifications and standards, further net benefits will be generated for all stakeholder categories under analysis. Net benefits will accrue up to approximately:

- For **cloud users** EUR 7.5 billion or +1.39%, compared with the baseline scenario over the period 2015-2020.
- For **cloud providers** around EUR 300 million or an increase by +1.57% compared with the baseline scenario over the period 2015-2020.
- For **economy and society** around EUR 1 billion or an increase of +1.77% compared with the baseline scenario over the period 2015-2020.

Pessimistic scenario of no increase in users' uptake

In the pessimistic case that promotion of existing certifications and standards does not create additional user uptake, the overall net benefits generated by this measure are going to be slightly smaller than the realistic scenario of 1% additional uptake. For each of the stakeholder categories, the net benefits will accumulate to approximately:

- For **cloud users** a reduction of almost EUR 600 million or -0.11%, compared with the baseline model. This is caused solely by the fact that the same group of cloud users are now faced with a higher service price and no additional uptake and thus new benefits are generated by new users.
- For **cloud providers** EUR 61 million or an increase by +0.31% compared with the baseline scenario.
- For **economy and society** almost EUR 152 million or an increase of +0.27% compared with the baseline scenario over the period 2015-2020.

7.1.2 Net benefit across sectors

The outcome of the promotion of existing certifications and standards has a rather uniform impact on the 5 different sectors under considerations. The sector with all other industries (residual category) sees an increase of 0.72% of NPV over the period 2015-2020. Both the Finance & business services sector and the Government, Education & Health sector have an increase of 0.71% followed by the Distribution, Retail & Hotels with 0.69% and the Manufacturing sector with an additional NPV over the period 2015-2020 of 0.53%.

The table below provides an overview of the NPV for each of the sectors over the period 2015-2020 in the baseline scenario, the NPV after the introduction of the security certifications and the difference compared with the baseline scenario.

Table 26 – Overview of NPV per sector – Baseline vs. promotion of existing certifications and standards

Sectors	Discounted NPVs 2015-2020, baseline model	Discounted NPVs 2015-2020, promotion of certifications and standards	Change compared with baseline scenario
Finance & business services	EUR 141.0 billion	EUR 142.0 billion	+ EUR 1.0 billion (+0.71%)
Government, education & health	EUR 84.7 billion	EUR 85.3 billion	+ EUR 0.6 billion (+0.71%)
Distribution, retail & hotels	EUR 212.8 billion	EUR 214.2 billion	+ EUR 1.5 billion (+0.69%)
Manufacturing	EUR 83.4 billion	EUR 83.9 billion	+ EUR 0.4 billion (+0.53%)
Others	EUR 85.7 billion	EUR 86.3 billion	+ EUR 0.6 billion (+0.72%)

7.2 Removal of data location restrictions

Following the details outlined under section 6.2.2, this section describes the main quantitative effects of the policy measurement to remove the data location requirement.

It is important to note that the model can only quantify the overall effects for cloud service providers, the professional cloud users and the economy and society as a whole. As explained under section 6.2.2, the model does not allow differentiating amongst the different types of service providers (e.g. SMEs and large enterprises providing cloud computing services).

Although the policy measurement brings overall positive net benefits for cloud service providers, cloud users and the economy and society as a whole, the removal of the data location requirement could have a detrimental effect on the small service providers that use data location as a competitive advantage necessary for their survival in a competitive market against large competitors.

7.2.1 Net benefit to users, providers and wider economy and society

The cost-benefit analysis of the policy measurement to remove the data location requirement for cloud service providers provides **overall positive net benefits** to users, providers and the wider economy and society.

The table below offers an overview of the impact of the measure on the discounted NPVs for the period 2015-2020 for the affected stakeholders.

Table 27 – Changes in NPV across all three stakeholders after removal of data location requirements

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 542.2 billion	1.36%
Cloud providers	EUR 19.5 billion	21.53%
Society	EUR 57.6 billion	1.49%
Total NPV added	**EUR 11.6 billion**	**1.90%**

The following figure provides a comparison, for **cloud users**, between the net benefits realised under the baseline scenario as detailed under section 6.2.2 and the additional net benefits generated through the implementation of the policy measure starting from 2018.

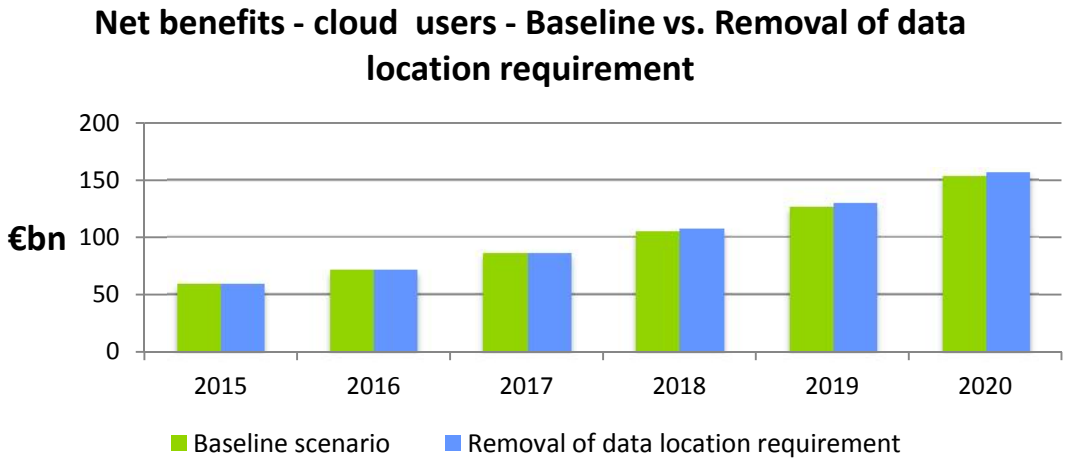


Figure 52 – Comparison between the net benefits for the cloud users generated in the baseline scenario vs. the removal of the data location requirement

As the graph above indicates, the net benefits increase for the cloud users is rather modest in relative terms. Compared with the baseline scenario, the removal of the data location requirement would generate an additional net benefit of EUR 7.2 billion or 1.36% over the period 2015-2020. Such effect is mainly produced by a reduction in prices of cloud solutions.

The stakeholder category that benefits the most, in relative terms, of this policy measurements are **cloud service providers** (at least, those providers that do not depend on data location restrictions for defining their offers). The decrease in operating costs will be compensated only partially by the decrease of revenues.

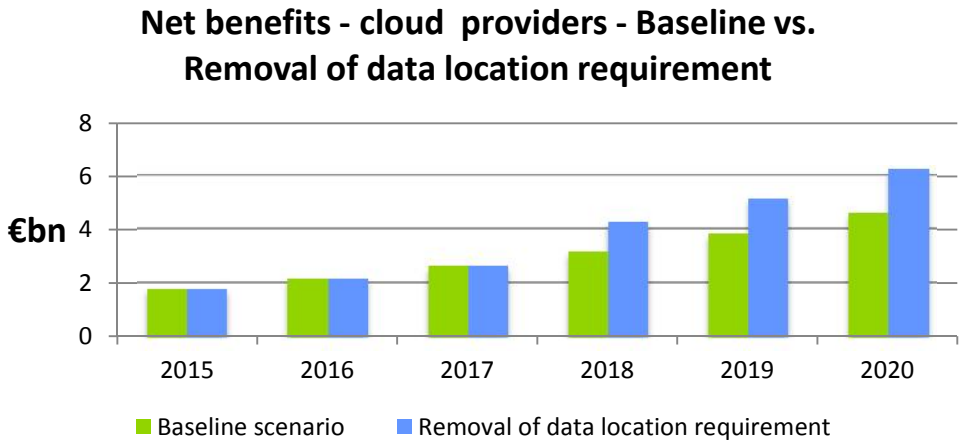


Figure 53 – Comparison between the net benefits for the cloud providers generated in the baseline scenario vs. the removal of the data location requirement

As the policy measure takes affect starting in 2018, cloud service providers are expected to benefit mainly due to the drop in operating costs. Over the period 2015-2020, the measurement would result in the generation of almost EUR 3.5 billion compared with the baseline scenario, meaning an increase by 21.53% in terms of net benefits. This significant increase can be explained due to the higher margins and the higher uptake of cloud services in the EU.

Finally, the **Member States and Society** also generate additional net benefits due to this policy measure as shown in the figure below. This as an effect of:

- Decreasing VAT due to lower prices;
- Higher overall income taxes due to improved profitability of cloud providers
- Additional benefits generated through the reduction of the environmental impact due to higher adoption and uptake of cloud solutions.

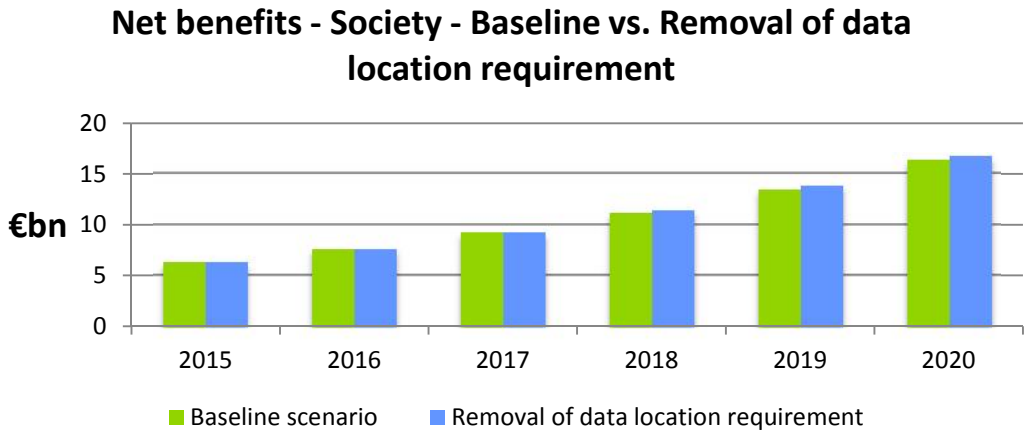


Figure 54 – Comparison between the net benefits for the Society generated in the baseline scenario vs. the removal of the data location requirement

Compared with the baseline scenario, the Member States and wider society will gain approximately EUR 846 million additional net benefits due to the removal of the data location requirements. This equals to an increase of 1.49%.

The figures described above for cloud professional users, providers and society as a whole refer to a 'realistic' set of assumptions on the impact of the removal of data location restrictions on the uptake of cloud computing by.

Additional scenarios (a more optimistic and a more pessimistic scenario) are presented below, as a sensitivity analysis. Additional scenarios are presented in Annex E.

Optimistic scenario of of significant increase in users' uptake

In the optimistic case that an additional 5% of users' uptake is also generated due to the lower services prices, further net benefits will be generated for all stakeholder categories under analysis. Net benefits will cumulate up to approximately:

- For **cloud users** EUR 20.5 billion or +3.84%, compared with the baseline model over the period 2015-2020.
- For **cloud providers** almost EUR 4 billion or an increase by +24.8% compared with the baseline scenario over the period 2015-2020.
- For **economy and society** almost EUR 2.3 billion or an increase of +3.98% compared with the baseline scenario over the period 2015-2020.

Pessimistic scenario of no increase in users' uptake

In the pessimistic case that the lower service price does not create additional user uptake, the overall net benefits generated by this measure are going to be slightly smaller than the realistic scenario of 1% additional uptake. For each of the stakeholder categories, the net benefits will accumulate up to approximately:

- For **cloud users** EUR 4 billion or +0.74%, compared with the baseline model over the period 2015-2020.
- For **cloud providers** EUR 3.3 billion or an increase by +20.7% compared with the baseline scenario over the period 2015-2020.
- For **economy and society** almost EUR 0.5 billion or an increase of +1.28% compared with the baseline scenario over the period 2015-2020.

7.2.2 Net benefit across sectors

When comparing the impact of the removal of the data location requirement across the 5 different sectors being considered, the analysis shows that all sectors improve as an effect of this policy measure. Looking at the relative gains across the sectors, the Manufacturing sector achieves the largest benefit with 2.23% additional NPV over the period 2015-2020. Following is the Distribution, retail & hotels sector with 2.12% increase in NPV with respect to the baseline scenario. Both the Finance & business services and Government, Education & Health sector benefit similarly under this measure with 1.77% and 1.76% increase in NPV respectively. Finally, the sector with Other Industries generates an additional 1.42% NPV over the period 2015-2020.

The table below provides an overview of the initial, baseline NPV for each of the sectors over the period 2015-2020, the NPV after the implementation of the removal of the data location requirement and the difference compared with the baseline scenario.

Table 28 – Overview of NPV per sector – Baseline vs. data location

Sectors	Discounted NPVs 2015-2020, baseline model	Discounted NPVs 2015-2020, removal data location requirement	Change compared with baseline scenario
Finance & business services	EUR 141.0 billion	EUR 143.5 billion	+ EUR 2.5 billion (+1.77%)
Government, education & health	EUR 84.7 billion	EUR 86.2 billion	+ EUR 1.5 billion (+1.76%)
Distribution, retail & hotels	EUR 212.8 billion	EUR 217.3 billion	+ EUR 4.5 billion (+2.12%)
Manufacturing	EUR 83.4 billion	EUR 85.3 billion	+ EUR 1.9 billion (+2.23%)
Others	EUR 85.7 billion	EUR 86.9 billion	+ EUR 1.2 billion (+1.42%)

7.3 Combination of both policy measures

The table below provides an overview of the generated NPV over the period 2015-2020 for each of the stakeholders under consideration (cloud users, cloud providers and economy and society as a whole) under each of the different model options (baseline, Option 1: removal of data location requirement, Option 2: introduction of security certifications and Option 3: the combination of options 1 & 2).

Table 29 – Overview of NPV under each of the considered model options

Stakeholders	Discounted NPVs 2015-2020, baseline model	Discounted NPVs 2015-2020, removal of data location requirement	Discounted NPVs 2015-2020, promotion of certifications and standards	Discounted NPVs 2015-2020, combination of policy options
Cloud users	EUR 534.9 billion	EUR 542.2 billion	EUR 538.4 billion	**EUR 549.0 billion**
Cloud providers	EUR 16.0 billion	EUR 19.5 billion	EUR 16.2 billion	**EUR 19.9 billion**
Society	EUR 56.7 billion	EUR 57.6 billion	EUR 57.3 billion	**EUR 58.5 billion**
Total NPV	**EUR 607.7 billion**	**EUR 619.2 billion**	**EUR 611.9 billion**	**EUR 627.4 billion**
% NPV change	**-**	**+1.90%**	**+0.70%**	**+3.25%**

The detailed assessment of the impact on stakeholder categories and sectors is presented in the sections below.

7.3.1 Net benefit to users, providers and wider economy and society

If the decision is made to promote existing certifications and standards in 2017 and the removal of the data location requirement is implemented starting from 2018, the cost-benefit analysis of shows that **all stakeholders will experience a significant increase in additional net benefits**. Overall, the introduction of these two policy measures could create an additional NPV over the period of 2015-2020 of 3.25%.

The table below offers an overview of the discounted NPVs over the period 2015-2020 for each of the three stakeholders and the percentage change compared with the baseline scenario detailed under section 6.2.2.

Table 30 – Changes in NPV across all three stakeholders after introducing both policy measures

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 549.0 billion	2.63%
Cloud providers	EUR 19.9 billion	23.57%
Society	EUR 58.5 billion	3.15%
Total NPV added	**EUR 19.8 billion**	**3.25%**

The graph below shows the yearly net benefits for the **cloud users** under this scenario compared with the initial baseline.

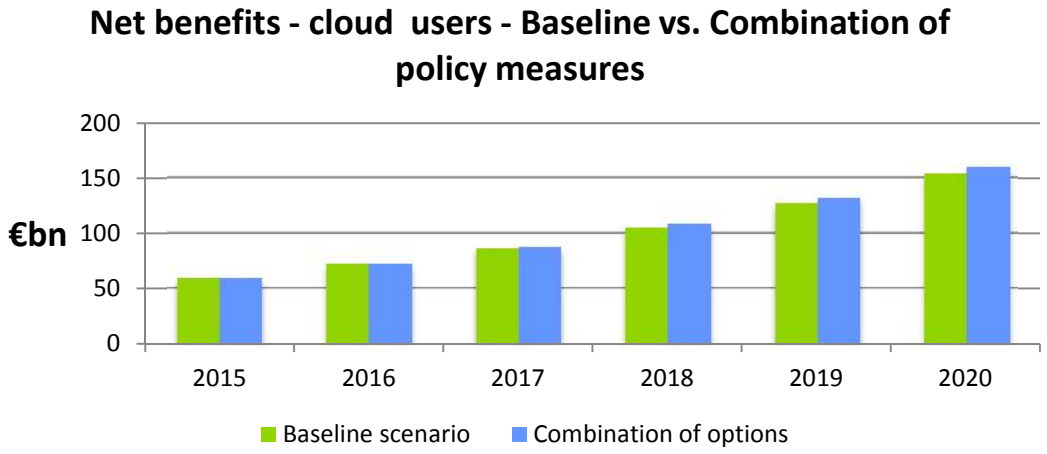


Figure 55 – Comparison between the net benefits for the cloud users generated in the baseline scenario vs. the combination of both policy measures

Over the period under consideration, the additional amount of net benefits for the cloud users accumulate to around EUR 14 billion. This can mainly be explained by the additional users' uptake in 2017 (+1%) associated with the certifications and standards and in 2018 (+1.04%) due to the lower price and some further reinvestment in cloud services.

The results of the same analysis for **cloud service providers** are shown below.

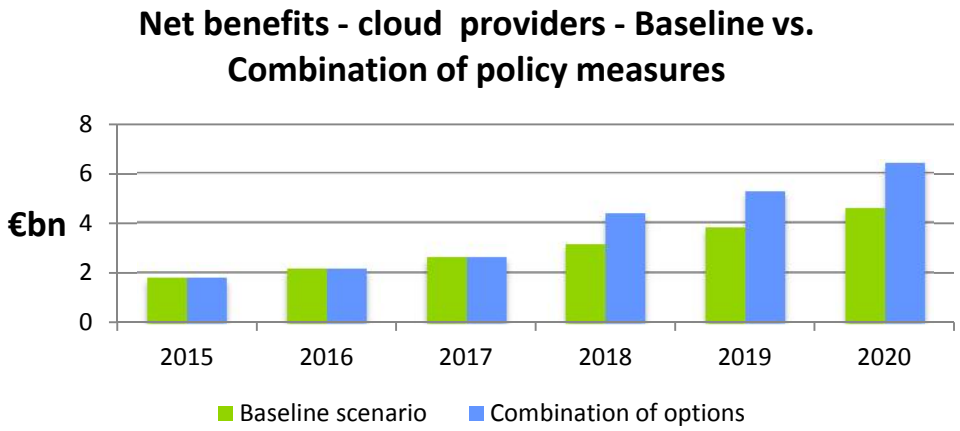


Figure 56 – Comparison between the net benefits for the cloud providers generated in the baseline scenario vs. the combination of both policy measures

Cloud providers are the stakeholders experiencing the largest relative (+23.57%) gains under the scenario of the implementation of both policy measures. Starting in 2017 with the promotion (and adoption) of certifications and standards, the cloud providers will gain some additional net benefits due to the slightly higher service price (+0.5%) and the additional user uptake (+1%). However, the largest effect takes place from 2018 onwards, when the removal of the data location requirement decreases total costs of operations with 9%. On top of this, the lower price increases the additional user uptake with another 1.04%. Overall, the cloud providers could generate additional NPVs over the period 2015-2020 of EUR 3.8 billion.

As mentioned in section 7.2.1, the analysis carried out does not allow differentiating amongst the different types of service providers (e.g. SMEs and large enterprises providing cloud computing services). Therefore, while the policy measures assessed are expected to bring positive net benefits for cloud service providers, it is possible that they have a detrimental effect on some segments for providers. For instance, it is extremely likely that the removal of data location restrictions will impact negatively those small service providers that use data location as a competitive advantage necessary for their survival in a competitive market against large competitors.

Finally, **economy and society as a whole** gain additional NPVs over the period of 2015-2020 of 3.15%; the graphical representation is shown in the figure below.

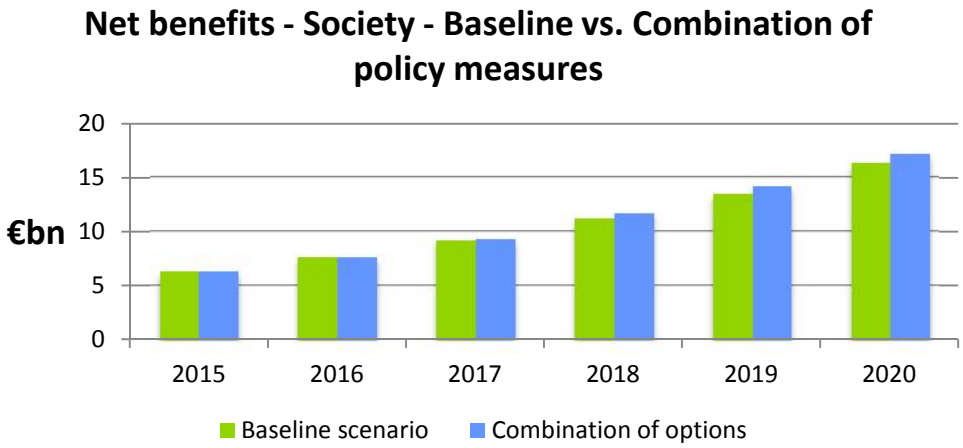


Figure 57 – Comparison between the net benefits for economy and society generated in the baseline scenario vs. the combination of both policy measures

Overall, the Society gains additional NPV over the period 2015-2020 of EUR 1.8 billion. This can mainly be explained by the lower VAT associated with the lower prices, the overall higher tax income linked with the higher profitability of cloud service providers and the additional benefits generated through the reduction of the environmental impact due to the higher uptake of cloud computing in the EU.

The results presented above are the outcomes of the most realistic scenario, in which the initial user uptake is modelled as the baseline scenario detailed under section 5.1.1, and the additional uptake due to the different policy measures is set on +1% due to the introduction of the security certifications and +1% due to the lower price after the removal of the data location requirements. As already described above, the additional users' uptake can range between 0% and 2% (section 7.1, on promoting existing certifications and standards) and between 0% and 5% (section 7.2, after removal of data location requirement). A more in-depth analysis on the different levels of these additional users' uptakes can be found under section 5.1.1 and annex E.

7.3.2 Net benefit across sectors

Looking to the effect of the combination of both policy measures on the 5 different sectors, a similar positive trend can be identified. All sectors generate additional net benefits after the promotion of certifications and standards in 2017 and the removal of the data location requirement in 2018 onwards. The Manufacturing sector is the sector realizing the largest gain with additional NPV over the period of 2015-2020 of 3.57%. The Distribution, Retail & Hotel sector follows closely with an increase of 3.46% followed by both the Finance & business service sector and the Government, Education & Health sector with 3.12% and 3.11% respectively. The fifth category grouping all other sectors sees additional NPV growth over the period 2015-2020 of 2.78%.

The table below provides an overview of the initial, baseline NPV for each of the sectors over the period 2015-2020, the NPV after implementing both the removal of the data location requirement and the promotion of existing certifications and standards, and the difference compared with the baseline scenario.

Table 31 – Overview of NPV per sector – Baseline vs. combination of policy measures

Sectors	Discounted NPVs 2015-2020, baseline model	Discounted NPVs 2015-2020, combination of policy measures	Change compared with baseline scenario
Finance & business services	EUR 141.0 billion	EUR 145.4 billion	+ EUR 4.4 billion (+3.12%)
Government, education & health	EUR 84.7 billion	EUR 87.3 billion	+ EUR 2.6 billion (+3.11%)
Distribution, retail & hotels	EUR 212.8 billion	EUR 220.1 billion	+ EUR 7.4 billion (+3.46%)
Manufacturing	EUR 83.4 billion	EUR 86.4 billion	+ EUR 3.0 billion (+3.57%)
Others	EUR 85.7 billion	EUR 88.1 billion	+ EUR 2.4 billion (+2.78%)

8 Conclusions

This section presents the key findings of the study with regard to the developmemt of cloud computing and to expected impacts of policy initiative to support cloud computing in Europe.

8.1 Costs and benefits under the baseline scenario

The estimates for the baseline scenario of cloud computing in Europe answers to the question '*how will the market for cloud computing evolve in absence of further policy measures?'* (analysis of the Status Quo)

Based on the model developed for the study, the net benefits for the three main groups of stakeholders identified (i.e. professional users, providers of cloud computing services and society as a whole) will grow to 2020, reaching a total of EUR 202 billion. All the three groups would see a net benefit, while the benefits for (professional) users will exceed those for providers and society.

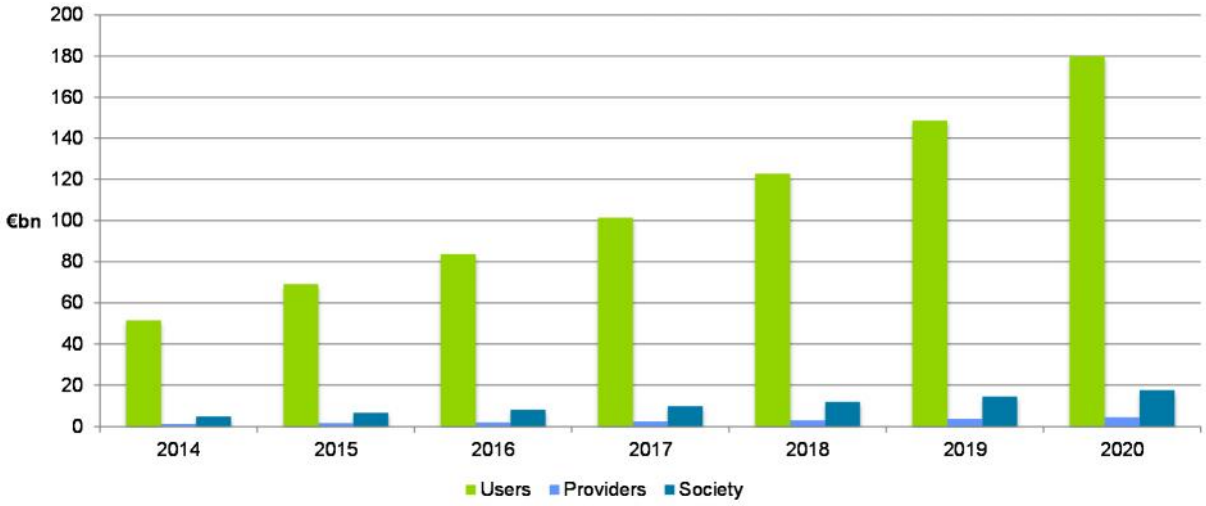


Figure 58 – Costs and benefits of cloud computing (baseline scenario)

In more details, the average annual net benefit for **professional users** is estimated to be EUR 108 billion, with expenditure for cloud computing services estimated to increase up to EUR 35 billion by 2020. Such benefits include are CAPEX and OPEX savings (estimated to reach about EUR 116 billion by 2020) as a result of:

- Shift from CAPEX to OPEX;
- Power and cooling savings; and
- Additional lowering of IT operating costs (OPEX).

Providers of cloud computing services are estimated to have an average annual net benefit of EUR 2.8 billion, raising over time to 2020. The quantified benefits are the revenues from provision of cloud solutions, which are expected to rise to EUR 45 billion by 2020 in EU28. Such estimated benefits exceed the operating costs for providers, estimated to rise to EUR 36 billion by 2020 in EU28.

For society as a whole, the average annual net benefit is estimated to be EUR 11 billion, increasing up to EUR 35 billion in 2020. Such benefits include tax revenues and savings on environmental costs, as well as the business creation benefits included in user calculations.

Concerning the distribution of costs and benefits of cloud services to cloud users across sectors, the highest benefits can be observed by cloud users in the Distribution, Retail & Hotels sectors, followed by Finance & Business services sectors. Based on our estimations, these two sectors account for, respectively, 34% and 24% of the overall net benefit to cloud users. Government, Education & Health sector account for 14% of the net benefits, and Manufacturing for 13%.

8.2 Policy measures for cloud computing in Europe

8.2.1 Policy initiatives supporting cloud computing in Europe

The policy measures considered for the cost-benefits analysis can be divided in three groups. The first two groups include measures that have already been taken and can be further developed to support the free flow of data, i.e. measures on standards and schemes, certification, and trust and on Safe and fair contractual terms for cloud computing. The third group includes measures to remove data location requirements, which directly relate to the Free Flow of Data Initiative (FFDI) recently launched by the Commission.

Out of these measures, only two were included in the cost-benefit analysis of policy initiatives supporting cloud computing in Europe, based on expected (qualitative) impacts and on available literature and data upon which to base the analysis. These measures were the following:

Promotion of existing certifications and standards; and

- Removal of data location restrictions.

These policy initiatives were first considered separately and then combined together.

8.2.2 Costs and benefits of policy initiatives supporting cloud computing in Europe

Promotion of existing certifications and standards

As the promotion of certifications and standards is likely to provide assurance to the cloud users that the service is safe and reliable, an additional user uptake is expected of 1%. The results of the cost-benefit analysis on this policy initiatives indicate that **all the stakeholders** under consideration, namely cloud professional users, cloud service providers, and the society will **benefit** from this policy option, although the additional benefits to the overall value chain are mild (less than 1%).

Table 32 – Changes in NPV across all three stakeholders after promotion of existing certifications and standards

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 538.4 billion	0.64%
Cloud providers	EUR 16.2 billion	0.94%
Society	EUR 57.3 billion	1.02%
Total NPV added	**EUR 4.2 billion**	**0.70%**

Overall, cloud **users** are expected to experience an additional NPV creation of 0.64% (which corresponds to around EUR 3.5 billion) compared with the baseline scenario. This is due to the additional user uptake generated by these certifications and standards and the reassurance they provide that these cloud services can be considered safe and reliable.

C**loud service providers** are the category of stakeholders directly targeted by this policy measure. Facing additional costs associated with acquiring certifications and adopting standards, they are estimated to increase their price by 0.5%. Overall, the profitability of cloud providers remains the same, but they generate additional revenues due to the additional user uptake of +1% linked with the promotion of these certifications and standards. Over the period 2015-2020, an additional EUR 184 million NPV value is generated, equal to an increase of 0.94% compared to the baseline scenario.

Finally, **society as a whole** experiences a similar impact. The additional net benefits for society are linked to a higher VAT income and additional net income taxes associated with the higher prices for cloud computing services, higher expenditure and higher uptake of cloud services in the EU. Overall, an additional EUR 586 million (+1.02%) of discounted NPV is generated over the period 2015-2020 with respect to the baseline scenario.

When considering the impact of this policy initiative on different industries, the promotion of certifications and standards has a rather uniform impact on the 5 different sectors under considerations. Both the Finance & business services sector and the Government, Education & Health sector have an increase of 0.71% followed by the Distribution, Retail & Hotels with 0.69% and the Manufacturing sector with an additional NPV over the period 2015-2020 of 0.53% with respect to the baseline scenario.

Removal of data location restrictions

The cost-benefit analysis of the policy measurement to remove the data location requirement for cloud service providers provides **overall positive net benefits** to users, providers and the wider economy and society.

Table 33 – Changes in NPV across all three stakeholders after removal of data location requirements

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 542.2 billion	1.36%
Cloud providers	EUR 19.5 billion	21.53%
Society	EUR 57.6 billion	1.49%
Total NPV added	**EUR 11.6 billion**	**1.90%**

The net benefits for **cloud professional users** is estimated to be rather modest in relative terms. Compared with the baseline scenario, the removal of the data location requirement would generate an additional net benefit of EUR 7.2 billion or 1.36% over the period 2015-2020. Such effect is produced mainly by a reduction in prices of cloud solutions.

The stakeholder category that benefits the most, in relative terms, of this policy measurements are **cloud service providers**. The decrease in operating costs is expected to prevail over the decrease of revenues. As the policy measure is expected to start producing effects from 2018, cloud service providers are expected to benefit mainly due to the drop in operating costs. Over the period 2015-2020, the measurement would result in the generation of almost EUR 3.5 billion compared with the baseline scenario, meaning an increase by 21.53% in terms of net benefits. This significant increase can be explained due to the higher margins and the higher uptake of cloud services in the EU.

Finally, **society as a whole** is also likely to experience additional benefits with respect to the baseline scenario via the combined effect of:

- Decreasing VAT due to lower prices;
- Higher overall income taxes due to improved profitability of cloud providers;
- Additional benefits generated through the reduction of the environmental impact due to higher adoption and uptake of cloud solutions.

When comparing the impact of the removal of the data location requirement across the five different sectors being considered, it is clear that all sectors improve as an effect of this policy option. Looking to the relative gains across the sectors, the Manufacturing sector realizes the largest benefit with a generation of 2.23% additional NPV over the period 2015-2020. Following is the Distribution, retail & hotels sector with 2.12%. Both the Finance & business services and Government, Education & Health sector benefit similarly under this measure with respectively 1.77% and 1.76%. Finally, the sector with Other Industries generates an additional 1.42% NPV over the period 2015-2020.

Combination of both policy measures

If the decision is made to promote existing certifications and standards in 2017 and the removal of the data location requirement is implemented starting from 2018, the cost-benefit analysis of shows that **all stakeholders will experience a significant increase in additional net benefits**. Overall, the introduction of these two policy measures could create an additional NPV over the period of 2015-2020 of 3.25% with respect to the baseline scenario.

Table 34 – Changes in NPV across all three stakeholders after introducing both policy measures

Stakeholders	Discounted NPVs 2015-2020	% change compared with baseline scenario
Cloud users	EUR 549.0 billion	2.63%
Cloud providers	EUR 19.9 billion	23.57%
Society	EUR 58.5 billion	3.15%
Total NPV added	**EUR 19.8 billion**	**3.25%**

Over the period under consideration, the additional amount of net benefits for **cloud professional users** is expected to reach around EUR 14 billion. This can mainly be explained by the additional users' uptake in 2017 (+1%) associated with certifications and standards and in 2018 (+1.04%) due to the lower price and some further reinvestment in cloud services.

Cloud providers are the stakeholders experiencing the largest relative gains (+23.57%) under the scenario of the implementation of both policy measures. Starting in 2017 with the promotion of certifications and standards, cloud providers are likely to gain additional net benefits due to the slightly higher service price (+0.5%) and the additional user uptake (+1%). However, the largest effect takes place from 2018 onwards, when the removal of the data location requirement is expected to decrease the total costs of operations by 9%. In addition, the lower price increases the additional user uptake with another 1.04%. Overall, the cloud providers could generate additional NPVs over the period 2015-2020 of EUR 3.8 billion.

However, the analysis carried out does not allow differentiating amongst the different types of service providers (e.g. SMEs and large enterprises providing cloud computing services). Therefore, while the policy measures assessed are expected to bring positive net benefits for cloud service providers, it is possible that they have a detrimental effect on some segments for providers. For instance, it is extremely likely that the removal of data location restrictions will impact negatively those small service providers that use data location as a competitive advantage necessary for their survival in a competitive market against large competitors.

Finally, **society as a whole** is expected to gain additional 3.15% NPV over the period of 2015-2020 (or about EUR 1.8 billion). This can mainly be explained by the lower VAT associated with the lower prices, the overall higher tax income linked with the higher profitability of cloud service providers and the additional benefits generated through the reduction of the environmental impact due to the higher uptake of cloud computing in the EU.

Looking to the combined effect of both policy measures on the five different sectors, a similar positive trend can be identified. All sectors generate additional net benefits after the promotion of certifications and standards in 2017 and the removal of the data location requirement in 2018 onwards. The Manufacturing sector is the sector realizing the largest gain with additional NPV over the period of 2015-2020 of 3.57%. The Distribution, Retail & Hotel sector follows closely with an increase of 3.46% followed by both the Finance & business service sector and the Government, Education & Health sector with 3.12% and 3.11% respectively. The fifth category grouping all other sectors sees additional NPV growth over the period 2015-2020 of 2.78%.

Annex A. Acronyms and Abbreviations

This annex contains a list of the most commonly used abbreviations and terms used in this report as well as their meaning.

Acronyms and Abbreviations	Meaning
CAPEX	Capital available of Firms for other investments
CBA	Cost Benefit Analysis
CCBE	Council of Bars and Law societies in Europe
CEF	Connecting Europe Facility
CERT	Computer Emergency Response Team
CIPP	Certified International Privacy Professional
CSC	Cloud Standard Coordination Initiative
DAE	Digital Agenda for Europe
DG	Directorate General
DPA	Digital Public Authorities
DSI	Digital Service Infrastructure
EC	European Commission
ECP	European cloud Partnership
ENISA	European Agency for Network and Information Society

Acronyms and Abbreviations	Meaning
EP	European Parliament
EPON	European Network of Privacy Officers
ETSI	European Telecommunication Standards and Technology Institute
EU	European Union
GDP	Gross Domestic Products
IaaS	Infrastructure as a service
IAPP	International Association for Privacy Professional
IJOSSP	International Journal of Open Source Software and Process
OPEX	Operating Expenses of Firms
PaaS	Platform as a service
PUE	Power Usage Effectiveness
QA	Quantitative Analysis
SaaS	Software as a service
SLA	Service Level Agreement
SME	Small Medium Enterprises
ToR	Terms of Reference

Annex B. Professional users survey

Section 1: profile of the respondent

1. What is the country of establishment of your organisation? (*)

(free text)

2. Are you replying on behalf of a (*)

Small company (less than 50 employees)
Medium sized company (less than 250 employees)
Large company (250 employees or more)
Public administration;
Industry association
Research/academia/university
Individual expert

3. Sector of activity of the organisation (select from multiple choice) (*)

Taxation
Social Security
Healthcare
Education
Legal services
Other

If other, please specify

4. Sector of activity of the organisation (select from multiple choice) (*)

Public Sector
Information & Communication Technologies
Media and entertainment
Financial services and banking
Manufacturing industries
Retail

Other (please specify)

If other, please specify

5. May we contact you if we have further questions based on your replies? (*)

Yes
No

6. Please provide your details (optional):

Name of organisation	Free text
Name	Free text
Role in the organisation	Free text
Email address	Free text
Other contact details	Free text

Section 2: Baseline

Use of cloud computing services

7. Adoption of cloud computing services by your organisation (*)

Currently using cloud computing services
Testing cloud computing services (limited use/trial)
Planning to use cloud computing services
Not using and not planning to use any cloud services

8. Please indicate how many cloud computing services your organisation is currently using (*).

One cloud service solution
Two cloud service solution
Three or more cloud service solution

If three or more, please specify the number of solutions currently in use

9. Please indicate what types of cloud computing services your organisation is using.

E-mail/calendar/diary applications (SaaS)
Personnel/HR applications (SaaS)
Content management applications (SaaS)
Salesmanagement / CRM applications (SaaS)
Accounting / Backoffice applications (SaaS)
Business intelligence and analytics (SaaS)
Security (e.g. e-mail and web security) (SaaS)
Database management systems (PaaS)

Application design, development and or testing (PaaS)
Storage on-line including back-up and/or disaster recovery (IaaS)
System & network management (IaaS)
Infrastructure/compute power (IaaSO

10. What it is the current level of expenditure in your organisation as a percentage of your revenue (*):

0%
1%
2%
3%
4%
5%
6%
7%
8%
9%
10% or more

If 10% or more, please specify

11. What is the current level of expenditure on cloud computing services as a percentage of your expenditure?

0%
0-5%
5-10%
10-15%
15-20%
20-25%
25-30%
30-35%
35-40%
40% or more

12. If you are currently using, testing or planning to use cloud computing services, what are the reason(s) behind this choice?

Reduction of IT costs
Shift from Capital Expenditure (CAPEX, e.g. investment in hardware) to Operational Expenditure (OPEX, e.g. pay per use)
Core process executed in standard way
Increased scalability and flexibility
Providing new services across your organisation

Mobile working
Increased productivity
Opening new business lines
Opening offices in new locations
Increased business volume (revenues)
Other

If other, please specify

Section 3: Benefits from adoption of cloud computing services

13. Has your organisation experienced an impact on overall IT expenditure as a result of adoption cloud computing Services?

Yes
No

14. Please provide an indication of the impact on your annual Capital Expenditure for IT (CAPEX)

Increase
Decrease

15. CAPEX increased/decreased by

0-10%
10-20%
20-30%
30-40%
40-50%
50-60%
60% or more

16. Please provide an indication of the impact on your annual Operational Expenditure for IT (OPEX)

Increase
Decrease

17. OPEX increased/decreased by

0-10%
10-20%
20-30%
30-40%
40-50%
50-60%
60% or more

Section 4: Barriers to adoption of cloud computing services

18. Do any of the following barriers:
    - Reduce the (likelihood off) adoption of cloud computing services for your organisation?
    - Impose costs for your organisation when procuring cloud computing services?
19. Please rate the importance of the barriers identified in terms of the impact it has on the decision on whether to adopt cloud computing services in your organisation (*):
20. Please elaborate on the specific concerns you have in this domain

Barriers	**Do any of the barriers:**		**Importance of barriers on the decision to adopt cloud computing**				**Please elaborate**
	Reduces likelihood of adoption	Imposes costs for my organisation	High impact	Medium impact	Low impact	No impact	
Legal jurisdiction/ enforceability: *"If we have a dispute with the cloud service provider, we may have to go to court in another country inside or outside the EU"*							
Information security, data protection and privacy concerns (incl. intellectual property and confidentiality): *"We are worried about the security and data protection guaranteed by* **cloud** *services"*							
Data location requirements/restrictions: *"We do not know and/or cannot control the location of our corporate data" and/or "We are restricted as to the location of the data storage"*							
Tax incentives: *"Tax and other incentives make buying with capital more attractive than paying for what we use on subscription."*							

Barriers	Do any of the barriers:		Importance of barriers on the decision to adopt cloud computing				Please elaborate
	Reduces likelihood of adoption	Imposes costs for my organisation	High impact	Medium impact	Low impact	No impact	
Procurement rules: *"We need to adhere to specific procurement requirements that makes it difficult the procure cloud computing services."*							
Trust: *"It is difficult to judge which cloud services are trustworthy"*							
Evaluation of usefulness: *"We do not know how to evaluate the usefulness of cloud service for our organisation"*							
Change control: *"We cannot control software changes and upgrades made by the vendor"*							
Ownership of customisation: *"We do not know who owns the customisations/changes we make to the cloud services"*							
Data access and control: *"We have concerns about continuous availability and access to our data stored on cloud services, and/or to delete it"*							
Data portability: *"We have concerns about the ability to move data/business processes/software and systems from one vendor to another or onto our own IT"*							
Interoperability: *"We have concerns about the ability to connect business processes in the cloud services to business processes on our existing systems"*							

Barriers	Do any of the barriers:		Importance of barriers on the decision to adopt cloud computing				Please elaborate
	Reduces likelihood of adoption	Imposes costs for my organisation	High impact	Medium impact	Low impact	No impact	
Local language: *"There is no local language version of the services"*							
Local support: *"There is no local support for the services"*							
Slow Internet connection: *"Our Internet connection(s) is/are not reliable or fast enough*							

21. Do you see any other barriers to the adoption of cloud computing services by your organisation?
22. Do any of the following barriers:
    - Reduce the (likelihood off) adoption of cloud computing services for your organisation?
    - Impose costs for your organisation when procuring cloud computing services?
23. Please rate the importance of the barriers identified in terms of the impact it has on the decision on whether to adopt cloud computing services in your organisation (*):

Barriers	**Do any of the barriers:**		**Importance of barriers on the decision to adopt cloud computing**			
	Reduces likelihood of adoption	Imposes costs for my organisation	High impact	Medium impact	Low impact	No impact
Other barrier 1, please specify						
Other barrier 2, please specify						
Other barrier 3, please specify						
Other barrier 4, please specify						
Other barrier 5, please specify						

Section 5: Costs related to barriers to adoption of cloud computing services

24. If the barriers indicated above impose costs on you as a (potential) customer of cloud, what kind of costs are these? :

Costs in terms of time invested
Costs related to legal aspects (e.g. understanding contracts, Service Level Agreements, legal fees, etc.
Direct costs (e.g. costs for tailored advice on cloud computing services)
Other costs

If other, please specify

25. If you have incurred such costs, would you be able to provide an estimate of these costs? (*)

Yes
No

26. If yes, please provide an overall estimate

Costs in terms of time invested [hours]
Costs related to legal barriers (e.g. legal fees) [EUR]
Direct costs (e.g. costs for tailored advice on cloud computing services) [EUR]
Other costs (please specify)

Section 6: Impacts of policy measures au EU level: standards, certification, trust

In the context of the European cloud computing Strategy different measures have been initiated or planned at European level to 'unleash the potential of cloud computing in Europe' and 'support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology".

The following four EU policy measures are aimed at enhancing trust through standards and certification schemes:

(please read the following short explanations of what these measures consists of, the expected results and involved stakeholders, the question below concerns these measures)

Promote trusted and reliable cloud offerings:

- **The measure consist of**: Ensuring that there is a clear set of standards for cloud computing providers to use, e.g. in relation to security, privacy, terminology and so forth. This is done by mapping the standards that are used and creating a list/framework of reviewed (and "approved") standards. This ensures that cloud services can be described and assessed on equal terms, which

is important to ensure fair competition to cloud providers and to improve transparency for cloud users.

- **The expected result is:** To reduce ambiguities and incompatibilities in current cloud services. This makes it easier to know precisely which assurances are being provided. It also helps cloud users to ensure the security of data in the cloud, to support interoperability, and to allow data to move more easily between cloud s (data portability) , so that users would be more easily able to change providers.
- **Stakeholders involved:** ETSI is leading the initiative and a number of cloud computing companies as well as other organisations are involved.

Development of EU-wide voluntary certification schemes

- **The measure consist of:** promote cloud certification schemes in the cloud market, mapping key existing schemes and supporting the development of new schemes if there are gaps in current schemes. This measure is entirely industry driven: schemes are created, managed and applied without public sector involvement. This allows cloud providers to more easily demonstrate the merits of their services, and allows cloud users to more easily identify services that meet their requirements. This measure can also be supported by tools that, during the procurement of cloud services, makes it possible to select relevant requirements and see what certification schemes cover these.
- **The expected result is**: to make it easier for cloud users to see what certifications are relevant for them, and for cloud providers to be able to obtain relevant certifications that allow comparison on a fair and equal footing.
- **Stakeholders involved:** ENISA is leading the initiative and a number of cloud computing companies as well as industry groups are involved.

Development of certification schemes through EU trustmarks

- **The measure consist of:** mapping, developing and promoting cloud certification schemes as described above, but would also be public sector driven through one or more EU trustmarks . The measure is thus not purely industry managed, and relies on the involvement of a public sector third party that might be perceived as more neutral than a purely industry driven scheme.
- **The expected result is:** to make it easier for cloud users to see what certifications are relevant for them, and for cloud providers to be able to obtain relevant certifications that allow comparison on a fair and equal footing; and to benefit from the greater neutrality that an EU trustmark might provide .
- **Stakeholders involved:** The measure would require the involvement of the cloud industry, but also of public sector organisations such as potentially the Commission, ENISA, and/or the Article 29 Working Party.

Enhance trust in cloud computing services

- **The measure consist of:** recognising technical specifications for the protection of personal information in accordance with the new Regulation on European Standardisation. This would improve transparency and predictability ,since cloud providers and cloud users can both more easily determine which specifications (e.g. in relation to security, privacy, service levels, data

formats/portability etc.) have obtained some form of external recognition, making it more likely that they are appropriate for their own activities.

- **The expected result is**: is to help make it easier for cloud users to select an appropriate cloud provider on the basis of recognised specifications, and for providers to know that they are using standards which specifications are generally that are recognised as being safe, reliable and of good quality. The measure would thus eliminate some of the uncertainty around this issue that currently still exists.
- **Stakeholders involved:** The initiative would need to be driven by European standardisation bodies such as ETSI, CEN and CENELEC, with a mandate from the European Commission, and including appropriate liaisons to international standardisation organisations (such as ISO) to avoid overlaps, and with close involvement of the cloud industry.

27. Do you think these measures will:
    - Improve the ease with which your organisation can adopt cloud computing service?
    - Reduce the costs your organisation faces to adopt cloud computing services? (please distinguish between one-off and recurrent costs
28. Please rate the importance of this measure in terms of adoption of cloud computing services in your organisation (*):

Measure	Do any of the barriers:			Importance of the measure on adoption of cloud computing			
	Improve the ease of adoption	Reduces one-off costs of adoption	Reduces the yearly (recurrent) costs of adoption	High impact	Medium impact	Low impact	No impact
Promote trusted and reliable cloud offerings based on 'approved' standards							
Development of EU-wide voluntary certification schemes							
Development of certification schemes through EU trustmarks							
Enhance trust in cloud computing services through recognized technical specifications							

Section 6: Impacts of policy measures au EU level: safe and fair contract terms

In the context of the European cloud computing Strategy different measures have been initiated or planned at European level to 'unleash the potential of cloud computing in Europe' and 'support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology".

The following three EU policy measures are aimed at enhancing safe and fair contract terms:

(please read the following short explanations of what these measures consists of, the expected results and involved stakeholders, the question below concerns these measures).

Develop with stakeholders model terms for cloud computing service level agreements for contracts

- **The measure consist of:** developing a standard model terms for service level agreements (SLAs – which include elements like scope of the service, availability and uptime guarantees, response times to support requests, etc. – what you get -, the quality and responsibilities) between the cloud providers and their (professional) customers. This allows providers to describe their service levels on equal terms, and makes it easier for customers to know that the SLAs have appropriate and balanced clauses in place.
- **The expected result is:** a set of standard terms for SLAs that will make it easier for cloud users to know what service will be provided when procuring a cloud solution, thereby making it easier not only to ensure getting what is needed, but also to compare the offerings of different cloud providers. The measure helps to overcome some of the knowledge gap that often exists between provides and buyers (especially for SMEs).
- **Stakeholders involved:** The European Commission is leading the initiative through a study that will produce model terms by mid-2015. Further interactions with stakeholder groups and cloud industry will be needed to ensure that the model terms are adopted in practice. EU research activities working around cloud SLAs (SPECS, SLALOM, A4Cloud, etc.) should also be engaged to ensure that advanced use cases such as automated comparison and negotiation can be supported.

Propose European model contract terms and conditions to consumers and small firms

- **The measure consist of:** standardising important contract terms and conditions for cloud services and providing best practice terms and conditions for contracts related to digital content (e.g. online music stores, mail, etc.). As with the measure above, this allows providers to describe their cloud service on equal terms, and makes it easier for customers to know that the contracts have appropriate and balanced clauses in place.
- **The expected result is:** to enable cloud users to more easily understand what appropriate rights are granted on key topics such as data ownership, privacy, portability (being able to move your data to another provider), etc., based on standard terms and conditions, so that once you know your rights under these you know what you get from the providers that offer these terms and conditions. For providers, the model terms can serve as a template or checklist to ensure that their terms are in accordance with reasonable expectations.

- **Stakeholders involved:** The European Commission (DG Justice) is leading the initiative and representatives of cloud service providers, consumers and SMEs, academics and legal professionals are involved.

Facilitate Europe's participation in the global growth of cloud computing

- **The measure consist of**: reviewing standard contractual clauses related to the transfer of personal data to countries outside the EU and adapting them as needed based on the EU's Data Protection Directive. For providers and customers alike, this will help them to address privacy and data protection challenges which are seen as one of the barriers to cloud services in Europe.
- **The expected result is:** to ensure the best possible protection of your data , including when it is exported abroad (to data centres outside the EU), so that you can feel safe about what is happening to your data through standardised legal protections that comply with EU data protection law, while ensure effective protections to the personal data of European citizens.
- **Stakeholders involved**: The European Commission (DG Justice) is leading the initiative in coordination with data protection experts and national data protection authorities.

29. Do you think these measures will:
    - Improve the ease with which your organisation can adopt cloud computing service?
    - Reduce the costs your organisation faces to adopt cloud computing services? (please distinguish between one-off and recurrent costs
30. Please rate the importance of this measure in terms of adoption of cloud computing services in your organisation (*):

Measure	Do any of the barriers:			Importance of the measure on adoption of cloud computing			
	Improve the ease of adoption	Reduces one-off costs of adoption	Reduces the yearly (recurrent) costs of adoption	High impact	Medium impact	Low impact	No impact
Develop with stakeholders model terms for cloud computing service level agreements for contracts							
Propose European model contract terms and conditions to consumers and small firms							
Facilitate Europe's participation in the global growth of cloud computing							

Section 7: Impacts of policy measures au EU level: security and data protection

In the context of the European cloud computing Strategy different measures have been initiated or planned at European level to 'unleash the potential of cloud computing in Europe' and 'support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology".

The following three EU policy measures are aimed at enhancing security and data protection:

(please read the following short explanations of what these measures consists of, the expected results and involved stakeholders, the question below concerns these measures)

Work with industry to agree a code of conduct for cloud computing providers to support a uniform application of data protection rules

- **The measure consist of**: setting up a code of conduct for cloud providers to encourage them all to apply the data protection rules in a uniform way. A standard set of rights of cloud customers will be ensured, allowing them e.g. to know where their data is, how they can get it back, which security measures are provided or available, and where they can go for support requests. This Code will be evaluated by all European data protection authorities and governed by a neutral body, so that the market (including both cloud providers and customers) can be confident that providers offer a high level of data protection and privacy assurances.
- **The expected result is:** that you will know how the cloud providers apply the data protection rules, making sure that you know how your data is protected and that you can trust any provider that adheres to the code of conduct. Transparency, security and quality of cloud services will be strengthened, enabling greater confidence for cloud customers.
- **Stakeholders involved:** The European Commission is leading the initiative and cloud companies and industry organisations are involved initiative is industry driven, via the Cloud Special Interest Group (C-SIG), with the support of the European Commission. The national data protection authorities are similarly involved, since the Code must be verified by the Article 29 Working Party (which contains representatives of all data protection authorities)

Cloud computing security

- **The measure consist of:** raising users' awareness on cloud computing security issues such as relating to encryption and public procurement by addressing cloud computing security specific issues as part of, for example the ENISA cyber security month. This should be considered in the finalisation and implementation of the NIS Directive, and will improve customers' justifiable faith in cloud security, while (and by) strengthening security practices with cloud providers.
- **The expected result is:** a better, more homogeneous and effective application of security measures for cloud services, and more efficient enforcement of the law in case of incidents.
- **Stakeholders involved:** Legislators at the EU initiative are currently finalising the NIS Directive, which will thereafter need to be implemented at the national level. This will involve national legislators, but also national CERTs and security services, and cloud security organisations.

Data Location Requirements

- **The measure consist of:** identifying any national requirements (whether through law, administrative practice or policy) in relation to data location, identifying the rationale behind the requirements, and assessing if and how cloud services could satisfy the requirements. This would allow the requirements to be rationalised, ensuring that geographic barriers are not introduced when the same result could be obtained through e.g. requirements on security, accessibility, response times, etc. This would open new markets to providers, and would allow users to procure cloud services in a more efficient way.
- **The expected result is:** a rationalisation of current requirements, ensuring that geographic data location requirements are not needlessly maintained.
- **Stakeholders involved:** The initiative should be lead by the Commission, with support from the Member States and from key industry groups that commonly face data location requirements (e.g. financial services, health care, legal services, etc.).

31. Do you think these measures will:
    - Improve the ease with which your organisation can adopt cloud computing service?
    - Reduce the costs your organisation faces to adopt cloud computing services? (please distinguish between one-off and recurrent costs
32. Please rate the importance of this measure in terms of adoption of cloud computing services in your organisation (*):

Measure	Do any of the barriers:			Importance of the measure on adoption of cloud computing			
	Improve the ease of adoption	Reduces one-off costs of adoption	Reduces the yearly (recurrent) costs of adoption	High impact	Medium impact	Low impact	No impact
Code of Conduct for cloud computing providers to support a uniform application of data protection rules							
Cloud computing security							
Rationalise data location requirements							

Annex C. Cloud providers/ intermediaries survey

Section 1: profile of the respondent

1. What is the country of establishment of your organisation? (*)

(free text)

2. What kind of organisation do you represent (*)

Small company (less than 50 employees)
Medium sized company (less than 250 employees)
Large company (250 employees or more)
Public administration;
Industry association
Individual expert

3. What is the position of your organisation in the supply chain of cloud services?(*)

Provider (i.e. companies that produce directly cloud computing service offerings
Intermediary (i.e. a third-party business that acts as an intermediary between the purchaser of a cloud computing service and the sellers of that service, for instance by tailoring more general cloud services to the specific consumers' needs

4. May we contact you if we have further questions based on your replies? (*)

Yes
No

5. Please provide your details (optional):

Name of organisation	Free text
Name	Free text
Role in the organisation	Free text
Email address	Free text
Other contact details	Free text

Section 2: Services and customers

6. What is the annual turnover from provision of cloud computing services in your organisation [EUR]?:

7. What is the number of personnel (FTE) directly involved in the provision of cloud computing services in your organisation?:

8. What type(s) of cloud computing service models does your organisation provide?:(*)

Software as a Service (SaaS)
Platform as a Service (PaaS)
Infrastructure as a Service (IaaS)

9. Please provide an indication of the % of turnover from cloud services?

SaaS
PaaS
IaaS

10. What type(s) of cloud computing deployment models does your organisation provide?:(*)

Private cloud
Public cloud
Hybrid cloud
Others (e.g. community cloud , distributed cloud , intercloud, multicloud)

11. Please indicate the % of turnover from cloud computing services per each deployment model:

Private cloud
Public cloud
Hybrid cloud
Others (e.g. community cloud , distributed cloud , intercloud, multicloud)

12. In which geographical market(s) are your customers established?

Domestic only
EU market
Third countries

Please specify the countries:

13. Please indicate the % share of the markets above as a percentage of your sales/returns from cloud computing services?

Domestic only
EU market
Third countries

14. What types(s) of customers do you serve with cloud computing services? (*)

Business clients (B2B)
Government clients (B2G)
Individual clients (B2C)

15. Please indicate the % of turnover from cloud computing services according to the type of customer

Business clients (B2B)
Government clients (B2G)
Individual clients (B2C)

16. Sector of activity of the customer served with cloud computing services

Public sector
Information and Communication Technologies
Media and Entertainment
Financial services and Banking
Manufacturing industries
Retail
Other

If others, please specify:

Section 3: Barriers to the adoption of cloud computing

17. Does this barrier:
    - o Reduce the likely base or annual sales/turnover from cloud computing services for your company?
    - o Impose costs for your company for providing cloud computing services?
18. Please rate the importance of the barriers identified in terms of the impact it has on the provision of cloud computing services in your markets (*):
19. Please elaborate on the specific concerns you have in this domain

Barriers	**Does this barrier:**				**Importance of barriers on the provision of cloud computing**				**Please elaborate**
	Reduces sales in our **domestic** market	Imposes costs in our **domestic** market	Reduces sales in markets **across the EU**	Imposes costs in markets **across the EU**	High impact	Medium impact	Low impact	No impact	
Legal jurisdiction/ enforceability: *"If we have a dispute with the cloud service provider, we may have to go to court in another country inside or outside the EU"*									
Information security, data protection and privacy concerns (incl. intellectual property and confidentiality): *"We are worried about the security and data protection guaranteed by* **cloud** *services"*									
Data location requirements/restrictions: *"We do not know and/or cannot control the location of our corporate data" and/or "We are restricted as to the location of the data storage"*									

Barriers	Does this barrier:				Importance of barriers on the provision of cloud computing				Please elaborate
	Reduces sales in our **domestic** market	Imposes costs in our **domestic** market	Reduces sales in markets **across the EU**	Imposes costs in markets **across the EU**	High impact	Medium impact	Low impact	No impact	
Tax incentives: *"Tax and other incentives make buying with capital more attractive than paying for what we use on subscription."*									
Procurement rules: *"We need to adhere to specific procurement requirements that makes it difficult the procure cloud computing services."*									
Trust: *"It is difficult to judge which cloud services are trustworthy"*									
Evaluation of usefulness: *"We do not know how to evaluate the usefulness of cloud service for our organisation"*									
Change control: *"We cannot control software changes and upgrades made by the vendor"*									
Ownership of customisation: *"We do not know who owns the customisations/changes we make to the cloud services"*									
Data access and control: *"We have concerns about continuous availability*									

Barriers	Does this barrier:				Importance of barriers on the provision of cloud computing				Please elaborate
	Reduces sales in our **domestic** market	Imposes costs in our **domestic** market	Reduces sales in markets **across the EU**	Imposes costs in markets **across the EU**	High impact	Medium impact	Low impact	No impact	
and access to our data stored on cloud services, and/or to delete it"									
Data portability: *"We have concerns about the ability to move data/business processes/software and systems from one vendor to another or onto our own IT"*									
Interoperability: *"We have concerns about the ability to connect business processes in the cloud services to business processes on our existing systems"*									
Local language: *"There is no local language version of the services"*									
Local support: *"There is no local support for the services"*									
Slow Internet connection: *"Our Internet connection(s) is/are not reliable or fast enough*									

Section 4: Impacts of policy measures au EU level: standards, certification, trust

In the context of the European cloud computing Strategy different measures have been initiated or planned at European level to 'unleash the potential of cloud computing in Europe' and 'support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology".

The following four EU policy measures are aimed at enhancing trust through standards and certification schemes:

(please read the following short explanations of what these measures consists of, the expected results and involved stakeholders, the question below concerns these measures)

Promote trusted and reliable cloud offerings:

- **The measure consist of**: Ensuring that there is a clear set of standards for cloud computing providers to use, e.g. in relation to security, privacy, terminology and so forth. This is done by mapping the standards that are used and creating a list/framework of reviewed (and "approved") standards. This ensures that cloud services can be described and assessed on equal terms, which is important to ensure fair competition to cloud providers and to improve transparency for cloud users.
- **The expected result is:** To reduce ambiguities and incompatibilities in current cloud services. This makes it easier to know precisely which assurances are being provided. It also helps cloud users to ensure the security of data in the cloud, to support interoperability, and to allow data to move more easily between cloud s (data portability), so that users would be more easily able to change providers.
- **Stakeholders involved:** ETSI is leading the initiative and a number of cloud computing companies as well as other organisations are involved.

Development of EU-wide voluntary certification schemes

- **The measure consist of:** promote cloud certification schemes in the cloud market, mapping key existing schemes and supporting the development of new schemes if there are gaps in current schemes. This measure is entirely industry driven: schemes are created, managed and applied without public sector involvement. This allows cloud providers to more easily demonstrate the merits of their services, and allows cloud users to more easily identify services that meet their requirements. This measure can also be supported by tools that, during the procurement of cloud services, makes it possible to select relevant requirements and see what certification schemes cover these.
- **The expected result is**: to make it easier for cloud users to see what certifications are relevant for them, and for cloud providers to be able to obtain relevant certifications that allow comparison on a fair and equal footing.
- **Stakeholders involved:** ENISA is leading the initiative and a number of cloud computing companies as well as industry groups are involved.

Development of certification schemes through EU trustmarks

- **The measure consist of:** mapping, developing and promoting cloud certification schemes as described above, but would also be public sector driven through one or more EU trustmarks . The measure is thus not purely industry managed, and relies on the involvement of a public sector third party that might be perceived as more neutral than a purely industry driven scheme.
- **The expected result is:** to make it easier for cloud users to see what certifications are relevant for them, and for cloud providers to be able to obtain relevant certifications that allow comparison on a fair and equal footing; and to benefit from the greater neutrality that an EU trustmark might provide .
- **Stakeholders involved:** The measure would require the involvement of the cloud industry, but also of public sector organisations such as potentially the Commission, ENISA, and/or the Article 29 Working Party.

Enhance trust in cloud computing services

- **The measure consist of:** recognising technical specifications for the protection of personal information in accordance with the new Regulation on European Standardisation. This would improve transparency and predictability ,since cloud providers and cloud users can both more easily determine which specifications (e.g. in relation to security, privacy, service levels, data formats/portability etc.) have obtained some form of external recognition, making it more likely that they are appropriate for their own activities.
- **The expected result is:** is to help make it easier for cloud users to select an appropriate cloud provider on the basis of recognised specifications, and for providers to know that they are using standards which specifications are generally that are recognised as being safe, reliable and of good quality. The measure would thus eliminate some of the uncertainty around this issue that currently still exists.
- **Stakeholders involved:** The initiative would need to be driven by European standardisation bodies such as ETSI, CEN and CENELEC, with a mandate from the European Commission, and including appropriate liaisons to international standardisation organisations (such as ISO) to avoid overlaps, and with close involvement of the cloud industry.

20. Do you think these measures will:
    - Impact the costs of providing cloud computing services for your organisation?
    - If yes, what will the impact be most likely?
21. Do you think these measures will:
    - Impact the market potential for you cloud computing services?
    - If yes, what will the impact be most likely?
22. Please indicate the importance of this measure in terms of the provision of cloud computing services in your organisation (*):

Measure	Do you think these measures will				Do you think any of these measures will				Importance of the measure on provision of cloud computing			
	It will increase our OPEX	It will decrease our OPEX	It will increase our CAPEX	It will decrease our CAPEX	Reduce sales in our **domestic** market	Impose costs in our **domestic** market	Reduce sales in markets **across the EU**	Impose costs in markets **across the EU**	High impact	Medium impact	Low impact	No impact
Promote trusted and reliable cloud offerings based on 'approved' standards												
Development of EU-wide voluntary certification schemes												
Development of certification schemes through EU trustmarks												
Enhance trust in cloud computing services through recognized technical specifications												

Section 5: Impacts of policy measures au EU level: safe and fair contract terms

In the context of the European cloud computing Strategy different measures have been initiated or planned at European level to 'unleash the potential of cloud computing in Europe' and 'support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology".

The following three EU policy measures are aimed at enhancing safe and fair contract terms:

(please read the following short explanations of what these measures consists of, the expected results and involved stakeholders, the question below concerns these measures).

Develop with stakeholders model terms for cloud computing service level agreements for contracts

- **The measure consist of:** developing a standard model terms for service level agreements (SLAs – which include elements like scope of the service, availability and uptime guarantees, response times to support requests, etc. – what you get -, the quality and responsibilities) between the cloud providers and their (professional) customers. This allows providers to describe their service levels on equal terms, and makes it easier for customers to know that the SLAs have appropriate and balanced clauses in place.
- **The expected result is:** a set of standard terms for SLAs that will make it easier for cloud users to know what service will be provided when procuring a cloud solution, thereby making it easier not only to ensure getting what is needed, but also to compare the offerings of different cloud providers. The measure helps to overcome some of the knowledge gap that often exists between provides and buyers (especially for SMEs).
- **Stakeholders involved:** The European Commission is leading the initiative through a study that will produce model terms by mid-2015. Further interactions with stakeholder groups and cloud industry will be needed to ensure that the model terms are adopted in practice. EU research activities working around cloud SLAs (SPECS, SLALOM, A4Cloud, etc.) should also be engaged to ensure that advanced use cases such as automated comparison and negotiation can be supported.

Propose European model contract terms and conditions to consumers and small firms

- **The measure consist of:** standardising important contract terms and conditions for cloud services and providing best practice terms and conditions for contracts related to digital content (e.g. online music stores, mail, etc.). As with the measure above, this allows providers to describe their cloud service on equal terms, and makes it easier for customers to know that the contracts have appropriate and balanced clauses in place.
- **The expected result is:** to enable cloud users to more easily understand what appropriate rights are granted on key topics such as data ownership, privacy, portability (being able to move your data to another provider), etc., based on standard terms and conditions, so that once you know your rights under these you know what you get from the providers that offer these terms and conditions. For providers, the model terms can serve as a template or checklist to ensure that their terms are in accordance with reasonable expectations.

- **Stakeholders involved:** The European Commission (DG Justice) is leading the initiative and representatives of cloud service providers, consumers and SMEs, academics and legal professionals are involved.

Facilitate Europe's participation in the global growth of cloud computing

- **The measure consist of**: reviewing standard contractual clauses related to the transfer of personal data to countries outside the EU and adapting them as needed based on the EU's Data Protection Directive. For providers and customers alike, this will help them to address privacy and data protection challenges which are seen as one of the barriers to cloud services in Europe.
- **The expected result is:** to ensure the best possible protection of your data , including when it is exported abroad (to data centres outside the EU), so that you can feel safe about what is happening to your data through standardised legal protections that comply with EU data protection law, while ensure effective protections to the personal data of European citizens.
- **Stakeholders involved**: The European Commission (DG Justice) is leading the initiative in coordination with data protection experts and national data protection authorities.

23. Do you think these measures will:
    - Impact the costs of providing cloud computing services for your organisation?
    - If yes, what will the impact be most likely?
24. Do you think these measures will:
    - Impact the market potential for you cloud computing services?
    - If yes, what will the impact be most likely?
25. Please indicate the importance of this measure in terms of the provision of cloud computing services in your organisation (*):

Measure	Do you think these measures will				Do you think any of these measures will				Importance of the measure on provision of cloud computing			
	It will increase our OPEX	It will decrease our OPEX	It will increase our CAPEX	It will decrease our CAPEX	Reduce sales in our **domestic** market	Impose costs in our **domestic** market	Reduce sales in markets **across the EU**	Impose costs in markets **across the EU**	High impact	Medium impact	Low impact	No impact
Develop with stakeholders model terms for cloud computing service level agreements for contracts												
Propose European model contract terms and conditions to consumers and small firms												
Facilitate Europe's participation in the global growth of cloud computing												

Section 6: Impacts of policy measures au EU level: security and data protection

In the context of the European cloud computing Strategy different measures have been initiated or planned at European level to 'unleash the potential of cloud computing in Europe' and 'support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology".

The following three EU policy measures are aimed at enhancing security and data protection:

(please read the following short explanations of what these measures consists of, the expected results and involved stakeholders, the question below concerns these measures)

Work with industry to agree a code of conduct for cloud computing providers to support a uniform application of data protection rules

- **The measure consist of**: setting up a code of conduct for cloud providers to encourage them all to apply the data protection rules in a uniform way. A standard set of rights of cloud customers will be ensured, allowing them e.g. to know where their data is, how they can get it back, which security measures are provided or available, and where they can go for support requests. This Code will be evaluated by all European data protection authorities and governed by a neutral body, so that the market (including both cloud providers and customers) can be confident that providers offer a high level of data protection and privacy assurances.
- **The expected result is:** that you will know how the cloud providers apply the data protection rules, making sure that you know how your data is protected and that you can trust any provider that adheres to the code of conduct. Transparency, security and quality of cloud services will be strengthened, enabling greater confidence for cloud customers.
- **Stakeholders involved:** The European Commission is leading the initiative and cloud companies and industry organisations are involved initiative is industry driven, via the Cloud Special Interest Group (C-SIG), with the support of the European Commission. The national data protection authorities are similarly involved, since the Code must be verified by the Article 29 Working Party (which contains representatives of all data protection authorities)

Cloud computing security

- **The measure consist of:** raising users' awareness on cloud computing security issues such as relating to encryption and public procurement by addressing cloud computing security specific issues as part of, for example the ENISA cyber security month. This should be considered in the finalisation and implementation of the NIS Directive, and will improve customers' justifiable faith in cloud security, while (and by) strengthening security practices with cloud providers.
- **The expected result is:** a better, more homogeneous and effective application of security measures for cloud services, and more efficient enforcement of the law in case of incidents.
- **Stakeholders involved:** Legislators at the EU initiative are currently finalising the NIS Directive, which will thereafter need to be implemented at the national level. This will involve national legislators, but also national CERTs and security services, and cloud security organisations.

Data Location Requirements

- **The measure consist of:** identifying any national requirements (whether through law, administrative practice or policy) in relation to data location, identifying the rationale behind the requirements, and assessing if and how cloud services could satisfy the requirements. This would allow the requirements to be rationalised, ensuring that geographic barriers are not introduced when the same result could be obtained through e.g. requirements on security, accessibility, response times, etc. This would open new markets to providers, and would allow users to procure cloud services in a more efficient way.
- **The expected result is:** a rationalisation of current requirements, ensuring that geographic data location requirements are not needlessly maintained.
- **Stakeholders involved:** The initiative should be led by the Commission, with support from the Member States and from key industry groups that commonly face data location requirements (e.g. financial services, health care, legal services, etc.).

26. Do you think these measures will:
    - Impact the costs of providing cloud computing services for your organisation?
    - If yes, what will the impact be most likely?
27. Do you think these measures will:
    - Impact the market potential for you cloud computing services?
    - If yes, what will the impact be most likely?
28. Please indicate the importance of this measure in terms of the provision of cloud computing services in your organisation (*):

Measure	Do you think these measures will				Do you think any of these measures will				Importance of the measure on provision of cloud computing			
	It will increase our OPEX	It will decrease our OPEX	It will increase our CAPEX	It will decrease our CAPEX	Reduce sales in our **domestic** market	Impose costs in our **domestic** market	Reduce sales in markets **across the EU**	Impose costs in markets **across the EU**	High impact	Medium impact	Low impact	No impact
Code of Conduct for cloud computing providers to support a uniform application of data protection rules												
Cloud computing security												
Rationalise data location requirements												

Section 7: Impacts of policy measures au EU level: insurance, taxation and international dialogue

In the context of the European cloud computing Strategy different measures have been initiated or planned at European level to 'unleash the potential of cloud computing in Europe' and 'support the development of an environment favourable to the adoption of cloud computing in Europe and thus to the full realisation of the benefits of this technology".

The following three EU policy measures are aimed at addressing insurance, taxation and international dialogue:

(please read the following short explanations of what these measures consists of, the expected results and involved stakeholders, the question below concerns these measures)

Insurance and liability for cloud computing services

- **The measure consist of:** the identification of liability rules, practices and scenarios for cloud services in order to assess if and what level of insurance would be needed to cover these risks. This would ensure that cloud providers can satisfy their legal obligations, and that cloud customers can obtain compensation for damages.
- **The expected result is:** include a better understanding of liability risks and claims possibilities, and the support of effective dispute resolution and compensation mechanisms that consider the international nature of cloud computing and the frequent disparities between the legal budgets of providers and customers.
- **Stakeholders involved**: The initiative should be lead by the European Commission, and should include consultation of providers, customers and stakeholders in the insurance industry.

Taxation and cloud computing

- **The measure consist of:** an assessment of how taxation rules (including VAT, but potentially also corporate taxations and other forms of levies) apply to cloud services, and to identify any cases of unfairness, multiple taxation, or non-taxation that disrupt fair competition in the European cloud market. This will ensure that providers can compete on an equal basis, and strengthens access to cloud services for cloud customers in the EU.
- **The expected result is:** are a rationalisation of current taxation laws, ensuring that they do not introduce disruptions or distortions in the cloud market.
- **Stakeholders involved:** The initiative should be led by the Commission, with support from the Member States and from the cloud industry itself.

International Perspective on cloud computing services

- **The measure consist of:** establishing an international dialogue on cloud computing services between public sector bodies, cloud industry and civil society, specifically on topics that transcend purely EU competences. Key examples are national data location requirements, taxation rules, national security and privacy requirements: if countries outside the EU implement rules that directly contradict EU legal requirements, this implies that cloud providers can only offer their services in certain jurisdictions or risk being noncompliant. This should be avoided, given the inherently international nature of cloud computing.

- **The expected result is**: a better understanding and gradual alignment of legislation and policies on these topics, avoiding rules conflicts for cloud service providers and ensuring legitimate trust in cloud services for cloud customers.
- **Stakeholders involved:** The initiative would need to be lead jointly by the European Commission, Member States, cloud industry and civil society, and should include representatives of key European trade partners in order to be effective.

29. Do you think these measures will:
    - Impact the costs of providing cloud computing services for your organisation?
    - If yes, what will the impact be most likely?
30. Do you think these measures will:
    - Impact the market potential for you cloud computing services?
    - If yes, what will the impact be most likely?
31. Please indicate the importance of this measure in terms of the provision of cloud computing services in your organisation (*):

Measure	Do you think these measures will				Do you think any of these measures will				Importance of the measure on provision of cloud computing			
	It will increase our OPEX	It will decrease our OPEX	It will increase our CAPEX	It will decrease our CAPEX	Reduce sales in our **domestic** market	Impose costs in our **domestic** market	Reduce sales in markets **across the EU**	Impose costs in markets **across the EU**	High impact	Medium impact	Low impact	No impact
Insurance and liability schemes for cloud computing services												
Rationalisation of taxation of cloud computing services												
International perspective on cloud computing services												

Annex D. List of interviews

Strategic interviews

Organisation	Department	Interviewee
DG JUSTICE	Unit A.2 - Contract law	Isabelle Rouveure
ENISA	Cloud security	Dimitra Liveri
EU Data Protection Supervisor (EDPS)		Giovanni Buttarelli
Member States and EEA countries	Early adopters - UK	Tony Singleton
Member States and EEA countries	Well-informed - Germany	Thomas Niessen

Stakeholders' interviews

Contact person	Organisation	Market side
Jonathan Sage	IBM	Supply
Sebastian Krause	IBM	Supply
Jean-Marc Favennec	IBM	Supply
Stephan Ducable	Amazon	Supply
Ani Fox Bochenkov	Amazon	Supply
Christian Zahorski-Philippe	Amazon	Supply
Rita Balogh	Google	Supply
Charlotte Thornby	Oracle	Supply
Thang Nguyen	Orange	Supply
Roxana Banica	NEC	Supply
Luc Hendrickx	UEAPME	Supply/Demand
William Spiteri Bailey	Spiteri Bailey & Co.	Demand
Conor Ward	Hoganlovells	Demand
Andreas Weiss	EuroCloud	Demand
Laura Buijs	FEE	Demand
Danielle Jacobs	INTUG	Demand
Eric Henault	EuroCIO	Demand
Alban Schmutz	OVH (France)	Supply
Juha Saarnio	Teknologiateollisuus (Finland)	Supply/Demand
Radu Crahmaliuc (Romania)	Individual consultant	Supply
Sietske de Groot	FSB (UK)	Demand
Charlotte Chung	FSB (UK)	Demand
Daniele Cateddu	CSA	Supply
Agustin Reya	BEUC	Demand
Eduardo Sánchez	AMTIC (Spain)	Supply/Demand
Enrique Matorras	AMTIC (Spain)	Supply/Demand

Annex E. Costs and benefits of cloud computing - Sensitivity analysis

Baseline scenario ('Status Quo')

Overall uptake of cloud computing: comparison between the realistic scenario and the optimistic and pessimistic scenarios

In the main body of the report, the assessment of the impact of policy options has been based on a scenario in which – based on IDC data – a realistic uptake projection has been considered for cloud computing. However, as briefly touched upon under section 5.1.1, it is the uptake of cloud services across the EU could be either accelerated or face potential obstacles that could slow down their adoption.

To accommodate these potential scenarios, also foreseen by IDC, the cost-benefit analysis has been extended with an optimistic scenario and a more pessimistic scenario on the **uptake projections**. The purpose of this annex is to highlight the main differences between these alternative scenarios.

As the cloud users are the main drivers of the value generated by cloud services in the EU, this annex solely focuses on this stakeholder.

The annex also focuses only on the baseline model and the model under which both policy measures are implemented. No attention is given to the individual policy options.

Optimistic scenario

Under the realistic scenario, the initial uptake of cloud services for the period 2015-2020 takes into account a CAGR of 21.1%, whereas under the **optimistic scenario** this is scaled up to 28.2%.

The figure below, showing the net benefits generated by the cloud users, provides a graphical representation on how this more optimistic initial uptake affects the **baseline** scenario in terms of NPV (without policy measures being implemented).

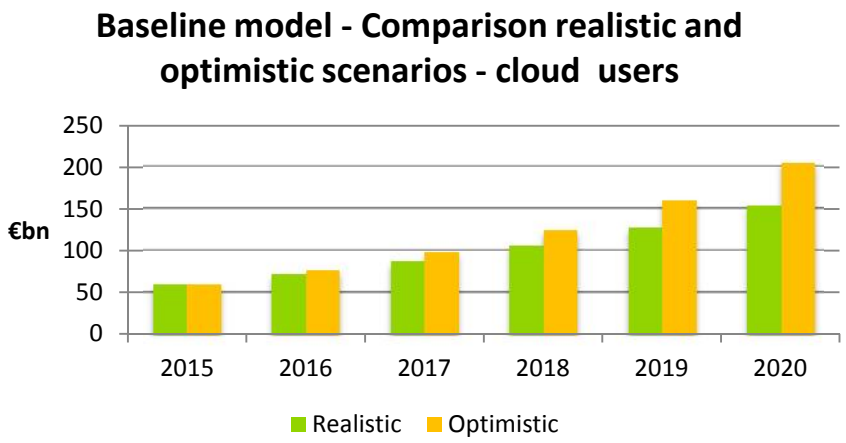


Figure 59 – Baseline model comparison of realistic and optimistic scenario – focus on cloud users

As evident in Figure 59, the impact of a higher user uptake is significant. Overall, the optimistic baseline scenario compared with the realistic baseline scenario would generate EUR 114 billion additional NPV over the period 2015-2020. The total amount of discounted NPV would accumulate to EUR 721.7 billion over this period.

Compared with this optimistic baseline model, the scenario under which b**oth policy measures are implemented** would have an even more profound effect compared with the realistic model. the figure below offers a comparison between the realistic scenario of the dual policy implementation and the optimistic scenario.

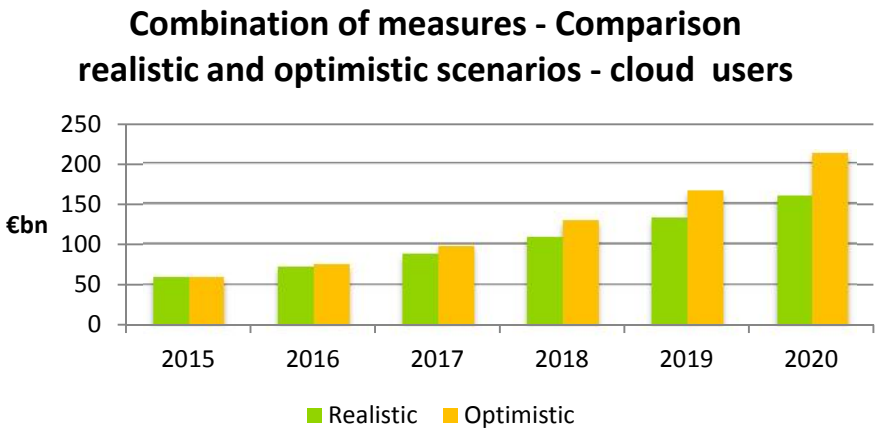


Figure 60 – Comparison of the realistic and optimistic scenario for the model option when both policy measures are implemented – focus on net benefits of cloud users

In case of the implementation of both policy measures, the additional generated net benefits would amass to a total of EUR 24.8 billion compared with the optimistic baseline model. The total amount of discounted NPV over the period 2015-2020 would be EUR 746.6 billion.

Pessimistic scenario

Compared to the realistic scenario, under which the initial uptake of the cloud is modelled with a CAGR of 21.1% over the period 2015-2020, this initial uptake under the more realistic scenario has been scaled down to 10.5%.

The figure below, showing the net benefits generated by the cloud users, provides a graphical representation on how this pessimistic initial uptake affects the baseline scenario (under which no policy measures are implemented).

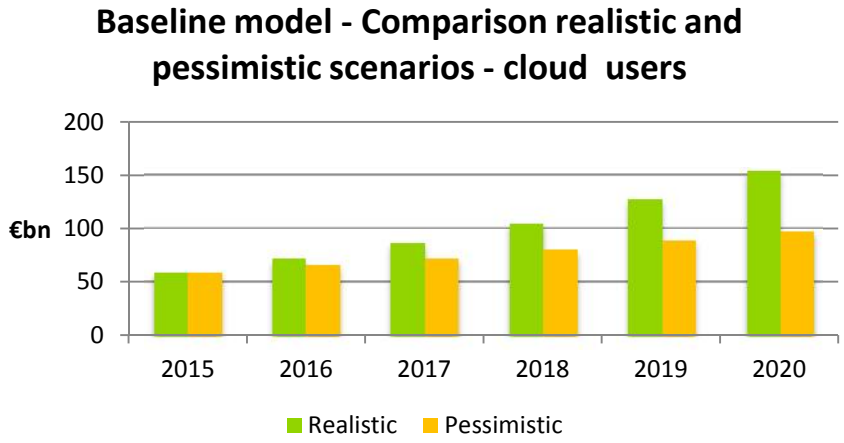


Figure 61 – Baseline model comparison of realistic and pessimistic scenario – focus on cloud users

As is clearly evident from the figure above, the pessimistic scenario generates significantly less net benefits for the cloud users in particular and the overall cloud industry in the EU in general. Overall, a total of EUR 137.8 billion NPV would be generated less over the period 2015-2020 under this pessimistic scenario. The total amount of discounted NPV over this period would only amount to EUR 469.9 billion.

The figure below offers a graphical representation of the net benefits generated when both policy options are implemented.

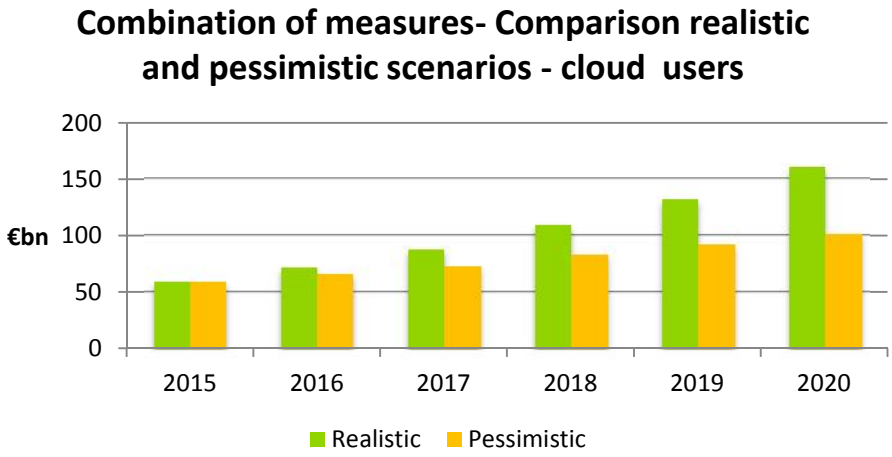


Figure 62 – Comparison of the realistic and pessimistic scenario for the model option when both policy measures are implemented – focus on net benefits of cloud users

The total generated additional value under these circumstances still points to a significant loss in net benefits under the pessimistic scenario. Over the period 2015-2020, a total of EUR 483.6 billion discounted NPV would be generated under this scenario, being an improvement compared to the pessimistic baseline model of EUR 13.7 billion.

Costs and benefits of policy initiatives for cloud computing in Europe

The realistic scenario – Sensitivity analysis on the impact of the measures

The purpose of this annex is to show the more pessimistic and optimistic outcomes of the realistic scenario when both policy measures are implemented, through a sensitivity analysis on the impact of those measures on the user uptake. The sections below show the graphical representations of the different scenarios.

As explained under section 6.2.1, each of the proposed policy measures has an effect on the user uptake of cloud services in the EU. Throughout the report and the modelling, these additional effects have been treated as being realistic on its own and have been set at 1%. However, in the case of the additional uptake linked to the lower service price, this additional uptake can range between 0% and 5% (summary of quantitative effect has been provided under section 6.3) and in the case of the introduction of security certifications, this additional uptake ranges from 0% to 2% (summary of quantitative effect has been provided under section 7.1).

The table below provides an overview of the key factors considered under this sensitivity analysis. The assumptions describe above all impact the additional user uptake index of the cost-benefit analysis. Therefore, this additional user uptake index is split across its 3 components being:

- The **extra uptake linked with the reinvestment** in cloud services following the lower prices set by the cloud providers in response to their lower operating costs. This equals 1% of the 4% price reduction, being 0.04% and does not change according to assumptions;
- The **extra uptake stimulated by the lower price of the cloud services** following the drop in operating costs for the cloud providers. The pessimistic assumption does not foresee additional uptake, the realistic assumption foresees 1% additional uptake and the optimistic assumption estimates an additional 5% uptake;
- The **extra uptake stimulated by the introduction of security certifications** to provide a certain level of assurance to cloud users. The pessimistic assumption does not foresee additional uptake, the realistic assumption foresees 1% additional uptake and the optimistic assumption estimates an additional 2% uptake.

The effect of these different assumptions and a comparison with the realistic assumption used under Chapter 7 is also provided in this table.

Table 35 – Sensitivity analysis of the different assumptions on the user uptake under the realistic scenario

Stakeholders	Pessimistic assumptions on user uptake	Realistic assumptions on user uptake	Optimistic assumptions on user uptake
User uptake (reinvestment)	+ 0.04%	+ 0.04%	+ 0.04%
User uptake (lower price)	+ 0%	+ 1%	+ 5%
User uptake (certifications)	+ 0%	+ 1%	+ 2%
User uptake if both policy measures are implemented	**+ 0.04%**	**+ 2.04%**	**+ 7.04%**
NPV over 2015-2020	**EUR 615.1 billion**	**EUR 627.4 billion**	**EUR 651.6 billion**
Difference with realistic assumptions	- **EUR 12.4 billion**	**N/A**	**+ EUR 24.1 billion**

Pessimistic scenario

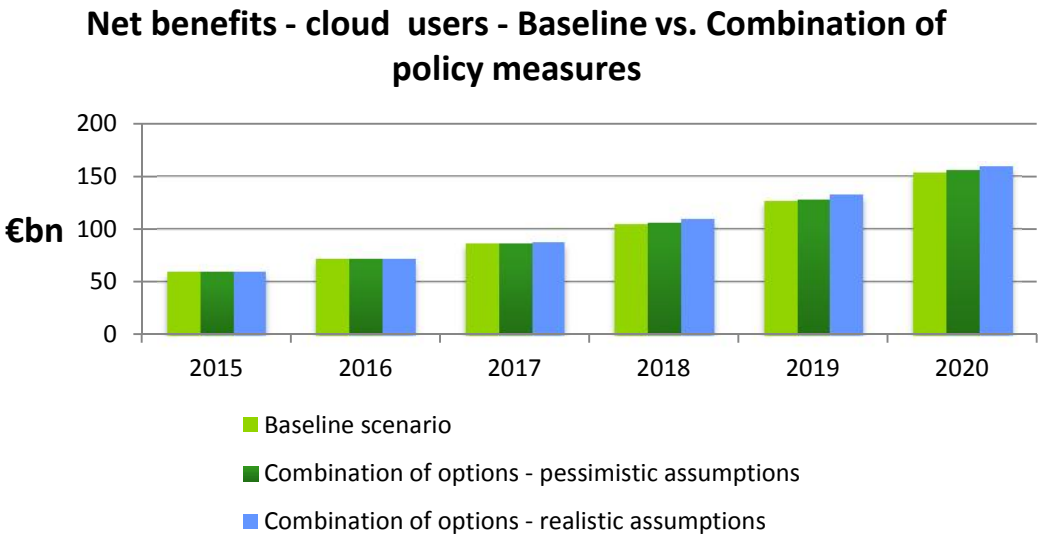
Under this scenario, no additional user uptake is expected in 2017 due to the introduction of the security certifications and no additional user uptake is expected in 2018 due to the lower service price following the decrease in operating costs after the removal of the data location requirement.

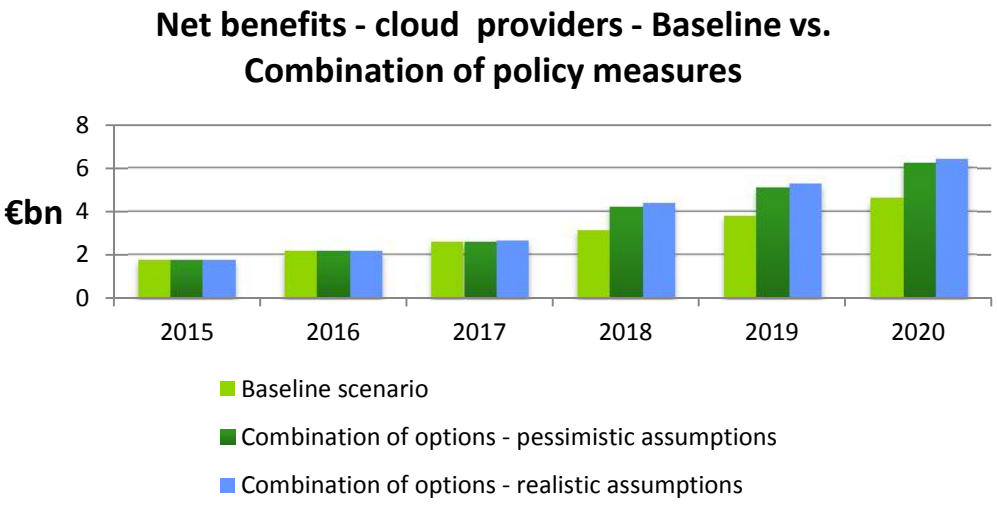
Table 36 – Comparison under the realistic scenario between the realistic and pessimistic assumptions of the additional user uptake

Stakeholders	Discounted NPVs 2015-2020 – +1% additional uptake in both 2017 and 2018	Discounted NPVs 2015-2020 – +0% additional uptake in both 2017 and 2018
Cloud users	EUR 549.0 billion	EUR 538.2 billion (-1.97%)
Cloud providers	EUR 19.9 billion	EUR 19.4 billion (-2.13%)
Society	EUR 58.5 billion	EUR 57.4 billion (-1.97%)
Total NPV added	**EUR 19.8 billion**	**EUR 7.4 billion**

As shown in the table above, a total of almost EUR 12.4 billion discounted NPV disappears if none of the policy measures will generate any additional user uptake.

The figures below, presenting the net benefits generated for the three different stakeholders over the period 2015-2020, show the comparison between the baseline model and the option under which both policy measures have been implemented. To highlight the differences between the realistic assumptions of +1% additional uptake in both 2017 and 2018, and the pessimistic assumptions of no (+0%) additional uptake, the bar charts are shown next to each other.


Net benefits - cloud users - Baseline vs. Combination of policy measures
€bn
200
150
100
50
0
2015
2016
2017
2018
2019
2020
Baseline scenario
Combination of options - pessimistic assumptions
Combination of options - realistic assumptions


Net benefits - cloud providers - Baseline vs. Combination of policy measures
€bn
8
6
4
2
0
2015
2016
2017
2018
2019
2020
Baseline scenario
Combination of options - pessimistic assumptions
Combination of options - realistic assumptions

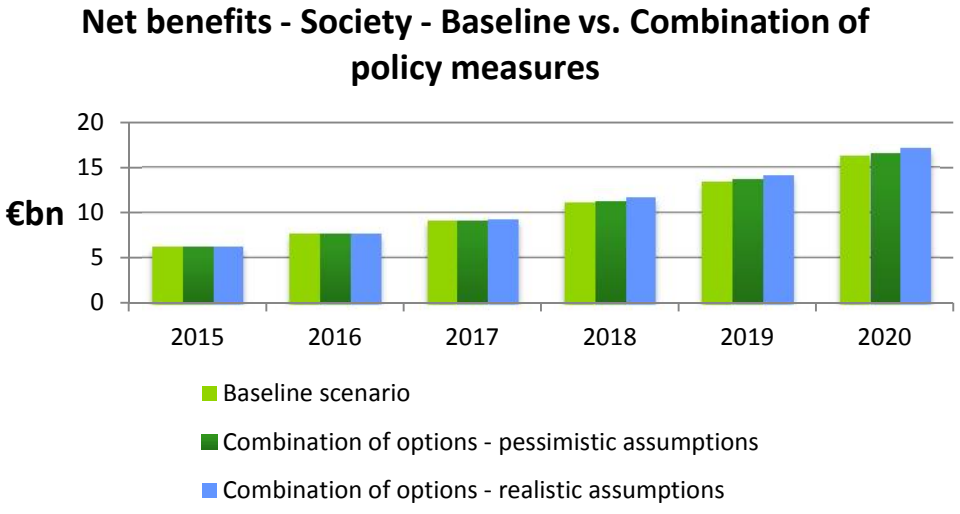

Net benefits - Society - Baseline vs. Combination of policy measures
€bn
20
15
10
5
0
2015
2016
2017
2018
2019
2020
Baseline scenario
Combination of options - pessimistic assumptions
Combination of options - realistic assumptions

Figure 63 – Net benefits of all three stakeholders under the realistic scenario with the most pessimistic assumptions on the additional user uptakes

As evident from Table 36 and the figures above, all three stakeholders still enjoy positive net benefits under these pessimistic assumptions. As compared with the more initial baseline scenario in which no policy measures would be taken, the cloud providers would enjoy the largest gain in net benefits over the period 2015-2020, amounting to +EUR 3.4 billion (+21.12%), followed by the cloud users with +EUR 3.3 billion (+0.63%) and economy and society as a whole with +EUR 0.6 billion (+1.15%).

Optimistic scenario

Under this scenario, the introduction of the security certifications is expected to increase the user uptake with 2% in 2017 and would be followed by a further increase of the user uptake by 5% in 2018 due to the lower service price following the decrease in operating costs after the removal of the data location requirement.

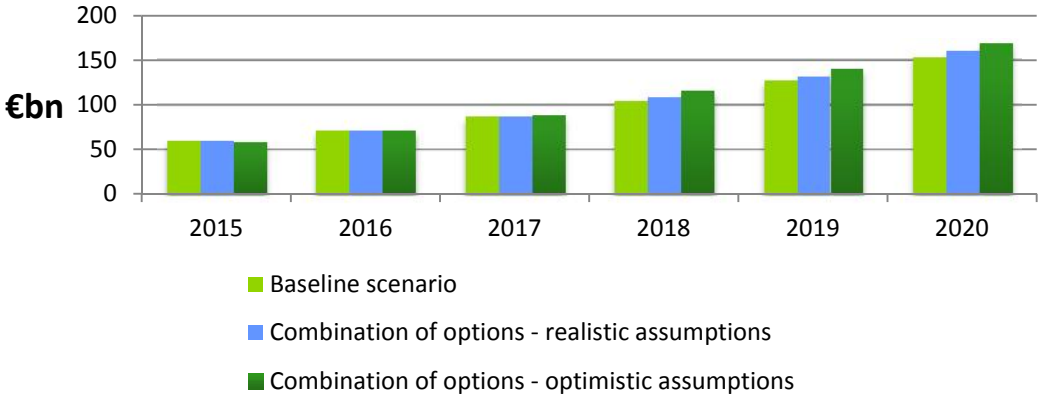
Table 37 – Comparison under the realistic scenario between the realistic and optimistic assumptions of the additional user uptake

Stakeholders	Discounted NPVs 2015-2020 – +1% additional uptake in both 2017 and 2018	Discounted NPVs 2015-2020 – +2% additional uptake in 2017 and +5% in 2018
Cloud users	EUR 549.0 billion	EUR 570.1 billion (+3.83%)
Cloud providers	EUR 19.9 billion	EUR 20.7 billion (+4.19%)
Society	EUR 58.5 billion	EUR 60.8 billion (+3.84%)
Total NPV added	**EUR 19.8 billion**	**EUR 43,.9 billion**

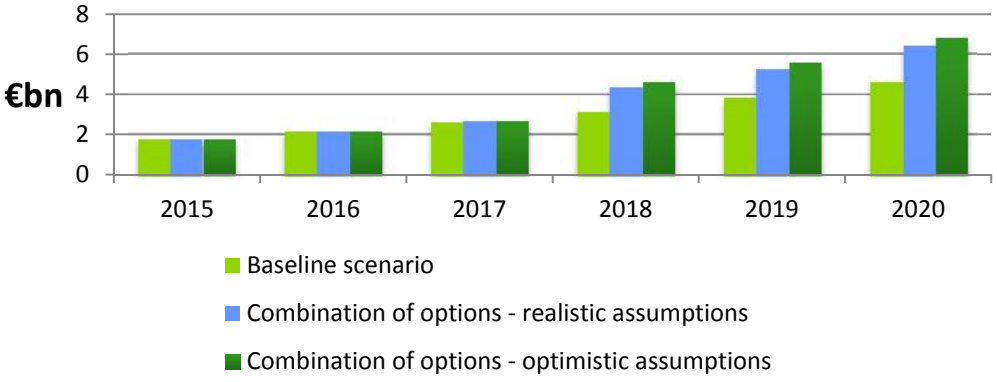
Under the most optimistic assumptions, the implementation of both policy measures would lead to the generation of additional EUR 24.1 billion net benefits over the period 2015-2020 on top of the EUR 19.8 billion generated under the most realistic scenario with realistic assumptions.

The figures below, presenting the net benefits generated by the three different stakeholders over the period 2015-2020, show the differences between the baseline model and the model considering the implementation of both policy measures. The realistic assumption, +1% additional user uptake in both 2017 and 2018 is plotted next to the optimistic assumption of +2% due to the introduction of the certifications in 2017 and the +5% due to the lower price from 2018 onwards.

Net benefits - cloud users - Baseline vs. Combination of policy measures



Net benefits - cloud providers - Baseline vs. Combination of policy measures



Net benefits - Society - Baseline vs. Combination of policy measures

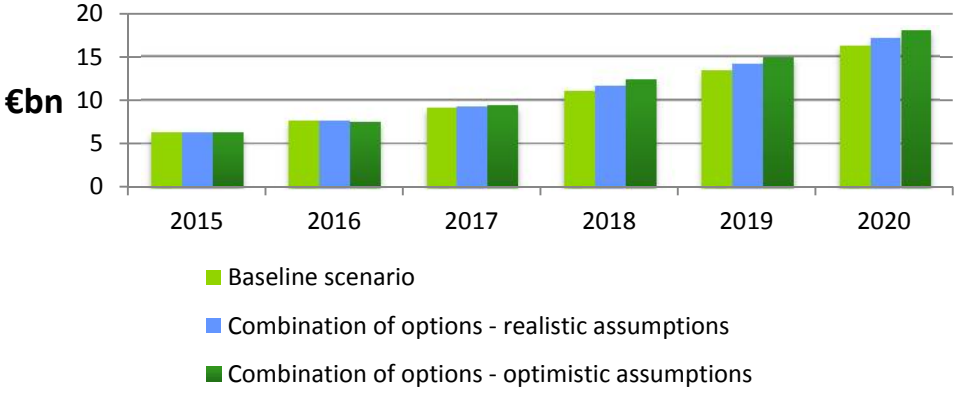


Figure 64 – Net benefits of all three stakeholders under the realistic scenario with the most pessimistic assumptions on the additional user uptakes

When comparing the net benefits generated through the three stakeholders under the baseline scenario with this most optimistic scenario, in the case both policies are implemented, the cloud users would see an increase in net benefits over the period 2015-2020 of EUR 35.1 billion (+6.49%). cloud providers would generate over EUR 4.6 billion (+28.48%) additional net benefits and the Member States and society EUR 4 billion (+7.02%).

Annex F. References

- Borah A.M., Muchahary D., Singh S.K., and Borah J. (2015), Power Saving Strategies in Green cloud computing Systems, in International Journal of Grid Distribution Computing, Vol.8, No.1, pp.299-306, available at: http://dx.doi.org/10.14257/ijgdc.2015.8.1.28, accessed June 2015
- CEBR (2010), The cloud dividend – The economic benefits of cloud computing to business and the wider EMEA economy
- Cloud computing and the Sustainability: The Environmental Benefit of moving to the cloud (2010), Accenture, WSP and Microsoft and http://www.scientificamerican.com/article/cloud-computing-saves-energy;
- Cloud Standards Coordination Final Report (2013). See: http://www.etsi.org/images/files/Events/2013/2013_CSC_Delivery_WS/CSC-Final_report-013-CSC_Final_report_v1_0_PDF_format-.PDF
- Directive on the protection of individuals with regard to the processing of personal data and on the free movement of such data (95/46/EC). See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31995L0046:en:HTML
- EGCCC Discussion Paper on audit and reporting (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/dp_audit_reporting__cloud_services_en.pdf
- EGCCC Discussion Paper on data disclosure and integrity (2014). See: http://ec.europa.eu/justice/contract/files/data_disclosure__integrity_en.pdf
- EGCCC Discussion Paper on data transfers in the cloud (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/discussion_paper_data_transfers_in_cloud.pdf
- EGCCC Discussion Paper on subcontracting (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/expert_group_subcontracting_discussion_paper_en.pdf
- EGCCC Working Paper on Availablity (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/availability_working_paper_en.pdf
- EGCCC Working Paper on Control and Use of Content (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/control_use_working_paper_en.pdf
- EGCCC Working Paper on Liability for non-performance including remedies (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/liability_working_paper_en.pdf
- EGCCC Working Paper on Switching – transfer and deletion of data after the end of the relationship (2014). See: http://ec.europa.eu/justice/contract/files/expert_groups/switching_working_paper_en.pdf

- Etro F. (2011), The economics of cloud computing, available at: http://www.intertic.org/Policy%20Papers/Report.pdf
- European Commission, A coherent framework for building trust in the Digital Single Market for e-commerce and online services (2011). See: http://eur-lex.europa.eu/resource.html?uri=cellar:87375c7c-1bd0-445d-b251-60599af8c73b.0009.03/DOC_1&format=PDF
- European Commission, A Roadmap for Advanced cloud Technologies under H2020 (2012). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=2165
- European Commission, Advances in cloud s, Research in Future cloud computing (2012). See: http://ec.europa.eu/information_society/newsroom/cf//document.cfm?doc_id=1174
- European Commission, Application form for approval of Binding Corporate Rules for the transfer of personal data for processing activities (2012). See: http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2012/wp195_application_form_en.doc
- European Commission, cloud Service Level Agreement Standardisation Guidelines (2014). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?action=display&doc_id=6138, and https://ec.europa.eu/digital-agenda/en/news/cloud-service-level-agreement-standardisation-guidelines
- European Commission, COM(2013) 48 final
- European Commission, COM(2015) 192 final
- European Commission, Communication on a Digital Single Market Strategy for Europe (2015). See: http://ec.europa.eu/priorities/digital-single-market/docs/dsm-communication_en.pdf
- European Commission, Comparative study on cloud computing contracts (2015). See: http://bookshop.europa.eu/en/comparative-study-on-cloud-computing-contracts-pbDS0115164/
- European Commission, Establishing a Trusted cloud Europe - A policy vision document by the Steering Board of the European cloud Partnership (2014). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=4935
- European Commission, Establishing a Trusted cloud Europe (2014). See: http://ec.europa.eu/digital-agenda/sites/digital-agenda/files/discussions/TrustedCloudEurope_3.pdf
- European Commission, Explanatory Document on the Processor Binding Corporate Rules (2013-215). See: http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2015/wp204.rev_en.pdf
- European Commission, Regulation on European Standardisation (EU No 1025/2012).http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:316:0012:0033:EN:PDF
- European Commission, SMART 2011/0045, (2012), Quantitative Estimates of the Demand for cloud computing in Europe and the Likely Barriers to Up-take, report prepared by IDC

- European Commission, Tasks of the Article 29 Data Protection Working Party. See: http://ec.europa.eu/justice/policies/privacy/docs/wpdocs/tasks-art-29_en.pdf
- European Commission, The future of cloud computing, Opportunities for European cloud computing beyond 2010 (2010). See: http://ec.europa.eu/information_society/newsroom/cf//document.cfm?doc_id=1175
- European Commission, Unleashing the Potential of cloud computing in Europe (COM(2012) 529). See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0529:FIN:EN:PDF
- European Commission, Uptake of cloud in Europe - Follow-up of IDC Study on Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up (2014), report prepared by IDC, See: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=9742
- European Commission, Working Document 02/2012 setting up a table with the elements and principles to be found in Processor Binding Corporate Rules (2012). See: http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2012/wp195_en.pdf
- Eurostat News Release, 9 December 2014, ICT usage in enterprises in 2014 cloud computing services used by one out of every five enterprises in the EU28 Lack of knowledge main reason for not using cloud services.
- Forrester, Adoption Profile: Private cloud In Europe, Q3 2014, March 2015
- Forrester, At Last, A Tech Market Recovery In Europe (2014)
- Gartner “Cloud Service Providers must understand deployment, adoption and buyer complexity to leverage cloud revenue opportunities” 13 January 2015
- Gartner, cloud Service Providers must understand deployment, adoption and buyer complexity to leverage cloud revenue opportunities” 13 January 2015
- Gartner, Forecast: Public cloud Services, 2012 – 2018, Q3 2014 update.
- ICT footprint Pilot testing on methodologies for energy consumption and carbon footprint of the ICT-sector (2013). See: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=1710
- IDC, The demand of cloud computing in Europe: drivers, barriers, market estimates. Research in Future cloud computing workshop (IDC 2012)
- KPMG (2012), Modelling the Economic Impact of cloud Australian Lessons and Experiences, available at: https://www.kpmg.com/AU/en/IssuesAndInsights/ArticlesPublications/Documents/modelling-economic-impact-cloud-computing.pdf accessed July 2015
- KPMG, Exploring the cloud . A Global Survey of Governments’ Adoption of cloud , 2012
- Liebenau J.,et al (2012), Modelling the cloud . Employment effects in two exemplary sectors in the United States, the United Kingdom, Germany and Italy, LSE Enterprise
- Market Definitions and Methodology: Public cloud Services (Gartner, 2014)

- McKinsey, Disruptive technologies: Advances that will transform life, business, and the global economy (2013). See: http://www.mckinsey.com/insights/business_technology/disruptive_technologies
- OECD, cloud computing: The Concept, Impacts and the Role of Government Policy, 2014
- Proposal for a Directive of the European Parliament and of the Council concerning measures to ensure a high common level of network and information security across the Union (COM(2013) 48). See: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013PC0048&from=EN
- Proposal for a Regulation on the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation) (COM(2012) 11). See: http://ec.europa.eu/justice/data-protection/document/review2012/com_2012_11_en.pdf
- Proposal for a Regulation on the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation) See: http://ec.europa.eu/justice/data-protection/document/review2012/com_2012_11_en.pdf
- R.H. Katz, (2009), Tech titans building boom, IEEE Spectrum (February), at http://www.spectrum.ieee.org/feb09/7327 accessed 23 February 2009.
- Regulation on a Common European Sales Law (COM(2011) 635). See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0635:FIN:en:PDF

European Commission

ECONOMIC IMPACT OF cloud COMPUTING IN EUROPE

Luxembourg, Publications Office of the European Union

2016 – 202 pages

ISBN 978-92-79-63570-0
DOI:10.2759/75071

KK-06-16-266-EN-N

doi:10.2759/75071 ISBN 978-92-79-63570-0