

KETs (Key Enabling Technologies)

Definition and Context

The KETs concept is seen by the European Commission as a non-sectoral and broad approach to industrial innovation: *"KETs are knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and highly-skilled employment. They enable process, goods and service innovation throughout the economy and are of systemic relevance. They are multidisciplinary, cutting across many technology areas with a trend towards convergence and integration"*¹. KETs aim at the re-industrialisation of Europe, which is about industry participation.

The KETs concept originated during discussions within the information and communication technology (ICT) community and semiconductor industry. A policy to strengthen the European ICT industry was needed in order to strengthen the industry base. But this proved to be relevant to other industries as well, and a non-sectoral approach using *technologies as enablers* crystallised. The following five KETs were regarded as strategically the most relevant: **NT** (nanotechnology); **MNE** (micro- and nanoelectronics, including semiconductors); **PHOT** (photonics); **AM** (advanced materials); **IB** (biotechnology). A sixth, more overarching, KET was added to include the manufacturing side of the industry: **AMT** (advanced manufacturing technologies).

In addition to the six individual KETs, the combination of KETs is also considered to be of importance. Within the H2020 programme, **cross-cutting KETs** are therefore seen as pivotal to innovation: *"The cross-fertilisation of different KETs is vital, in particular for the transition from R&D to pilot and industrial scale production. A considerable part of the KETs activities planned under Horizon 2020 will be dedicated to cross-cutting activities"*².

Increasing efficiency and effectiveness in innovation policy was the starting point for the KETs strategy. Although a strategic approach to research and innovation was seen in such areas as life science, energy, nanotechnology, and biotechnology, no real strategic approach was available for industrial innovation. This problem was addressed in the 2009 Communication³ on KETs, focusing on three issues: (i) **Focus:** Overall, technology and innovation has grown to be highly complex and too extensive to be covered. Critical mass is needed and requires a focused support effort. (ii) **Deployment:** The valorisation of high-quality European research into societal benefits is suboptimal and this should be supported. (iii) **Re-industrialisation:** Manufacturing is essential to economic growth and prosperity, but is shifting towards Asia. A policy is needed to support the manufacturing industry to increase innovativeness and competitiveness and to re-industrialise Europe.

This EU communication led to the creation of a High Level Group on Key Enabling Technologies (HLG KETs) (with a three-year-mandate in 2010 and 2013), where both industrial and research stakeholders were asked to propose recommendations on further policy actions.

One of the key aspects of the KETs strategy is addressing Europe's major weakness: the translation of its knowledge base into goods and services. With their final report⁴, the first HLG KETs evoked the concept of the "Valley of Death". It combines the two issues of deployment and re-industrialisation into an approach that differentiates between three fundamental stages in the innovation chain of KETs and KETs-based products:

- **Technological research**, transforming fundamental research into technologies.
- **Product development**, transforming technologies into product prototypes.
- **Competitive manufacturing**, creating production systems to commercially produce the products.

¹ [COM\(2009\) 512 final](#)

² [COM\(2012\) 341 final](#)

³ [COM\(2009\) 512 final](#)

⁴ http://ec.europa.eu/enterprise/sectors/ict/files/kets/hlg_ket_status_implementation_report_final_en.pdf

The main message of this tree-pillar approach is that new technologies will not easily cross the bridge to the market and that the barriers to transform product prototypes to low-rate mass production are mostly financial. A more nuanced view on this concept of the Valley of Death is provided by the Breakthrough Institute, which presents two valleys of death⁵:

- ***Technological Valley of Death***, in which further capital is needed to develop a commercial product and prove its basic market viability.
- And the ***Commercialisation Valley of Death***, where entrepreneurs seek capital to fund first-of-a-kind commercial-scale projects or manufacturing facilities. The implication is that support to cross the Valley of Death is not only about technology (product/manufacturing), but it should also address organisational and market issues.

Implementation

Only a few countries use the term KETs (e.g., Belgium, Germany, Austria)⁶. Elsewhere, it sometimes refers to the EU KETs strategy in order to align their RDI policy with funding from the European level. Other countries can also use an approach that is comparable to the EU KETs but using other terms (focus, deployment, re-industrialisation). The “Technologies Clés” from the French government, or the Italian National Research Program (using the Associazione Italiana Ricerca Industriale, AIRI, focus areas) are just a few examples of technology-oriented approaches. Often a more thematic focus can be seen on societal/industrial needs, such as the “top sectors” policy of the Netherlands.

Europe is a leader in knowledge creation for most of the KETs, reflected in, for example, patenting activity. But in exploiting this knowledge, Europe falls behind its main competitors⁷. In the mass manufacturing of KET-based products in particular, Asia, and especially China, is leading, thanks to low labour costs, but this is changing rapidly. Other Asian countries, such as Korea and Taiwan, have become leaders in specific KET domains. Within Europe, Germany dominates the market for KET-based products, followed by France, the UK, and Italy (with the last three ranked differently for different KETs)⁸. Specific clusters that build on KETs are present in Europe, in various Member States. These clusters are based on the proximity of leading actors, often multinational companies, but they do have a global scope in their activities, and rely on international counterparts for production.

Funding

As the costs of demonstration projects are sometimes an order of magnitude greater than those of upstream R&D, the high costs involved in pilot production activities require combined funding from public and private actors as well as different public funds (European, national, and regional). An order of magnitude of the financing needs in KET-related investments for the oncoming years was mentioned by the special HLG KETs Working Group on Financial Instruments in its May 2011 report: *"over 7 years, it could be necessary to reallocate approximately EUR 20 billion for KETs, including 20 globally competitive sites (EUR 3 billion per site of which 16 % would be funded by European institutions and focused on R&D aspects, if we use the reference of Joint Technological Initiatives, the industrial contribution would be 66 % with the remaining percentage covered by both regional and national governments) and a hundred pilot lines (approximately EUR 600M per site equally with European public support of one sixth of the total project). However, the financing of KETs R&D should be made at European level; a European coordination and a specialisation per site (smart specialisation) is therefore indispensable"*⁹.

⁵ http://thebreakthrough.org/blog/Valleys_of_Death.pdf

⁶ Butter et al (2013): "Vision and characteristics of multi KETs pilot lines" mKPL Project Report, Delft: mKETs-PL Project.

⁷ http://www.europarl.europa.eu/RegData/etudes/STUD/2014/536282/IPOL_STU%282014%29536282_EN.pdf

⁸ Ibid

⁹ [HLG KET - Working group on Financial Instruments - Report, May 2011](#)

KETs have become a fundamental part of Horizon 2020, with an allocation of about EUR 30 billion. It should however be noted that, in the absence of a distinct EU budget for KETs activities and investment at the EU level, it is difficult to calculate the exact level of public support for KETs up to 2020. Whereas some of the support is specifically for KETs, other policy instruments can also be used for activities and investments in other domains of technological and industrial development (i.e., outside KETs), some of which directly compete with KETs for available funding¹⁰.

Within H2020, most dedicated support to KETs is provided by the **Industrial Leadership** pillar (also known as the "second pillar")¹¹, in particular the LEIT/Leadership in Enabling & Industrial Technologies which dedicates almost EUR 6 billion to KETs. LEIT is specifically directed towards boosting the industrial deployment of KETs, meaning support for prototyping, product validation in pilot lines, and large-scale pilot and demonstration activities. About 30% of the LEIT budget will be allocated to cross-cutting KETs.

Two H2020 public-private partnerships (**PPP**) initiatives explicitly focus on KETs:

1. ECSEL (Electronic Components and Systems for European Leadership). This Joint technology initiative (**JTI**) is a merger of the ARTEMIS embedded systems JTI and the ENIAC nanoelectronics JTI, set up in 2008. ECSEL started in 2014 and will be fully operational up to 2020.
2. Factories of the Future (FoF) is a contractual PPP¹² (cPPP) to support European manufacturing enterprises in strengthening their technological base. FoF is industry-led with participation by SMEs and large enterprises, universities, research organisations and associations from across Europe who cooperate in pre-competitive, cross-border projects focusing on production technologies from multiple sectors. In 2008, FoF was launched under the European Economic Recovery Plan and continues under Horizon 2020. The indicative budget foreseen within H2020 for FOF amounts to €1.15 billion over 2014-2020¹³.

A KETs observatory¹⁴ has been launched to provide information (quantitative and qualitative) on the performance of EU Member States and competing economies regarding the deployment of KETs.

Possible synergies

Bringing KETs to the market can be very capital intensive. One solution is to use the Structural Funds. For example in Poland, the Operational Programme Innovative Economy was financed through €8.65 billion from ERDF and €1.53 billion from the State budget. In Hungary, the policy measure "Support to Market-oriented R&D Activities" had a total budget of €261.5 million of which 85% came from the Structural Funds and 15% from the State budget. In Romania, Structural Funds were used to train specialists from industrial SMEs and large companies to deploy KETs¹⁵.

¹⁰ Ibid.

¹¹ H2020 has 3 pillars: 1/ Excellent science 2/ Industrial leadership 3/ Societal challenges. Industrial Leadership involves applied research projects up to TRL8 (see TRL definition [here](#)).

The Industrial Leadership pillar is spread into: (i) LEIT/Leadership in Enabling & Industrial Technologies; (ii) access to risk financing, which includes the Risk-Sharing Finance Facility (RSFF) and the Risk-Sharing Instrument for SMEs (RSI); (iii) "innovation in SMEs", with a budget of about EUR 3 billion over the period 2014–2020, with funding from both the second and the third pillars of H2020. At least 20 % of the total budget of LEIT and Societal Challenges will be allocated to the SME Instrument particularly the LEIT action.

¹² Unlike JTIs, CPPPs do not require additional legislation because the funding is implemented by the Commission through normal procedures. JTIs and cPPPs are known as "Art. 187 initiatives".

¹³ http://ec.europa.eu/research/press/2013/pdf/ppp/fof_factsheet.pdf

¹⁴ <https://ec.europa.eu/growth/tools-databases/ketsobservatory/>

¹⁵ Source: <http://bookshop.europa.eu/en/exchange-of-good-policy-practices-promoting-the-industrial-uptake-and-deployment-of-key-enabling-technologies-pbNB0414312/>

This is why, in addition to H2020, the EU policy framework on KETs comprises a number of instruments¹⁶, notably the cohesion funds and smart specialisation. Combined funding, using different instruments to promote the deployment of KETs at different TRLs¹⁷ will include a mix of instruments that will help to foster the adoption of KETs at the EU, national, and regional level. Smart specialisation strategies within EU cohesion policy have initiated an increasing uptake of KET-based priorities for regional innovation policy; all types of regions now aim for KETs, not only innovation leaders, but also followers.

An especially relevant development for KETs is the launching of the EIT KIC on Added-value manufacturing¹⁸, to be launched in 2018, which will be a forum for the integration and promotion of trans-disciplinary skills and competence, particularly for the combination of multiple KETs. The concept of synergies is mentioned for cross cutting KETs in the regulation establishing H2020: "*Innovation requires enhanced cross-technology research efforts. Therefore, multidisciplinary and multi-KET projects should be an integral part of the priority 'Industrial Leadership'. (.../...) In addition, synergies will be sought, where appropriate, between KET activities and the activities under the cohesion policy for 2014–2020, as well as with the EIT*"¹⁹. Through knowledge and innovation communities (*KICs*), EIT develops and tests new models of how innovation is approached, financed, and delivered. More details on synergies through EIT KICs are available on the S2E fiche on EIT²⁰.

The second EUREKA/Eurostars initiative (2014–2020) provides funding for research-performing SMEs in market-oriented collaborative transnational R&D projects leading to innovation, especially those SMEs without previous experience in transnational research. Eurostars-2 aims to increase the accessibility, efficiency, and efficacy of public funding for research performing SMEs in Europe by aligning, harmonising, and synchronising national funding mechanisms. Through this *article 185* instrument, the total public budget is €1.14 billion with Eurostar countries co-funding €861 million from their national and regional²¹ budget and Horizon 2020 contributing €287 million²².

Considering *JTIs and KETs are both about public-private partnerships*, another example of funding synergy is the case of the ECSEL JTI mentioned above, which explicitly focuses on KETs²³. ECSEL provides combined funding from National / Regional authorities and from the EU via Horizon 2020, with capability to include "structural funds" via ESIF/ERDF²⁴. ECSEL operates since 2014 and will run for 10 years in the fields of nanoelectronics and embedded systems with public/private funding, typically between 25% and 50% from Horizon 2020, and the rest from industry (for other JTIs), complemented (in the case of ECSEL) with direct financial contributions from the Member States.

The Synergies Guide²⁵ provides examples combining funding in large investments in KETs observing State Aid rules²⁶:

1. total investment is €6 billion,
2. Project separated in (a) €2 billion pilot line plus (b) €4 billion investments for manufacturing.

¹⁶ in particular H2020, Structural Funds and EIB: http://europa.eu/rapid/press-release_MEMO-14-375_en.htm

¹⁷ TRL definition: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

¹⁸ <http://eit.europa.eu/newsroom/eit-set-new-kics>

¹⁹ Regulation No 1291/2013, p.133 <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1291&from=EN>

²⁰ <http://s3platform.jrc.ec.europa.eu/instruments-platforms-concepts>

²¹ <https://www.eurostars-eureka.eu/sites/default/files/publications/eurostars-review-2011.pdf>

²² <https://www.eurostars-eureka.eu/about-eurostars/funding>

²³ Further details on JTI funding synergies (via parallel or cumulative funding) are summarised in the S2E fiche on JTI:

<http://s3platform.jrc.ec.europa.eu/instruments-platforms-concepts>

²⁴ http://www.ecsel-ju.eu/web/downloads/Publications/ecsel_brochure.pdf

²⁵ https://ec.europa.eu/research/regions/pdf/publications/h2020_synergies_201406.pdf#view=fit&pagemode=none

²⁶ More details are summarized in the S2E fiche on JTI: <http://s3platform.jrc.ec.europa.eu/instruments-platforms-concepts>

- (a) Pilot Line: The pilot line project has clearly separated cost items that allow to attribute them to either the Joint Understanding -JU (H2020 plus industry or own national / regional funding) or ESIF plus industry or national / regional funding. State Aid intensities for experimental development + collaboration could be as high as 25% + 15% = 40%; 40% = €800 million; assuming that for clearly identified cost items of the pilot line construction an ECSEL Participating State or a Region will provide 25% own funding (combined with ERDF funding), while the ECSEL JU will provide for the remaining cost items further 25% (Horizon 2020) that do not constitute State Aid combined with private industry funds.
This means that half of the pilot line is funded by industry funds. The other half in this example would be funded by Horizon 2020 and ESIF.
- (b) Manufacturing: 10.5% of €4 billion = €420 million

In total: EUR 1420 million or 23.66% of the total investment would come from combined funding.

Finally, there is growing potential for synergies between civil and military research. Within Horizon 2020, the areas of "Leadership in Enabling and Industrial Technologies" including the KETs offer prospects of technological advances that can trigger innovation not only for civil applications, but also have a dual-use potential. The 2013 Communication on the defence and security sector²⁷ was mentioning that *"while the research and innovation activities carried out under Horizon 2020 will have an exclusive focus on civil applications, the Commission will evaluate how the results in these areas could benefit also defence and security industrial capabilities. The Commission also intends to explore synergies in the development of dual-use applications with a clear security dimension or other dual-use technologies like, for example, those supporting the insertion of civil RPAS (Remotely piloted aircraft systems) into the European aviation system to be carried out within the framework of the SESAR Joint Undertaking²⁸".* So this is another aspect to watch with respect to possible funding synergies in the future.

²⁷ COM (2013) 542: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52014DC0387>

²⁸ <http://www.sesariu.eu/> see also the S2E fiche on JTI: <http://s3platform.jrc.ec.europa.eu/instruments-platforms-concepts>