Proposed outline

1. [Introduction] (+IDS)
2. [Methodology and results] Glossary of key mitigation technologies
3. [Methodology and results] Identify “demanded” categories
4. [Methodology and results] Identify “supplied” categories
   1. Filter for mitigation technologies (IDS)
   2. Categorise technologies (IDS)
5. [Analysis] Compare and visualise, visualise where the demanded are
6. [Recommendations] Tentative: advise (explicit assumption of level-playing field, i.e. all technologies should be funded equally) to balance out funding by investing more in X and less in Y
7. [Conclusions] (+IDS)

# Toward aligning the EU innovation policy with the demand for clean technologies in 1.5 degree worlds

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## Abstract

Transition from a societal challenges approach to a mission-oriented approach in policy making is seriously discussed in the European Union (EU). One of the missions to orient European research and innovation to could be the pressing issue of halting dangerous climate change. To better design specific policies and allocate funds in a new framework programme an assessment of current and past efforts is crucial. In this paper we provide a rough-and-ready assessment in the domain of climate change mitigation technologies. The findings suggest a mismatch between the EU’s goals and the resources allocated to climate change mitigation. Assuming a level-playing field policy, funding should be scaled up for technologies which for the past decade have been under the radar of the EU funding, but which are crucial for EU contribution to global climate action. We provide a list of such technologies, some examples of which are synthetic fuels, distributed manufacturing, net-zero emission districts and other.

Keywords: innovation policy; climate change; mitigation; framework programme; clean technology; research and innovation; sustainable development; mission-oriented; prioritisation; research funding

## Introduction

The European Union (EU) Framework Programmes for Research and Technological Development play a crucial role in guiding European research and innovation (R&I). The new Horizon Europe framework programme for 2021-2027 will be “mission-oriented”, rather than driven by “societal challenges”, as were previous framework programmes. Supposedly, it would “specifically target [pre-defined] global challenges”[[1]](#footnote-1) and thus more impactful. Mission-oriented research and innovation could significantly boost the EU R&I efforts in mitigating dangerous climate change (EC 2017; Mazzucato 2017), especially since the EU already set its own climate action targets. For the best-operationalised new innovation policy and new framework programme an assessment of past efforts seems crucial. However, to date and to the best of our knowledge, no comprehensive assessment of past EU R&I efforts on climate change mitigation exists. This knowledge gap may hinder effective prioritisation of R&I areas, programmes and specific projects that would be best for mitigating climate change, and thus poses a problem for the efficacy of the new framework programme.

We aim to fill this knowledge gap in this paper. We pose a question: how is the EU committing to technological innovations that are most likely to help reach its climate goals? To answer the research question we break it down in two sub-questions: a) what technologies are most likely to help the EU reach its 2050 climate goals? and b) what technologies has the EU been investing in for the past decade? Once we know what mitigation innovations the EU ought to invest in to reach the climate goals, and what it has been investing in, we can compare these lists of “demanded” and “supplied” technologies. We base the list of supplied technologies on the analysis of the technology mix in Horizon 2020 and FP7. We base our list of demanded technologies on articulations by the European Commission (EC), European industries, and UNFCCC bodies. With the list of we aim to provide empirical ground for answering to the question of where the public funds may be spent on mitigation in Horizon Europe. We subsequently provide a list of mitigation technologies, whose research and innovation has been underinvested by EC in the past two framework programmes. Our assumption is a level-playing field policy, widely adopted by the EU as its understanding of fairness. At the very least, we assume in this paper that the demanded technologies should not be underinvested.

Our aim is that the answer to our question will provide valuable lessons for the EU innovation policy and the selection of priority issues to fund, and would contribute to the debate about the foci of Horizon Europe and national R&I priorities. For brevity, we use the terms “climate change mitigation technologies” and “clean technologies” interchangeably throughout the remainder of the paper.

In the next section we discuss our approach. In the section that follows we present and contrast the two lists in order to answer the research question, draw recommendations for the next EU framework programme and innovation policy, as well as discuss some of the key limitations of the present research. Finally, we conclude with a summary of the conducted work and suggest directions for further research on this topic.

- The transition towards a net-zero greenhouse gas economy … requires further scaling-up of technological innovations in energy, buildings, transport, industry and agriculture sectors. (p. 6, https://ec.europa.eu/clima/sites/clima/files/docs/pages/com\_2018\_733\_en.pdf)

## Methodology and results

### Key mitigation technological innovations

Since there is no up-to-date database of key clean technologies, we resorted to compile one. We collected a glossary of key mitigation innovations, drawing from the databases of the Climate Technology Centre and Network (CTCN) and Breakthrough Energy Coalition (BEC). CTCN is a UNFCCC organisation whose aim is to promote accelerated transfer of clean technologies from higher-income to lower-income countries through facilitation, capacity building and policy advice. On its website[[2]](#footnote-2) CTCN has collected a database of technologies useful for mitigation of climate change. Breakthrough Energy Coalition is a global group of some of the wealthiest people in the world who are promoting investments into clean technologies in the energy domain. The Coalition’s website[[3]](#footnote-3) features a list of clean technologies not only in the energy sector, but also manufacturing, transport, agriculture and other.

Finally, we complemented the glossary of clean technologies with a manual inductive search of the CORDIS databases. CORDIS is the EU’s Community Research and Development Information Service and is the main public repository of EU-funded projects. This was done as an attempt to minimise possible bias against innovations that may have been left under the radar of the other sources of information. We extracted and screened 5,421 projects, by searching the CORDIS Horizon 2020 and FP7 databases for the following terms:

* mitigation,
* greenhouse,
* gas,
* carbon,
* oil,
* coal,
* CO2,
* emission,
* climate,
* global warming,
* green,
* clean,
* sustainable.

We selected these terms because they are closely linked to the definition of climate change mitigation: “a human intervention to reduce the sources or enhance the sinks of greenhouse gases” (IPCC 2014). After manual screening 295 entries remained. We coded and added 7 identified technologies to the glossary. The final list of technologies and their descriptions can be found in Appendix I. With the glossary ready, we then compiled a list of the “demanded” innovations, i.e. innovations, as identified by the EC and EU industries, that would help the EU reach its climate goals.

### Demanded technological innovations

To pinpoint the technologies most likely to help the EU reach its climate goals in 2050 we identified reliable and representative sources of EU priorities. Admittedly, no one is better aware of sectoral priorities of the EU than the representatives of these sectors. Therefore, we conducted qualitative content analysis of the discourses of the European Commission (EC) and European industry associations: EU Public Private Partnership on Energy-Efficient Buildings, EU Public Private Partnership Sustainable Process Industry through Resource and Energy Efficiency, and Factories 4.0 and Beyond. We used the following sources:

* the European Strategic Energy Technology Plan (SET-Plan) (EC 2015, 2016b),
* the Low Carbon Economy 2050 roadmap (EC 2011a),
* the Energy Roadmap 2050 (EC 2011b),
* the Accelerating Clean Energy Initiative (EC 2016a),
* the White Paper “Roadmap to a Single European Transport Area” (EC 2011c),
* the EU Public Private Partnership on Energy-Efficient Buildings (EC 2013),
* the EU Public Private Partnership Sustainable Process Industry through Resource and Energy Efficiency (SPIRE n.d.),
* Factories 4.0 and Beyond (EFFRA 2016), and
* A Clean Planet for All (\*\*).

We also looked at the Roadmap to a Resource Efficient Europe (EC 2011d), but it did not contain relevant findings so we do not discuss it further.

The results are summarised in Table 1. We categorised the technologies into six sectors (energy, industry, transport, buildings, human settlements, and agriculture) based on the IPCC classification (IPCC 2014b, p. 68). Below is a description of the reviewed sources and their take on the priorities of mitigation technologies. The sources often overlap, so to avoid repetition we only list the complementarities they offer.

|  |  |  |
| --- | --- | --- |
| Sector | Technology in demand | Source |
| Energy | Concentrated solar power (CSP) | SET-Plan |
|  | Geothermal | SET-Plan |
|  | Grid management, micro-grids, off-grid systems | SET-Plan |
|  | Solar PV | SET-Plan |
|  | Tidal, wave and ocean energy | SET-Plan |
|  | Offshore wind | SET-Plan |
|  | Thermal energy storage | SET-Plan |
|  | Nuclear fission/fusion | SET-Plan |
| Transport | Electric vehicle design | SET-Plan |
|  | Electric battery | SET-Plan |
|  | Biofuel, fuel cell | SET-Plan |
|  | Traffic management | White Paper ‘Roadmap to a Single European Transport Area’ |
|  | Liquefied natural gas (LNG), compressed/converted natural gas, low GHG aircraft/freight design, lightweight transport design, low GHG public transport / rapid transit design | White Paper ‘Roadmap to a Single European Transport Area’ |
| Buildings | Combined heat and power (CHP) | SET-Plan |
|  | Innovative construction | PPP Energy-Efficient Buildings |
|  | Demand-side energy management, building management | PPP Energy-Efficient Buildings |
| Industry | Carbon capture and storage, carbon use | SET-Plan |
|  | Distributed manufacturing | Factories 4.0 and Beyond |
|  | Smelt reduction, inert anode, direct casting, waste heat reuse, energy-from-waste, wet/dry quenching | SPIRE |
|  | Pulp and paper drying, reuse of material | SPIRE |
|  | Gas turbine | SPIRE |
| Human settlements | District heating and/or cooling | SET-Plan |
|  | Heat pumps | SET-Plan |
| Agriculture | Manure management | Roadmap for moving to a competitive low carbon economy in 2050 |
|  | Livestock management, methane reduction | Roadmap for moving to a competitive low carbon economy in 2050 |
|  | Direct seeding, conservation tillage, nutrient management, soil management | Roadmap for moving to a competitive low carbon economy in 2050 |
|  | Biomass | A Clean Planet for All |
|  | Afforestation | A Clean Planet for All |
|  | Agroforestry | A Clean Planet for All |
|  | Forest management | A Clean Planet for All |

**Table 1. Technologies demanded/prioritised by the EC and the EU industry.**

#### SET-Plan

The SET-Plan (EC 2015, 2016b) is both a coalition and strategic document endorsed by the EU. It was created in 2007 by the SET-Plan steering group (high-level representatives from the EU and several neighbouring countries), the European Technology and Innovation Platforms, and the European Energy Research Alliance. The SET-Plan was created to help coordinate the EU members’ and participating countries’ research, development and deployment of low-carbon technologies. As indicated by the EC, the aim of the SET-Plan is to “identify those strategic priorities and actions needed to accelerate this EU energy system transformation in a cost-effective way” (EC 2015).

The SET-Plan features several main directions Europe should orient towards (Table 1). Offshore wind power “can afford a swift contribution to the penetration of renewable energy in Europe” (EC 2016b). The EU should focus on “strong cost reductions and better performance [of offshore wind] to ensure that the current EU technological leadership translates into real market opportunities in the near future” (ibid.). Development and deployment of next generation of photovoltaics should also be sped up. The same applies for concentrated solar power (CSP) and deep geothermal, which “both provide dispatchable electricity … and heat generation on demand” (ibid.). Complementary thermal storage technology would further improve these capabilities (ibid.). Ocean energy, including wave and tidal energy, is seen as another technology with potential. According to the SET-Plan, “[a] nascent European industry is in the lead and its strength needs to be maintained during the demonstration phase, so these technologies can convincingly reach the early deployment phase” (ibid.). Next is flexible European power grid and optimised integrated local energy systems. These technologies are aimed to respond to the increasing share of variable renewables in the EU generation capacities, and to adjacent technologies such as power-to-heat, electric vehicles, prosumer and demand-response schemes, etc. (ibid.). The SET-Plan specifically emphasises the important role of electric mobility in the 2050, namely “less costly, durable EV traction batteries, with improved energy storage, power performance and charging capabilities”, and various renewable fuels for them (ibid.). The SET-Plan also discusses safety in nuclear power, “particularly in existing and advanced power reactors and associated fuel cycles” (ibid.), as an important element in future European energy sector.

In the buildings sector “technology integration for and the deployment of net zero-energy/emission districts with positive energy blocks of various sizes as a central boundary-pushing element” (ibid.). Specific technologies that would bring the 1.5 worlds closer are heat pumps, micro combined heat and power (CHP), thermal energy storage, district heating and cooling.

In industries, carbon capture and storage (CCS) and carbon capture and use (CCU) are seen as important technologies “for the global decarbonisation in the power generation and energy intensive industries in a cost-effective manner”

#### Energy Roadmap 2050

The Energy Roadmap 2050 (EC 2011b) is a strategic document that “explores the challenges posed by delivering the EU's decarbonisation objective while at the same time ensuring security of energy supply and competitiveness” (ibid.). The roadmap contains scenarios of decarbonisation pathways of Europe’s energy system with the aim to “develop a long-term European technology-neutral framework” (ibid.).

The Energy Roadmap 2050 emphasises the need for higher energy efficiency in new and existing buildings, including the appliances inside (Table 1). Ideally, zero-energy or passive buildings, and even energy-producing homes, become the new norm. The same applies for the transport system, in which efficient vehicles and their efficient use are key. In transport a shift to alternative fuels may help achieve the climate goals. These could be electricity, biofuels, synthetic fuels, methane and liquefied petroleum gas (LPG), and would require further research, innovation and policy work “on batteries, fuel cells and hydrogen, which together with smart grids can multiply the benefits of electro-mobility both for decarbonisation of transport and development of renewable energy” (ibid.).

Efficiency in electricity generation should include utilisation of waste heat in combined heat and power plants (CHP). A major role in achieving a sustainable world in 2050 is played by mass deployment of renewable energy technologies (RET) after 2020: wind and solar power and its transmission from windy and sunny regions of Europe. In particular, upscaling the size of offshore wind turbines and their blades is deemed important. The rise of RET would allow renewable heating and cooling technologies such as heat pumps, storage heaters, solar heating, geothermal, biogas, biomass. The roadmap points out that for RET to work improvements in energy storage technologies remain critical.

Other energy technologies also play important roles in the different scenarios explored in the Energy Roadmap 2050. Namely, gas-fired power generation “might play an increasing role in the future”, and in case of large scale application of CCS, gas “may become a low carbon technology” (ibid.). CCS is considered “an important option for decarbonisation of several heavy industries” (ibid.).

According to the roadmap, “[i]n general, energy efficiency has to be included in a wide range of economic activities from, for example, IT systems development to standards for consumer appliances” (ibid.). ICT sector may further contribute to 1.5 degree worlds when integrated in innovative ways with energy and transport sectors: “The digital infrastructure that will make the grid smart will also require support at EU level by standardisation and research and development in ICT” (ibid.).

#### White Paper “Roadmap to a Single European Transport Area”

The Roadmap to a Single European Transport Area (EC 2011c) is another strategic document issued by the EC. It is a global outlook of “developments in the transport sector, at its future challenges and at the policy initiatives that need to be considered” in the EU (ibid.). Based on the White Paper the EU identified the following technological priorities:

* (co-operative) intelligent transport systems and other digital mobility solutions to help make freight transport more efficient,
* inter-operable electronic tolling systems to attract new funding to EU infrastructure and its decarbonisation,
* hydrogen fuels to reduce air and even noise pollution, allowing freight trucks to drive at night in urban areas,
* low- and zero-emission vehicles;
* charging and maintenance infrastructure for electric vehicles, including electric vehicle re-charging points in buildings, and
* energy storage, including next generation batteries.

#### Low Carbon Economy 2050 roadmap

The “Roadmap for moving to a competitive low carbon economy in 2050” (EC 2011a) is one of the main EU strategic documents in climate change mitigation: “It outlines milestones which would show whether the EU is on course for reaching its target, policy challenges, investment needs and opportunities in different sectors” (ibid.). Many of the technologies mentioned in the Low Carbon Economy 2050 roadmap feature in the SET Plan and other documents covered above. However, the Roadmap additionally emphasises technologies critical for mitigation in agriculture, which are not found elsewhere. These are:

* efficiency gains,
* efficient fertiliser use,
* bio-gasification of organic manure,
* improved manure management,
* better fodder,
* local diversification and commercialisation of production and improved livestock productivity,
* maximising the benefits of extensive farming.

ibid.

#### Accelerating Clean Energy Initiative

Accelerating Clean Energy Initiative is a strategic document providing a view on EU’s efforts toward its climate goals. It is a “co-ordinated effort to promote … enabling technologies, services, business models, and social innovation, thus contributing to growth and employment and making EU industries more competitive in world markets” (EC 2016a). Similar to the strategies above, the Initiative emphasises four strategic priorities:

1. Decarbonising the EU building stock by 2050: From nearly-zero energy buildings to energy-plus districts;
2. Strengthening EU leadership on renewables;
3. Developing affordable and integrated energy storage solutions;
4. Electro-mobility and a more integrated urban transport system.

ibid.

#### PPP Energy-Efficient Buildings roadmap

The EU’s public-private partnerships (PPPs) represent the efforts of the EC to involve businesses in large infrastructural projects. The PPP for high-tech building industry issued a multi-annual energy-efficient buildings roadmap that serves to help “turn energy efficiency into a sustainable business” (EC 2013). The document states that its objectives are to guide research and innovation in the industry toward developing, integrating and demonstrating “at least 40 new technologies by 2020” (ibid.). The document mentions some technologies already covered by other strategies (such as energy storage and net zero-energy buildings). It provides two original contributions to our list of prioritised technologies: innovative construction (“building envelope, multi-target design, prefabrication methods, approaches adapted to public buildings or commercial/private-housing ones” (ibid.)), and “performance monitoring tools” (ibid.).

#### SPIRE roadmap

SPIRE (Sustainable Process Industry through Resource and Energy Efficiency) is a PPP for process industries in cement, ceramics, chemicals, minerals and ores, and other sectors. SPIRE’s roadmap contains research and innovation guidelines for the industry by 2020 “to decouple human wellbeing from resource consumption and achieve increased competitiveness in Europe” (SPIRE, n.d.). SPIRE’s prioritises are:

* cogeneration-heat-power,
* process intensification,
* introduction of novel energy-saving processes,
* energy recovery,
* progressive introduction of alternative (renewable) energy sources within the process cycle,
* increasing chemical and physical transformation yields and/or using secondary (through optimised recycling processes) and renewable raw materials

ibid.

#### Factories 4.0 and Beyond

Factories 4.0 and Beyond (EFFRA 2016) is a document by the European Factories of the Future Research Association collecting recommendations to research and innovation for the manufacturing sector. Among the recommendations we find a focus on three technologies:

* agile value networks and distributed manufacturing,
* advanced manufacturing processes and services for zero-defect and innovative processes and products,
* interoperable digital manufacturing platforms.

ibid.

#### Clean Planet for All

The Clean Planet for All (\*\*) vision adds to what was already mentioned above the widening of efforts around

* Sustainable biomass
* Afforestation
* Agroforestry
* Forest management.

Overall, we presented the key mitigation technologies and demanded technologies. From the way the EU sources prioritise, we can already draw some conclusions. First, the EU sources tend to emphasise the importance of high-tech solutions …

### Supplied technological innovations

Obviously, not all of the key technologies are invested in by the EU, but how much does it invest in the demanded ones? To learn this we compiled a list of “supplied” innovations, or de facto funded ones.

We first filtered out non-mitigation and non-technology projects from the databases of H2020 and FP7 projects. FP7 and Horizon 2020 cover European R&D since 2008 to 2020. For that we accessed the databases through the EU Open Data Portal[[4]](#footnote-4),[[5]](#footnote-5). The databases hold detailed records of projects, including descriptions written by applicants, timeframe, budget, names of contact persons and contact addresses of involved organisations, etc. They do not, however, provide useful information on the type of technology in focus of a given project.

We filtered out projects that were not relevant to climate change mitigation technologies (i.e. not linked to the IPCC definition of climate change mitigation (IPCC 2014)). We left only projects whose self-reported descriptions contained terms (and their variations) “mitigation”, “green”, “clean” or “sustainable” in couple with “technology”, “method” or “solution”; or terms “decrease”, “reduce”, “cut”, “combat” or “mitigation” in couple with “emission”.

…

We then identified the key technology in each project.

…

## Comparing the technology mixes

The final list of currently demanded technologies shows a rather wide range of technologies. We see renewables and (low carbon) gas, electric vehicles and biofuel- and hydrogen-powered vehicles. ICT plays a large role in almost all sectors, facilitating so called ‘smart’ solutions that rely on interconnectivity and (big) data.



Figure 1. Total cumulative number of projects per sector during the reviewed period (2008-2017). Currently prioritised technologies are indicated with a frame.  
*Source: analysis based on CORDIS data.*



Figure 2. Funding dynamics of technologies that are prioritised in strategies.  
*Source: analysis based on CORDIS data.*



Figure 3. Current de facto prioritisation of technologies in FP7 and Horizon 2020. Italics is used for technologies with no funding.

## Recommendations

…

The recommendations above, not the findings of the present research, should not be interpreted uncritically as there are a number of important limitations. A key assumption in this paper is that public funding by the EU plays a coordinating and impactful role in directing European R&I. In reality, private funding plays an equally important, if not dominant, role. As such, a lack of public funding may not indicate under-funding. For one, national and commercial actors may be spending much more money on a technology than the EC does. Alternatively, different technologies may require different amounts of investment (e.g. due to their levels of maturity).

An additional limitation is related to semantics on which the results heavily rely. The search terms that we used to filter the CORDIS databases relied on the comprehensiveness of the self-reported project description which vary highly in detail and amount of text and on our chosen search terms, therefore we might have not captured all the relevant projects. The same applies for the names of technologies.

## Conclusions

In this paper we focused on the R&D of mitigation technologies with the aim of evaluating the extent to which the EU innovation policy is able to achieve the task to reach the EU climate targets. We set out to fill the knowledge gap on the progress of the EU to provide evidence for the claim that the EU is well on track to meet its climate and energy targets by year 2050. We focused on technological innovations. We asked: how is the EU committing to technological innovations that are most likely to help reach its climate goals? Our aim is that the answers to the questions posed in this paper would provide valuable lessons for the EU R&D spending and the selection of priority issues to fund, and would contribute to the debate about the foci of the next EU framework programme and national R&D priorities.

In the first part of this paper we analysed strategies by the European Commission and European industries to create a shortlist of technologies, research and innovation in which is required, according to the respective actors, to meet the climate goals of the EU and sectoral climate targets. We compared this list with the actual technologies focal in the EU research and innovation. We analysed the EU’s framework programmes for R&D for FP7 and Horizon 2020, reviewing a decade of European R&D since 2008 up till the last quarter of 2017. We concluded that none of the sectoral R&D has been strictly aligned with the mix of technologies expected to play a key role in mitigating climate change. Moreover, key technologies such as synthetic fuels, advanced manufacturing or net zero-emission districts and other are not funded at all. The findings should not be interpreted uncritically, however, because of the limitations discussed in the previous section.

At the same time, the findings provide first empirical evidence that is severely lacking on allocating funds for the next framework programme. Ultimately, this research helps to get a rough-and-ready understanding where the EU funds are being spent on in clean technology, and how to better align the actual spending with strategic goals.

Future research could and should study the situation in specific sectors. It would be interesting to compare the present findings with national R&D expenditures of the member states. That would give a more holistic understanding of how prepared the EU is for the 1.5 degree worlds. Equally interesting would be to look into technologies outside of the range of “the usual suspects”, i.e. outside of the scope of published strategies. Such projects with low visibility could add new technologies to the list of possible clean technologies.

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# Appendix I – Mitigation technology glossary

Pre-step to limit search to mitigation technologies? Key terms (with OR):

* mitigat\*,
* greenhouse,
* carbon,
* emission\*,
* “climate change”,
* “global warming”,
* sustainab\*,
* “energy efficien\*”.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **IPCC sectoral category**[[6]](#footnote-6) | **Technology group** | **Technology** | **Short description** | **Key terms (with OR operator)** | **Source** |
| Energy | Solar energy sources | solar PV | Also “solar photovoltaic”; technology of using solar cells to convert solar radiation directly into electricity. | photovoltaic, PV, “solar cell” | https://www.ctc-n.org/technologies/solar-pv |
| concentrated solar power (CSP) | Technology of producing electricity by concentrating the sun’s rays to heat a medium (usually a liquid or gas) that is then used in a heat engine process (steam or gas turbine) to drive an electrical generator. Four main CSP technologies can be distinguished: parabolic troughs (PT), solar towers with central receivers (CR), linear Fresnel reflectors (LF) and parabolic dishes (PD). | “concentrated solar power”, CSP, “concentrated solar”, “parabolic trough”, “solar tower with central receiver”, “Fresnel reflector” | https://setis.ec.europa.eu/technologies/concentrated-solar-energy |
| solar heating | Technology of capturing the sun's radiation and it use for heating water. | “solar heating” | https://www.ctc-n.org/technologies/solar-heating |
| solar dryer | Technology of drying substances, especially food, using solar energy. | “solar dryer” | https://www.ctc-n.org/technologies/solar-dryer |
| solar water pump | Technology of powering electrical water pumps with solar panels. | “solar water pump” | https://www.ctc-n.org/technologies/solar-water-pumps |
| Hydro energy sources | tidal energy | A hydropower technology that converts the energy of tides into electricity or other useful forms of energy. | “tidal energy”, “tidal power” | https://www.ctc-n.org/technologies/tidal-energy |
| wave energy | Technology of capturing energy found in ocean surface waves. Several wave energy technologies can be distinguished: attenuators, point absorbers, surge converters, oscillating water columns, overtopping devices and submerged pressure differentials. | “wave energy”, “wave power” | https://www.ctc-n.org/technologies/wave-energy |
| ocean thermal energy conversion (OTEC) | Technology of using the temperature difference between cooler deep and warmer shallow/surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity. | OTEC, “ocean thermal energy conversion” | https://www.ctc-n.org/technologies/ocean-thermal-energy-conversion |
| Other renewable energy sources | geothermal | Technology of heating buildings and/or producing electricity by using natural reservoirs with hot water inside the Earth's crust. | geothermal, “geothermal energy”, “geothermal power” | https://www.ctc-n.org/technologies/geothermal-electricity |
| osmotic | Also, “osmotic power”, “salinity gradient power” or “blue energy”; technology of producing energy from the difference in the salt concentration between seawater and river water. | “osmotic power”, “osmotic energy”, “salinity gradient” | https://www.ctc-n.org/technologies/osmotic-power |
| downdraft | Also, “downdraft” or “energy tower”; technology of producing energy using the flow of air at the bottom of a tall hollow tower to rotate wind turbines. The air flow is achieved through spraying water at the top of the tower. | downdraft, “energy tower” | https://www.ctc-n.org/technologies/energy-tower-downdraft |
| updraft | Also, “solar tower”; technology of producing energy using air heated by solar radiation under glass or plastic roof. This heat is then forced upwards through a chimney creating a wind force, which is caught by wind turbines. | updraft | https://www.ctc-n.org/technologies/solar-towers-updraft |
| System innovation | grid management | Here also “smart grid”; technology of controlling the production and distribution of electricity in electricity grids with connected electronic measurement and control mechanisms (such as smart meters and smart appliances). Here also includes vehicle-to-grid services. | “grid management”, “smart grid”, “intelligent grid”, “vehicle-to-grid” | https://www.ctc-n.org/technologies/smart-grid |
| low GHG transmission | Technology of long distance, ultra-low cost, high efficiency electric power transmission, including high-voltage direct current. | “efficient energy transmission”, “efficient power transmission”, “high efficiency energy transmission”, “high efficiency power transmission”, “high-efficiency energy transmission”, “high-efficiency power transmission”, “high efficiency electric power transmission”,  “high-efficiency electric power transmission” | http://www.b-t.energy/landscape/electricity/ultra-low-cost-transmission/ |
| combined cycle power plant | In power plants, technology of fuel-switching, or the replacement of fossil fuels with low-carbon fuels (e.g. replacing coal with natural gas). | “combined cycle” | https://www.ctc-n.org/technologies/natural-gas-combined-cycle-plants |
| Storage | energy storage | Technology of energy storage, such as batteries, pump systems or flywheels. Here does not mean energy storage in vehicles. | “energy storage”, “pump system”, flywheel; NOT vehicle, car | http://www.b-t.energy/landscape/electricity/ultra-low-cost-electricity-storage/ |
| thermal storage | Technology of storage of heat energy, usually using molten salt. | “thermal storage” | http://www.b-t.energy/landscape/electricity/ultra-low-cost-thermal-storage/ |
| compressed air energy storage (CAES) | Technology of energy storage using compressed air. In times of excess electricity in the grid (e.g. due to the high power delivery at times when demand is low), a CAES plant can compress air and store the compressed air in a cavern underground. When demand is high, the stored air can be released and the energy can be reused. | CAES, “compressed air energy storage” | https://www.ctc-n.org/technologies/compressed-air-energy-storage-caes |
| Nuclear energy sources | nuclear fission | Also simply “nuclear power”; technology of producing electricity by controlled splitting of atomic nuclei. | “nuclear fission” | http://www.b-t.energy/landscape/electricity/next-generation-nuclear-fission/ |
| nuclear fusion | Technology of controlled nuclear fusion: the fusing of two atomic nuclei to produce electricity. | “nuclear fusion” | http://www.b-t.energy/landscape/electricity/nuclear-fusion/ |
| Wind | onshore wind | Technology of converting the kinetic energy of the wind into electrical power, achieved with wind turbines. Onshore wind parks are placed on land. | “onshore wind” | https://www.ctc-n.org/technologies/shore-wind |
| offshore wind | Technology of converting the kinetic energy of the wind into electrical power, achieved with wind turbines. Offshore wind parks are placed in the sea or ocean. | “offshore wind” | https://www.ctc-n.org/technologies/offshore-wind |
| Transport | Fuel | biofuel | Technology of producing or using biofuel, or vegetable oil- or animal fat-based fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters. | biofuel | https://www.ctc-n.org/technologies/biodiesel-0 |
| fuel cell | Technology of producing or using hydrogen or certain alcohols such as methanol as transportation fuel. | “fuel cell” | https://www.ctc-n.org/technologies/fuel-cells-mobile-applications |
| electric battery | Technology of using electrochemical batteries as storage media in which reversible electrochemical reactions enable storage of electrical energy as chemical potential and release of that energy on demand. | “electric battery” | https://www.ctc-n.org/technologies/batteries |
| liquefied natural gas (LNG) | Technology of producing or using LNG, alternative natural gas-based fuel, for heavy duty trucks. | “liquefied natural gas”, LNG | https://www.ctc-n.org/technologies/liquefied-natural-gas-trucks-and-cars |
| compressed/converted natural gas | Technology of producing or using natural gas-based fuel for passenger vehicles. | “compressed natural gas”, “converted natural gas”, “compressed gas”, “converted gas” | https://www.ctc-n.org/technologies/compressed-natural-gas-cng-fuel |
| Vehicle design | electric vehicle design | Technology of vehicle propelling using solely electric motors. | “electric vehicle”, “electric car” | https://www.ctc-n.org/technologies/electric-vehicles |
| low GHG aircraft design | Technology of more efficient engines, improved aerodynamics, advanced lightweight materials and structures, improved navigation and other, directed at reducing emissions form aircraft travel. | aircraft, aviation | http://www.b-t.energy/landscape/transportation/low-ghg-air-transport/ |
| low GHG freight design | Any technology of low-emission road, rail, water, air, pipeline or non-motorised transportation. | freight | https://www.ctc-n.org/technologies/modal-shift-freight-transport |
| lightweight transport design | Technology of lightweight, but strong materials, such as carbon-fibre-reinforced plastics or metals. | “lightweight transport” | http://www.b-t.energy/landscape/transportation/lightweight-materials-and-structures/ |
| non-motorised transport design | Technology related to cycling and other non-motorised transport. | “non-motorised” | https://www.ctc-n.org/technologies/promotion-non-motorised-transport-0 |
| low GHG public transport / rapid transit design | Technology of reducing emissions in three modes of public transport: trains, light rail (or trams) and buses. | “public transport”, “rapid transit” | https://www.ctc-n.org/technologies/public-transport |
| System innovation | low GHG logistics | Technology of reducing emissions in transport logistics, which is the transport of goods to customers. | logistics | CORDIS |
| traffic management | Technology of ensuring smooth and efficient road traffic flow, fair access for different transport modes, safety of roads and streets for all users, minimisation of congestion, local pollution and noise, reduced greenhouse gas emissions, and other traffic management measures. | “traffic management”, “management of traffic” | https://www.ctc-n.org/technologies/traffic-management |
| reduced need for travel | Technologies of reducing the need to travel, such as advanced telepresence, virtual reality, virtual collaboration platforms (to conduct meetings or collaborate). | “reduced need for travel”, “advanced telepresence”, “virtual collaboration platform” | http://www.b-t.energy/landscape/transportation/technology-solutions-that-eliminate-the-need-for-travel/ |
| regenerative braking | Technology of reversing the electric current in the electric motors (e.g. of trains) slowing down the train and also causing the motors to generate electricity. | “regenerative braking”, “regenerative brake” | https://www.ctc-n.org/technologies/regenerative-braking-trains |
| Buildings | Building design | passive house | Also, “low carbon house/building” or “zero emissions house/building”. Here, an energy efficient building includes two or more of these technologies: well-insulated and highly air-tight building, strict design and construction standards, mainly heated by passive solar heat or other natural heat, and equipped with an energy recovery ventilator for a constant and balanced fresh air supply. Optionally, can be also integrated with onsite renewable energy technologies (wind, solar, etc.). | “passive house”, “low carbon house”, “low carbon building”, “zero emissions house”, “zero emissions building”, ”, “low-carbon house”, “low-carbon building”, “zero-emissions house”, “zero-emissions building” | https://www.ctc-n.org/technologies/passive-house-design |
| low GHG envelope | New materials, insulation or design that help reduce total energy use in walls and windows of buildings. | envelope | http://www.b-t.energy/landscape/buildings/high-efficiency-envelope-windows-and-insulation/ |
| daylight harnessing | Technologies of bringing diffused daylight into the building interior. Three types of technology can be distinguished: light shelves, light pipes and skylights. | “daylight harness”, “light shelves”, “light pipe”, “skylight” | https://www.ctc-n.org/technologies/daylight-harnessing |
| cool roof | Technology of reflecting sunlight and heat, thus reducing the temperature of the roofs. This provides passive cooling to enhance energy performance of the building. | “cool roof” | https://www.ctc-n.org/technologies/cool-roofs |
| Interior appliance design | combined heat and power (CHP) | Technology of an integrated system that combines electricity production and recovery of waste heat. | “combined heat and power”, CHP | https://www.ctc-n.org/technologies/large-scale-combined-heat-and-power |
| low GHG lighting | Technology of new high efficiency lighting including, and not limited to LED. | “high efficiency lighting”, “high-efficiency lighting”, “efficient lighting” | http://www.b-t.energy/landscape/buildings/high-efficiency-lighting/ |
| Decreased energy consumption design or practices | demand-side energy management | Technology inside buildings that help ensure that the energy system performance meets the design intentions; helps monitor, evaluate and manage the energy performance to optimise occupants’ comfort and the building’s functions, while maintaining or improving the energy efficiency of the building. | “demand-side energy management”, “demand-side management”, “demand side energy management”, “demand side management”, DSM | https://www.ctc-n.org/technologies/energy-management-and-performance-improvement |
| low GHG air conditioning | Technology of cooling the interior of buildings, such as air conditioners. | “air conditioning” | https://www.ctc-n.org/technologies/efficient-air-conditioning-systems |
| low GHG refrigeration | Technology of energy-efficient food storage at cool temperatures (e.g. 3 to 5 °C). Here does not refer to emission reductions caused by the refrigerant. | refrigeration | https://www.ctc-n.org/technologies/energy-efficient-refrigerators |
| Industry | Manufacturing innovation | low GHG steel | In iron and steel industry, technology of significant emissions reductions from iron and steel production, such as replacement of coal with plant-based charcoal and reduction of iron oxide. Here does not include carbon capture and storage, waste heat reuse, introduction of gas turbines or of renewable energy sources. | steel; NOT CCS, “carbon capture and storage”, “carbon capture and sequestration”, “carbon sequestration”, “waste heat reuse”, “gas turbine”, “renewable energy” | http://www.b-t.energy/landscape/manufacturing/low-ghg-steel/ |
| low GHG cement | In cement and cement-replacement industry, technology of low-emission substitutes for cement/concrete, such as such as coal fly ash, blast furnace slag or novel materials. | cement, “coal fly ash”, “blast furnace slag” | http://www.b-t.energy/landscape/manufacturing/lownegative-ghg-cement/ |
| low GHG coolant/refrigerant | Technology of producing or using low-emission refrigerants (substances that can be used in the refrigeration cycle of air conditioning and refrigeration equipment because of their thermodynamic properties). | refrigerant | https://www.ctc-n.org/technologies/shift-coolants-and-refrigerants-lower-gwp |
| low GHG chemicals | In chemical industry, technology of low-emission production of chemicals. Here does not refer to methane capture or carbon capture. | “chemical industry”; NOT CCS, “carbon capture and storage”, “carbon capture and sequestration” | http://www.b-t.energy/landscape/manufacturing/low-ghg-chemicals/ |
| methane capture | Technology of reducing fugitive methane emissions, including the development of advanced remote leak monitoring technologies. | “methane capture”, “remote leak monitoring”; NOT CCS, “carbon capture and storage”, “carbon capture and sequestration”, “carbon sequestration” | http://www.b-t.energy/landscape/manufacturing/fugitive-methane-emissions-from-industry/ |
| biorefinery design | Technology of sustainable processing of biomass into marketable products and energy. | biorefinery | https://www.ctc-n.org/technologies/biorefinery |
| pulp and paper drying | In pulp and paper industry, technology of (Condebelt) drying process that improves strength and other quality characteristics, increases drying rates and possibly saves energy. | “pulp and paper drying”, “pulp-and-paper drying”, “Condebelt drying” | https://www.ctc-n.org/technologies/condebelt-drying-pulp-and-paper-industry |
| wet/dry quenching | In iron and steel industry, technology of preventing the coke (fuel) from burning up in the air (wet quenching), or, in addition, allowing recovery of thermal energy (dry quenching). | “wet quenching”, “dry quenching” | https://www.ctc-n.org/technologies/coke-dry-quenching-iron-and-steel-sector |
| slag granulation | Technology of reusing material such as waste or residue in industry. | “slag granulation” | https://www.ctc-n.org/technologies/blast-furnace-slag-granulation |
| distributed manufacturing | Also, “distributed production”, “cloud producing” or “local manufacturing”; technology of producing goods that are partly assembled by consumers (e.g. Ikea or 3D-printing). | “distributed manufacturing”, “distributed production”, “cloud producing”, “local manufacturing” | CORDIS |
| CCS | carbon capture and storage | Also, “CCS” or “carbon sequestration”; technology of separating CO2 emissions generated through conventional power generation and industrial production processes, after which the compressed CO2 is transported to a suitable geological storage location. | “carbon capture and storage”, “carbon capture and sequestration”, “carbon sequestration”, CCS | https://www.ctc-n.org/technologies/co2-storage-technologies |
| Energy use innovation | gas turbine | Also, “combustion turbine”; technology of converting natural gas or other liquid fuels into mechanical energy. Here does not include gas turbine for transportation (e.g. in airplanes). | “gas turbine”, “combustion turbine” | CORDIS |
| low GHG data centers | Technology that helps to decrease the emissions from data centers. Can include efficient power electronic conversion, data center cooling technologies, technologies that increase server utilization rates above 5–10% range (e.g., virtualization), and next generation semiconductor chips. | “data center”, “data centre” | http://www.b-t.energy/landscape/manufacturing/extreme-efficiency-in-itdata-centers/ |
| smelt reduction | In iron and steel industry, technology of combining the gasification of coal with the melt reduction of iron ore. | “smelt reduction” | https://www.ctc-n.org/technologies/smelt-reduction-iron-and-steel-sector |
| inert anode | Technology of introducing inert anode in aluminium smelters. | “inert anode” | https://www.ctc-n.org/technologies/inert-anode-technology-aluminium-smelters |
| direct casting | In iron and steel industry, technology of integrating casting and hot-rolling of steel into one step, thereby reducing the need to reheat the steel before rolling it. | “direct casting” | https://www.ctc-n.org/technologies/direct-casting-iron-and-steel-sector |
| waste heat reuse | Technology of waste heat capture, conversion and reuse, including for scrap preheating. | “waste heat reuse” | http://www.b-t.energy/landscape/manufacturing/waste-heat-captureconversion/ |
| energy-from-waste | Also “waste-to-energy”; technology of generating energy in the form of electricity, heat or fuel from the primary treatment (e.g. incineration) of waste. | “energy-from-waste”, “waste-to-energy” | https://www.ctc-n.org/technologies/energy-supply-waste |
| Use of innovative materials | nanomaterial | Technology of improving the strength of existing materials with nanomaterials. Possible uses include solar panels, batteries, sorbents, insulation, etc. | nanomaterial | CORDIS |
| bioplastics | Technology of using renewable biomass materials in the manufacture of bioplastics, including biodegradable or compostable bioplastics. | bioplastic | https://www.ctc-n.org/technologies/bioplastics |
| biopolymer | Technology of replacing fossil-based polymers with renewable biomass-based biopolymers. | biopolymer | https://www.ctc-n.org/technologies/biopolymer-production-petro-chemical-sector |
| Improved durability | improved durability | Technology of producing (energy-intensive) products and materials with improved durability. | “improved durability” | http://www.b-t.energy/landscape/manufacturing/extreme-durability-for-energy-intensive-products-and-materials/ |
| Human settlements | Energy management | district heating and/or cooling | Pipe network that supplies heating/cooling and hot/cold water for connected consumers from a central power plant. | “district heating”, “district cooling” | https://www.ctc-n.org/technologies/district-heating-and-cooling |
| heat pumps | Heat pumps deliver heating, cooling and hot water to buildings. Three main types: ground source, ground water source, and air source. | “heat pump” | https://www.ctc-n.org/technologies/heat-pumps |
| micro-grids | A group of interconnected loads and distributed energy resources (DERs) within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A micro-grid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode. | “micro-grid”, microgrid | https://www.ctc-n.org/technologies/micro-grid |
| off-grid systems | A stand-alone power system (SAPS or SPS), also known as remote area power supply (RAPS), is an off-the-grid electricity system for locations that are not fitted with an electricity distribution system. Typical SAPS include one or more methods of electricity generation, energy storage, and regulation. | “stand-alone power system”, SAPS, SPS, “remote area power supply”, RAPS | https://www.ctc-n.org/technologies/grid-systems |
| Waste management | recycling | Technology of recycling product components and materials that are considered waste. Here does not include reuse of material in manufacturing processes. | recycling | https://www.ctc-n.org/technologies/product-component-and-materials-recycling |
| waste management | Technology of maximising efficiency of resource use in waste generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner. E.g. implementation of the 3R (reduce, reuse and recycle) principle. | “waste management”, “management of waste” | https://www.ctc-n.org/technologies/integrated-solid-waste-management |
| landfill composting | Technology of landfill aerobic biological treatment (composting) which is used to stabilize wastewater solids prior to their use as a solid amendment or mulch in landscaping, horticulture and agriculture. Here also includes landfill aeration. | “landfill compost”, “landfill aerobic biological treatment”, “landfill aeration” | https://www.ctc-n.org/technologies/landfill-composting |
| gasification of waste | Also, “thermal gasification of municipal solid waste” (MSW); technology of generating a gaseous, fuel-rich product out of municipal solid waste. This product can then be combusted in a boiler, producing steam for power generation. | “gasification of waste”, “gasification of municipal solid waste”, “gasification of MSW” | https://www.ctc-n.org/technologies/gasification-waste |
| landfill biocover | Here refers to technology of spraying landfill areas with special substances or covering landfills with special films to achieve microbial methane oxidation (which greatly reduces landfill methane emissions). | “landfill biocover” | https://www.ctc-n.org/technologies/biocovers-landfills |
| Urban forestry | urban forestry | Technology of caring and managing tree populations in urban settings for the purpose of improving the urban environment. | “urban forestry” | https://www.ctc-n.org/technologies/urban-forestry |
| Agriculture | Emissions and pollution reduction | direct seeding | In rice growing, technology of shortening the flooding period and decreasing soil disturbance. | “direct seeding” | https://www.ctc-n.org/technologies/direct-seeding-rice |
| increase of forage digestibility | Ammoniation is technology of adding liquid ammonia, urea, or ammonium bicarbonate to low-value forage such as corn stalks, rice straw, wheat straw, and straw of other crops to increase the digestibility of forage. Another technique is silage: fermenting fresh green fodder, forage grass, and other vines or materials by lactobacillus in the anaerobic conditions of an airproof silage container (tower or silo). | “straw ammoniation”, “straw solage” | https://www.ctc-n.org/technologies/straw-ammoniation-and-silage |
| conservation tillage | Technology of cultivating soil in a way that leaves the previous year’s crop residue (such as corn stalks or wheat stubble) on fields before and after planting the next crop to reduce soil erosion and carbon emissions. | “conservation tillage” | https://www.ctc-n.org/technologies/conservation-tillage |
| cover crop | Technology of planting fast-growing crops, such as winter rye and clovers, between periods of regular crop cultivation. | “cover crop” | https://www.ctc-n.org/technologies/cover-crop-technology |
| livestock management | Technology of improving feeding practices of livestock, using special agents or dietary additives, or longer management changes and animal breeding. | “livestock management”, “management of livestock” | https://www.ctc-n.org/technologies/livestock-management |
| nutrient management | Technology of integrating the use of natural and man-made soil nutrients to increase crop productivity and preserve soil productivity for future generations; or to decrease methane emissions in livestock. | “nutrient management”, “management of nutrient” | https://www.ctc-n.org/technologies/integrated-nutrient-management |
| low GHG food-delivery chain | Technology of reducing food spoilage across the whole food production and delivery chain from harvest to meal time. | “food spoil”, “food delivery chain”, “food-delivery chain” | http://www.b-t.energy/landscape/agriculture/eliminating-spoilageloss-in-the-food-delivery-chain/ |
| electron acceptor | In rice growing, technology of reducing methane emissions from rice fields by the addition of electron acceptors to stimulate microbial populations that compete with methanogens. | “electron acceptor” | https://www.ctc-n.org/technologies/electron-acceptors-rice |
| mid-season drainage | In rice growing, technology of mid-season drainage of rice fields which involves the removal of surface flood water from the rice crop for about seven days towards the end of tillering, interrupting methane production. | “mid-season drainage”, “midseason drainage” | https://www.ctc-n.org/technologies/mid-season-drainage-rice |
| low GHG fertiliser | Technology of producing fertiliser with significant reductions of ammonia emissions. | “fertili?er” | CORDIS |
| manure management | Technology of decreasing methane emissions from manure stored in lagoons or tanks if manure is cooled, covered with solid covers, mechanically separated into solids and slurry, or if the emitted methane is captured. | “manure management”, “management of manure” | https://www.ctc-n.org/technologies/manure-management |
| Resource saving | straw management | In rice growing, technology of removing straw from the fields to be used for mushroom growing, energy production, cattle feed, or other purposes. | “straw management”, “management of straw” | https://www.researchgate.net/publication/228850474\_Rice\_straw\_management |
| alternate wetting and drying | In rice growing, technology of saving water and mitigating methane emissions in lowland (paddy) rice growing. | “alternate wetting and drying” | https://www.ctc-n.org/technologies/alternate-wetting-and-drying-rice |
| soil management | Operations, practices and treatments used to protect soil and enhance its performance, such as leaving last season’s crop residue on the ground, planting cover crops, and controlling erosion. | “soil management”, “soil treatment”, “soil protection”, “management of soil”, “treatment of soil”, “protection of soil” | http://www.b-t.energy/landscape/agriculture/soil-management-solutions-for-ghg-reduction-and-co2-storage/ |
| Forest protection | forest management | Technology of increasing carbon stocks of standing forests, including maintaining forest cover, minimising losses of dead organic matter (including slash) or of soil carbon by reducing soil erosion, and avoiding burning slash and other high-emission substances. | “forest management”, “management of forest” | https://www.ctc-n.org/technologies/forest-management-techniques-mitigation-redd |
| agroforestry | Also, “agro-sylviculture”; technology of managing land use when trees or shrubs are grown around or among crops or pastureland. | agroforestry, sylviculture, “agro-sylviculture”, agrosylviculture | https://www.ctc-n.org/technologies/agroforestry |
| afforestation | Also, “reforestation”; technology of direct conversion of non-forest land to forest land through planting, seeding, and/or promotion of natural seed sources. | afforestation, reforestation | https://www.ctc-n.org/technologies/forest-management-techniques-mitigation-redd |
| Cleaner product | new sources of protein | Technology of producing alternatives to meat as a source of protein in human and animal food, such as insects, microalgae, bacteria, mycoprotein, and synthetic or lab-grown meat. | “alternative to meat”, “alternatives to meat”, “meat alternative” | http://www.b-t.energy/landscape/agriculture/developing-low-cost-low-ghg-new-sources-of-protein/ |
| biochar | Technology of producing and using biochar – a charcoal-like substance produced from agriculture and forest wastes which contains 70% carbon. It is used as soil enhancer to increase fertility, prevent soil degradation and to sequester carbon in the soil. Here does not mean carbon capture and storage. | biochar | https://www.ctc-n.org/technologies/biochar |

**Table 2. Compilation of key mitigation technologies.**

1. https://ec.europa.eu/info/designing-next-framework-programme/mission-oriented-policy-next-research-and-innovation-framework-programme\_en [↑](#footnote-ref-1)
2. <https://www.ctc-n.org/technology-sectors> [↑](#footnote-ref-2)
3. <http://www.b-t.energy/landscape/> [↑](#footnote-ref-3)
4. https://data.europa.eu/euodp/en/data/dataset/cordisH2020projects [↑](#footnote-ref-4)
5. https://data.europa.eu/euodp/en/data/dataset/cordisfp7projects [↑](#footnote-ref-5)
6. Sectoral categories are based on IPCC’s classification (2014b, p. 68). [↑](#footnote-ref-6)