

Investment Recipes

by  AtonRā Partners



23 OCTOBER 2019

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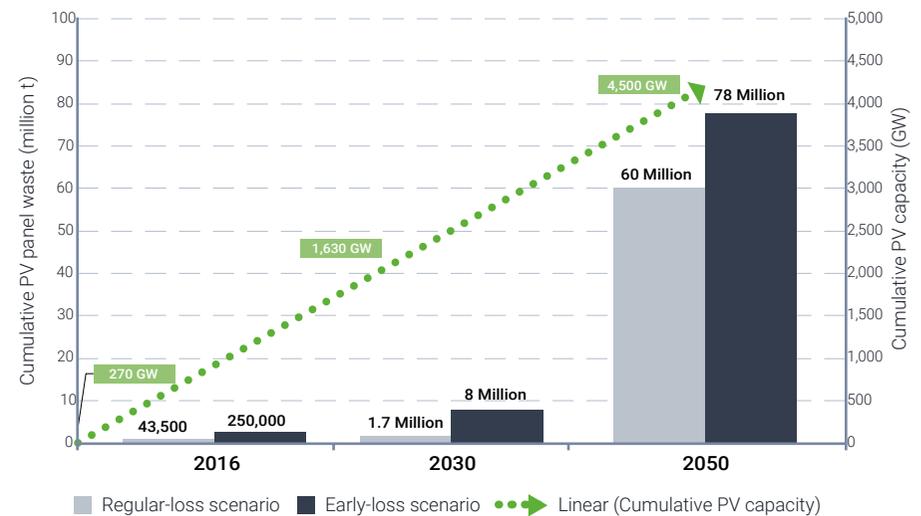
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PHOTOVOLTAIC RECYCLING

PV Panels: As Installations Grow, Waste Flies!

- **Solar photovoltaic (PV)** panels deployment has been growing at a fast pace over the past few years (**CAGR>20% since 2010**), reaching a total capacity of more than **400GW at the end of 2018 and expected to reach 4'500GW by 2050**.
- Along with fast PV deployment comes the question of end-of-life treatment & recycling.
 - PV panels have an average theoretical lifetime of **30 years** and waste will build up as panels start to reach their end-of-life and/or undergo early failure
 - First panels were installed in the early 90's, and while the massive deployment is still ahead of us, many of the first generation panels are now starting to be decommissioned.
- Estimates about global cumulative PV waste range between **43'500 and 250'000 tonnes** in 2016 and are forecast to reach **7–8mn tonnes by 2030 and 60–78mn tonnes by 2050**.
- The potential of this new market opportunity will depend on the development of **efficient recycling technologies** as well as the establishment of **favorable regulatory frameworks**.
- Global PV panel waste forecast (2016–2050) is based on two scenarios:
 - Regular-loss: assumes lifetime of solar panels is 30 years
 - Early-loss: takes into account “infant”, “mid-life” and “wear-out” failures of panels before the 30 years lifespan

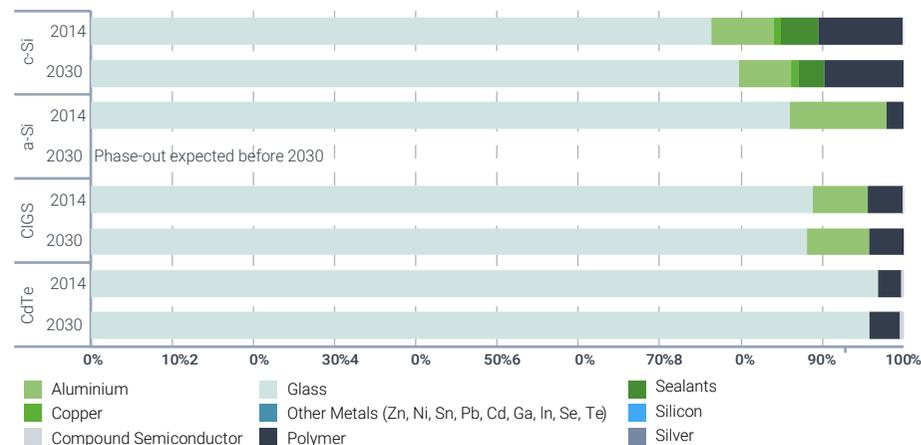
Overview of global PV panel waste projections, 2016-2050



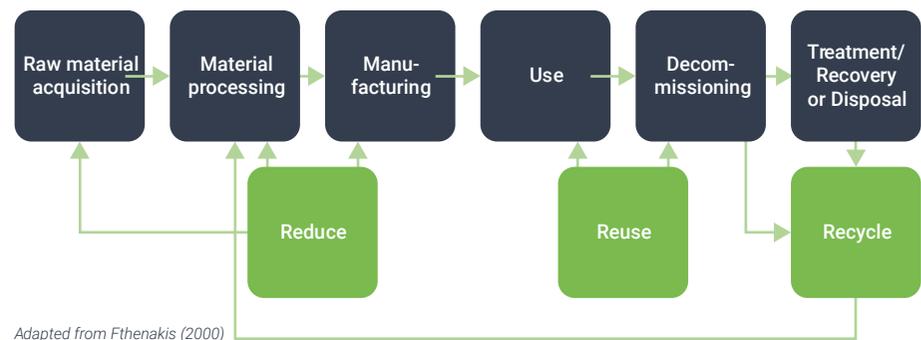
SOURCES:
IRENA, End-of-Life Management – Solar Photovoltaic Panels, (2016)

PV Waste Management: What Are The Options?

- Today's PV panels are mainly based on **Crystalline Silicon (90%)** and **Thin Film (9%)** technologies.
 - **Crystalline Silicon** (c-Si) panels are typically composed of glass (76%), polymer (10%), aluminum (8%), silicon (5%), copper (1%), and silver + other metals (<0.1%).
 - **Thin-film** panels are either Copper indium gallium (di)selenide (CIGS) or Cadmium telluride (CdTe) based.
 - Over 98% of these panels are **composed of non-hazardous** materials including glass, polymer and aluminum, but also contain **potentially hazardous** (copper, zinc) and **hazardous** materials (indium, gallium, selenium, cadmium, tellurium and lead.).
- Within the entire lifecycle of PV panels, waste management can be optimized by leveraging opportunities in **reducing, reusing, and recycling** certain components. Each option should be considered at different stages.
 - **Reduce:** Current R&D activity strives to reduce the usage of hazardous and rare material in panel productions enhancing the recyclability and resource recovery potential of panels.
 - **Reuse:** Panels which suffered from early failures (coating degradation, discoloration, glass breakage, loose frames, contact failures, etc.) before the end of their 30 years lifetime can sometimes be repaired and resold on a secondary market.
 - **Recycle:** Once PV installations reach the final decommissioning stage, panels should be sent to recycling plants in order to recover as much components as possible.



Based on Marini et al., (2014); Pearce (2014); Raithe (2014); Bekkelund (2013); NREL (2011) and Sander et al., (2007)

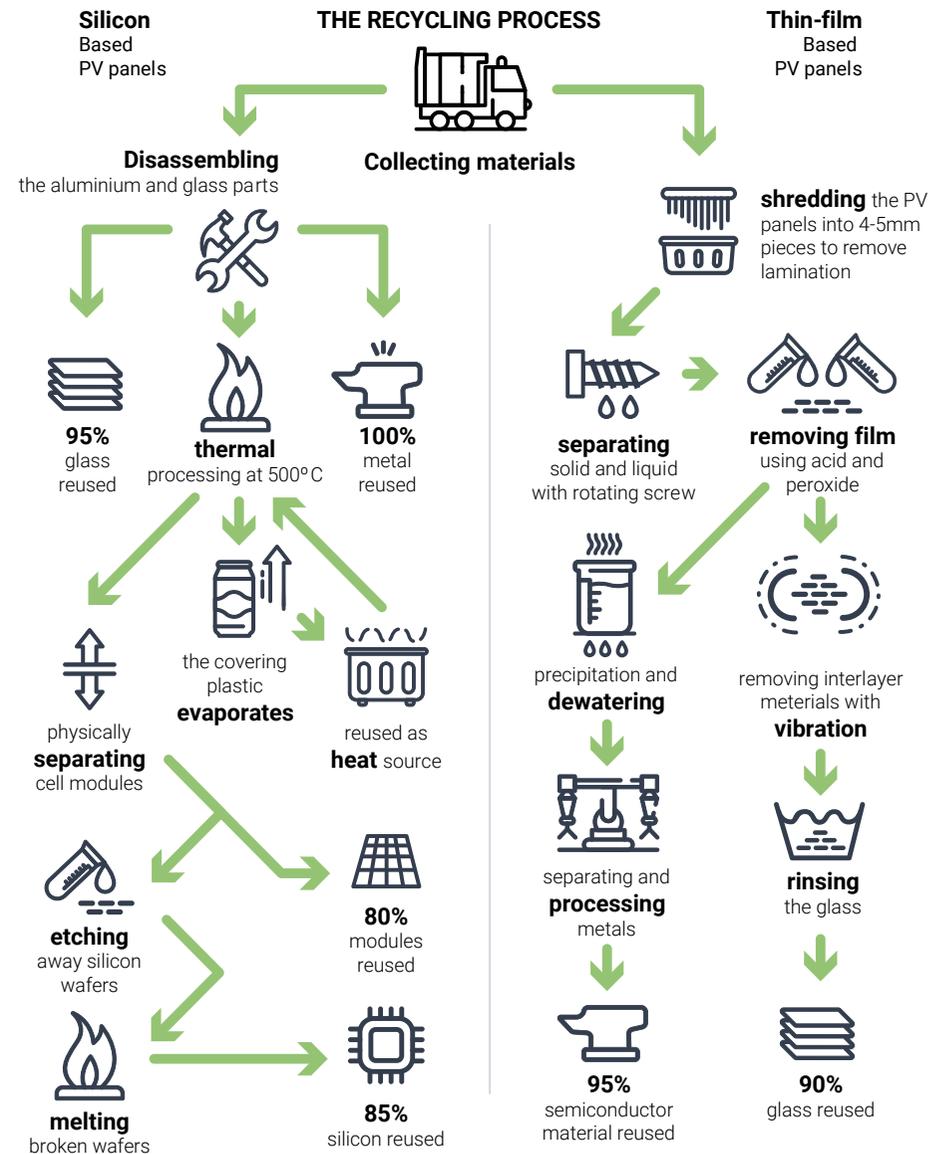


Adapted from Fthenakis (2000)

SOURCES:
IRENA (2016), Adapted from Fthenakis (2000)

Recycling: How and How Much?

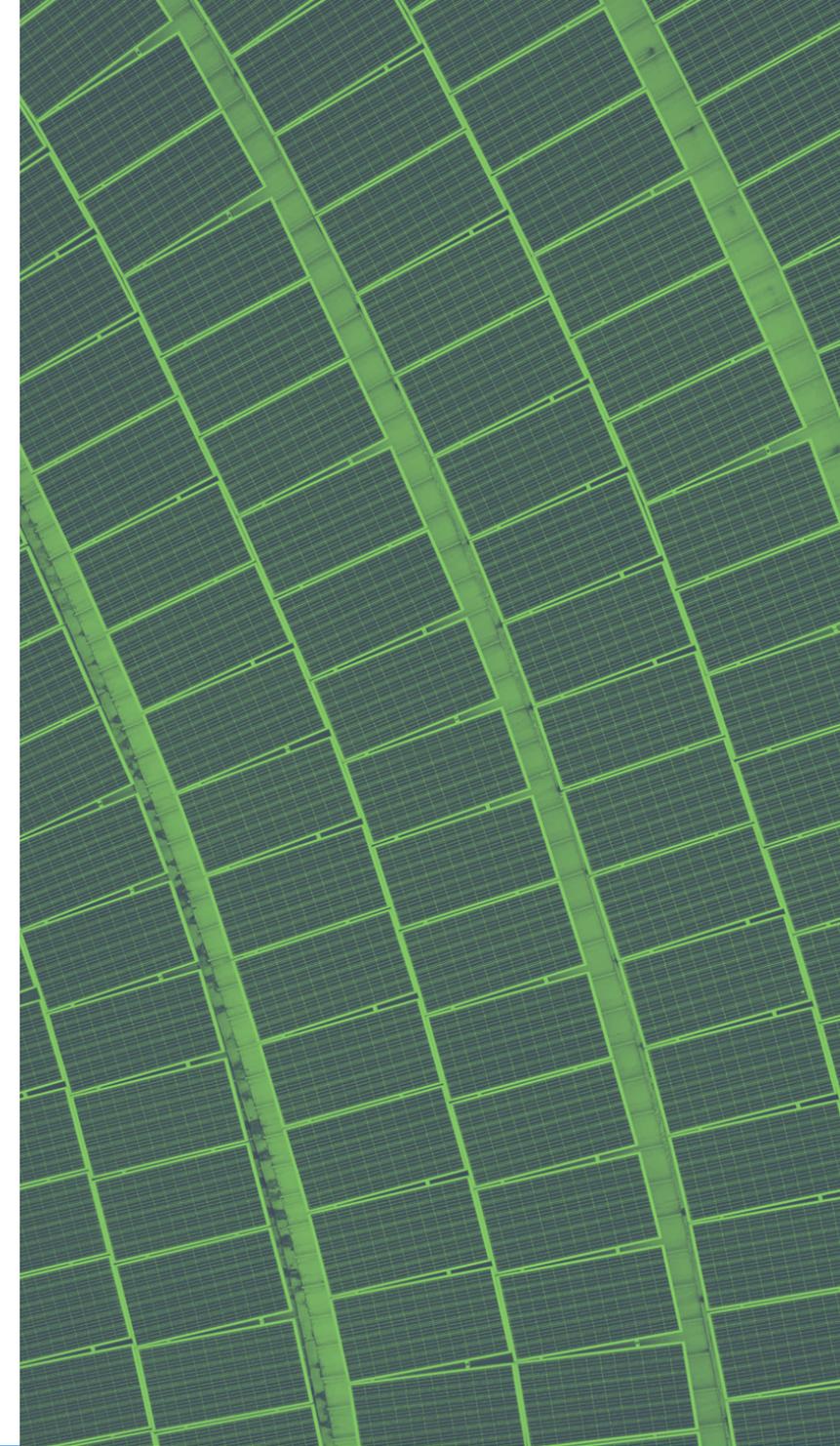
- Current PV **waste quantities are too low** to justify a dedicated PV panel recycling plants meaning that **old panels are currently processed into existing recycling plants** and typically go through a purely mechanical separation.
 - The **recovery rates** of major components such as glass, aluminum, and copper is already **above 85%**.
- Developing dedicated recycling plants for Silicon and Thin-film based panels incorporating more advanced processes can enable the recovery of scarcer valuable components as well as limit impurities in the recovered materials.
- **By 2030**, the cumulative value of recycled PV panel material should reach **\$450mn**, representing enough recovered material to produce 60mn new panels (or 18GW).
- According to IRENA (The International Renewable Energy Agency), based on current PV panels deployment forecasts the cumulative value of recycled material could reach **\$15bn by 2050**, with enough recovered material to produce 2bn panels (630GW).



SOURCES:
IRENA, End-of-Life Management – Solar Photovoltaic Panels, (2016)

Early Movers

- Given today's small amount of PV panels reaching their end-of-life, the market of PV recycling is still relatively small and **only a few actors have initiated voluntary actions for managing PV waste streams.**
 - As an example, **First Solar (FSLR US)** has built its own recycling facility which recycle its Thin-film PV panels
 - It recovers more than 90% of the semiconductor material and 90% of glass with a daily recycling capacity of 150 tonnes.
- The only existing jurisdiction addressing end-of-life management of PV panels is the **E.U. Waste Electrical and Electronic Equipment (WEEE) Directive** where producers selling panels in the E.U. market are legally responsible for their end-of-life management (including costs of collection, treatment, etc.).
 - Since its inception in 2002, the WEEE Directive has gone through several revisions to improve its annual collection and recycling targets, and we expect future WEEE revisions to **further increase** recovery rates and quality standards as new recycling techniques become available.
 - In order to comply with the WEEE regulation, most panel producers joined **PV Cycle**, a European association, fully financed by its members, for voluntary take back and recycling of PV modules.
 - The association has set up hundreds of collection points around Europe so that end-users can return old panels, and has partnered with several national waste recycling facilities.
- While there is no yet any specific PV regulations in big PV markets such as **China or U.S.**, these countries will likely follow the E.U. example and start adopting recycling policies as the stock of end-of-life panels grows.



Catalysts:

- **Increasing waste volumes:** Thanks to a fast-growing Solar PV industry, the amount of PV waste will rapidly reach a point where it becomes economically interesting to develop PV recycling facilities.
- **New regulations & government incentives:** National climate targets is likely to foster the development of PV recycling regulatory frameworks as a way to improve country's environmental footprint.
- **Pressure on companies:** Investors are putting pressure on PV manufacturing companies to always improve their environmental impact which incite them to adopt waste management strategies.

Risks:

- **Expensive recycling process:** Advanced tailor-made PV recycling processes can turn out to be quite expensive, and the price delta with raw material extraction may hamper the business case.
- **Poor quality of recovered material:** Depending on the recycling method, the quality of the recovered material can vary. High impurity levels could negatively impact resale prices.
- **Evolution of PV technology:** Next generation PV cells, using other materials (such as Perovskite cells, Organic cells, etc.) and implying different recycling methods could challenge the standardization of PV recycling techniques.

Bottom line:

- The emergence of Solar PV has just started and as the number of new **solar installations is booming**, the question of recycling and end-of-life management becomes increasingly relevant.
 - Today the PV recycling industry is **quite small** and only the E.U. has a PV-specific waste regulation in place.
 - PV recycling market should start gaining interest in the **next 10–20 years**
- Going forward, PV manufacturers will either build their own recycling facilities or externalize to third-party companies the recycling process.
 - The former is the path followed by **First Solar (FSLR US)** which has set up recycling facilities in the U.S., Germany, Malaysia and Vietnam.
 - For the latter, main actors include big diversified utilities such as **Veolia (VIE FP)**, electronic recycling specialists like **Sims Metal Management (SGM AU)** or smaller PV-specialized recycling companies like **Recycle PV (not listed)** in the U.S. and **Reclaim PV Recycling (not listed)** in Australia.

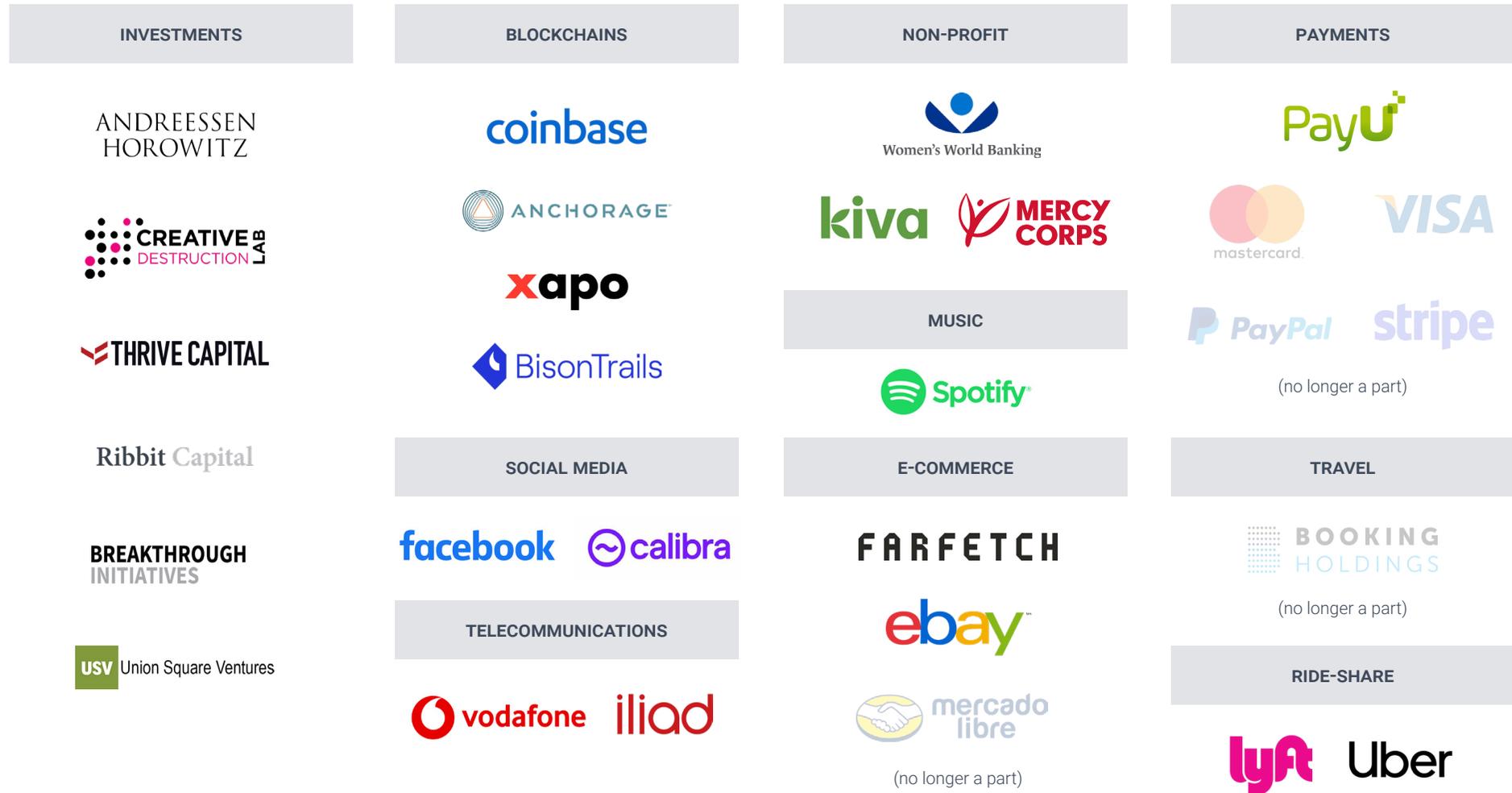
LIBRA (UN) CHAINED

A Comprehensive Update On Libra and what's next?

- We published a research piece on this topic in July 2019 – "**A Libra Debunking**".
- The project aims for **cheap and immediate transfer of money** all over the world through a blockchain-based stablecoin named Libra.
- Recent events are confirming our initial view: although the idea behind Libra is compelling, **the project is not actionable**.
 - **PayPal Holdings Inc. (PYPL US), Visa (V US), Mastercard (MA US), eBay (EBAY US), Stripe (not listed), Mercado Pago (business unit of Mercado Libre, MELI US), and Booking Holdings (BKNG US) have withdrawn from the Libra Association.**
 - David Marcus (Co-founder of Libra) was summoned to testify before the US Congress on the initiative, and Mark Zuckerberg is to testify before a House panel about Facebook's impact on the financial services sector.
 - France and Germany joined efforts against it: "no private entity can claim monetary power, which is inherent to the sovereignty of nations".
- We attended a **conference on Libra** at EPFL (Lausanne, CH) earlier this month, where our thesis found further support.
 - Jean-Pierre Danthine (former VP of the Swiss National Bank) stressed his view on how Libra is not the alternative currency the world is looking for.
 - Lamine Brahim (Taurus Group) highlighted Libra may be just a mean for Facebook to boost its currently low penetration rate in unbanked areas.
 - Bryan Ford (Associate Professor at EPFL) reviewed the technical aspects: Libra's innovations are few.



LIBRA (UN) CHAINED



SOURCE:
https://atonra.fra1.digitaloceanspaces.com/public/2019/07/09/libra_1pdiDXx.pdf
<https://medium.com/zenith-ventures/libra-a-governance-perspective-d1c2d9c87f65>

MOBILE PAYMENTS

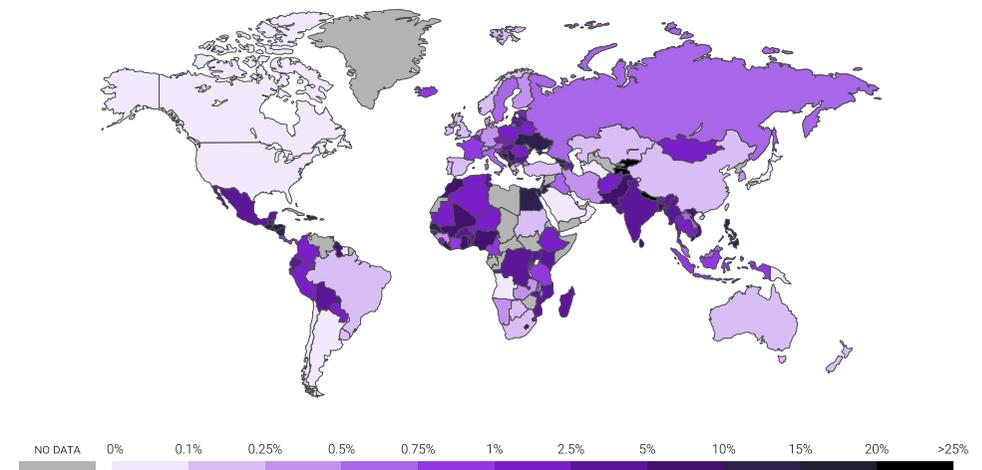
Headwinds From Every Corner

- Our research anticipated many topics of discussion raised from the project's launch onwards. Some of them we highlighted were:
 - Why **entrusting** a private entity with issuing money? What about **money laundering**? Can the Association become the new **monetary policy** maker?
 - How **independent** is the Libra Association and what role has its first supporter, Facebook (FB US)?
- **Regulatory and political concerns** took centerstage.
 - US Senators Brian Schatz and Sherrod Brown warned **Visa (V US)**, **Mastercard (MA US)**, and **Stripe (not listed)** of risks inherent in the project. In their letter, they suggested that an increased oversight from financial regulators was to be expected if they continued in the Libra Association – subsequently they withdraw from backing the project.
 - David Marcus stated that the Libra Association "has no intention of competing with any sovereign currencies or entering the monetary policy arena" during his 16th July testimony. Though, he did not provide many details about how the project would be managed and controlled.
- **Mobile payments** do not carry the same political and regulatory burden: they offer a mean of exchange, not its object. Their way to revolutionize the payments ecosystem does not threaten monetary authorities.
 - The world can already benefit from faster multicurrency transactions thanks to Revolut (not listed) and TransferWise (not listed), among others, and they do not raise concerns with **regulators**.

SOURCE:

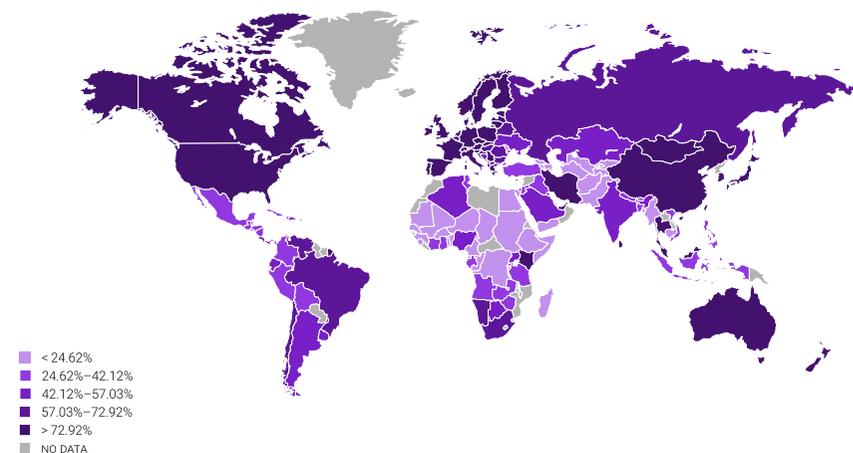
<https://www.theverge.com/2019/10/9/20906348/libra-association-visa-mastercard-stripe-blockchain-us-lawmakers-schatz-sherrod-brown>
<https://www.finma.ch/en/news/2019/09/20190911-mm-stable-coins/>
<https://www.banking.senate.gov/imo/media/doc/Marcus%20Testimony%207-16-19.pdf>
<https://ourworldindata.org/grapher/personal-remittances-received-of-gdp?time=1970..2017>
<https://cashesentials.org/app/uploads/2018/07/2018-world-cash-report.pdf>, p.27

PERSONAL REMITTANCES, RECEIVED (% OF GDP), 2015

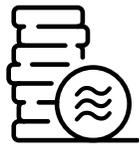


Personal remittances comprise personal transfers and compensation of employees. Personal transfers consist of all current transfers in cash or in kind made or received by resident households to or from nonresident households. Compensation of employees refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by nonresident entities.

ACCESS TO A BANK ACCOUNT (% OF POPULATION > AGE 15)



An example of Libra usage with Spotify



The Libra Association – an independent organization created by Facebook – mints the currency.



The association then distributes Libras through authorized sellers.



A consumer downloads a digital wallet from a new Facebook subsidiary called Calibra, then purchases Libras from an authorized seller's site.

The authorized seller exchanges the currency with the Libra Association, which then burns, or destroys, the currency

Spotify then exchanges the Libras that it received for dollars via a reseller.

The user uses Libras to make an online purchase, such as a subscription to Spotify, one of the corporate partners of the currency



SOURCE:

<https://www.wsj.com/articles/facebook-wanted-to-create-a-new-currency-it-wasnt-ready-for-the-backlash-11571242795?shareToken=st1e22ebcdf3c047ce8943a6961a284e2d>

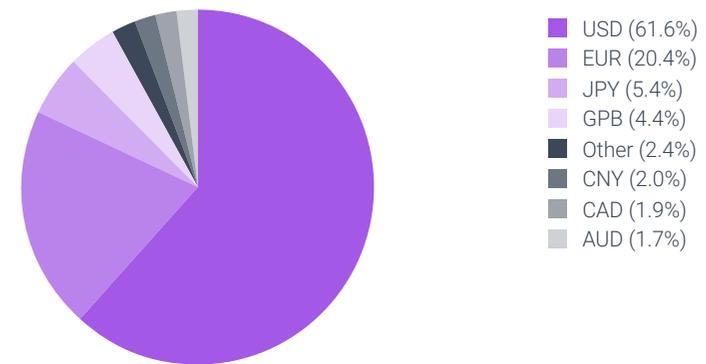
Libra – The Right Direction, But Not The Best Match

- As we mentioned in our research report, Libra wants to be the next **standardized currency**. It looks like more of a marketing boast than something real.
 - As of 2Q19, US Dollar accounts for 61.63% of worldwide reserves.
 - Mark Carney (Bank of England) says that he was keeping "an open mind but not an open door to Libra". While recognising the slowness and inefficiencies featuring the financial system, he proposed a Libra-like coin issued by central bankers.
- Jean-Pierre Danthine agreed on Mark Carney's view that central banks have to take action. De-dollarizing the world economy is a step to be taken.
- Meanwhile, fast and cheap **mobile payments** alternatives have been **spreading fast**, and are projected to overtake credit card and cash usage by 2021.
 - Japan recently raised its consumer tax to 10% from 8% – this is offset by a 5% reduction for consumers using digital means of payments at the smaller retailers.
 - Italy is considering to add VAT rebates for purchases made to small merchants through mobile payments methods. At the same time, cash payments would be burdened by a VAT increase.
- Moreover, data security and privacy guarantee are key components of the debate. Although Libra stated its independency, its ties to Facebook are clear and not boding well for gaining support from the public opinion or the authorities.

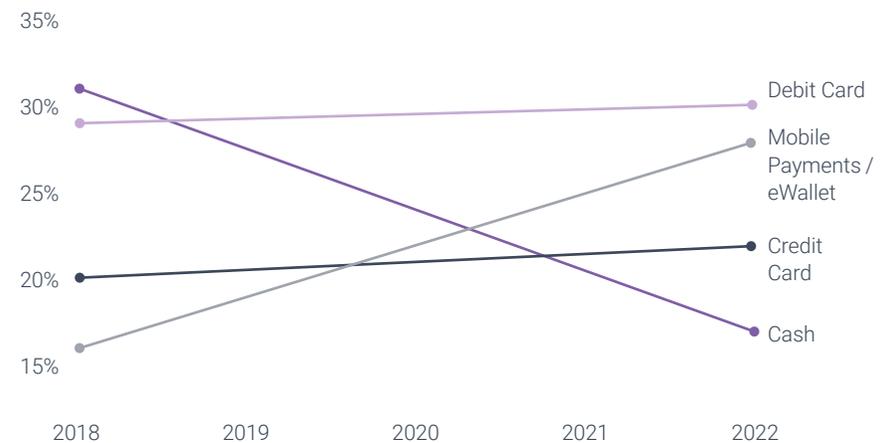
SOURCE:

<https://www.cnbc.com/2019/06/21/bank-of-england-mark-carney-on-facebooks-libra-uk-digital-economy.html>
<https://www.businesswire.com/news/home/20190206005268/en/Brazil-Mobile-Wallet-Payment-Market-Opportunities-Databook>
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<https://www.businesswire.com/news/home/20190528005636/en/Italy-Mobile-Wallet-Payment-Market-Opportunities-Databook>
<http://data.imf.org/?sk=E6A5F467-C14B-4AA8-9F6D-5A09EC4E62A4>
<https://www.merchantsavvy.co.uk/mobile-payment-stats-trends/>

WORLD – ALLOCATED RESERVES BY CURRENCY FOR 2019 Q2



GLOBAL SHARE OF POINT OF SALE PAYMENT METHODS



Catalysts:

- **Fast, cheap and universally accessible means of payments.** That is what Libra aims to offer. Mobile Payments are already serving the purpose while not raising the same scrutiny from the authorities.
- **Political power pushing for a cashless society.** The black economy would emerge as payments would be traced and therefore easier to monitor.
- **Adoption to further push adoption.** Trust in mobile payments spreads among sceptical potential users as many others embrace the technology.
 - Global use of Mobile Payments at point of sale is forecast to increase to 28% in 2022 from 16% in 2018, surpassing credit cards and cash.
 - Cash usage at point of sale is expected to shrink to 17% in 2022 from more than 30% in 2018.
- **Tech players entering the mobile payments business.** They will facilitate adoption to smartphone users. One of the latest examples is the partnership between Apple (AAPL US) and Goldman Sachs (GS US) to launch the Apple card.

Risks:

- **Libra may be a threat in the long-run.** It may threaten mobile payments by being their substitute, but in the short-term it will raise awareness on their importance.
- **Competition is increasing at a local level.** Within the mobile payments field, international players are spreading to many local niche markets, and consolidation is happening at a global scale.
- **Other projects are ongoing.** An open blockchain project (Venus) has been initiated by Binance (global cryptocurrency exchange) to develop localized stablecoins (and digital assets) pegged to fiat currencies around the globe.

Bottom Line:

- Libra wants to offer fast, cheap, safe transactions. Mobile payments are already serving that purpose without alarming the world economic and regulatory frameworks.
- As Libra's white paper was published this summer, throughout our research report we concluded that it is visionary but could not be enacted as proposed.
- Countries are pushing toward a cashless society.
- We believe that the next big thing will come from central banks themselves which are likely to issue digital currencies themselves and change the current banking landscape as we know it. We would cover this particular topic in our next Investment Recipes.
- The Fintech and Mobile Payments certificates have substantial exposure to names that are to benefit from this trend. The highest weighting are in **PagSeguro (PAGS US), GMO Payments (3769 JP), and Square (SQ US).**

TAILWINDS FOR THE BANKING SOFTWARE INDUSTRY

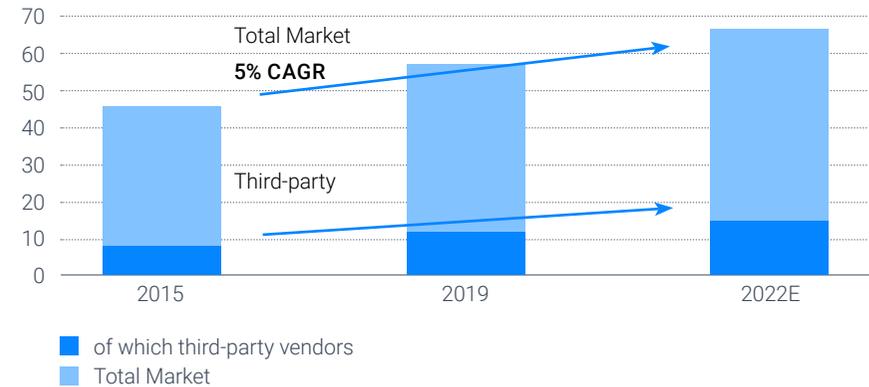
Banks Digital Transformation in Numbers

- Banks must either **pursue a digital transformation or disappear**. Margins are under pressure. They have to reduce costs while adapting to new and costly regulations.
- According to UBS, the total IT budget (software, hardware, personnel, etc.) of U.S. banks is estimated at \$67bn for 2019.
 - **JPMorgan (JPM US), Bank of America (BAC US), and Wells Fargo (WFC US)** lead the way, with IT budgets reaching \$11.4bn, \$10.0bn, and \$9.0bn respectively.
- According to **Temenos (TEMN SW)**, banks are expected to spend globally **\$57bn on software in 2019**, and this market is expected to grow at a CAGR of 5% over the next three years.
 - 80% of these expenses are still allocated to the in-house maintenance of legacy systems.
 - The U.S. is the largest market in the world, accounting for approx. 40% of the total banking software expenses.
- By switching to third-party software instead of in-house solutions, banks and financial institutions **can reduce costs, increase spending on innovation, and reduce time to market** for new products.
 - Third-party developers are **gaining market shares** compared to in-house banking software. This market is expected to grow at a CAGR of 8% over the next three years.
 - Even tier-1 players must rely on third-party products to implement the latest technology trends like cloud computing, big data, machine learning, chatbots and Robo-advisors, distributed ledgers, APIs, mobile and internet banking, etc.

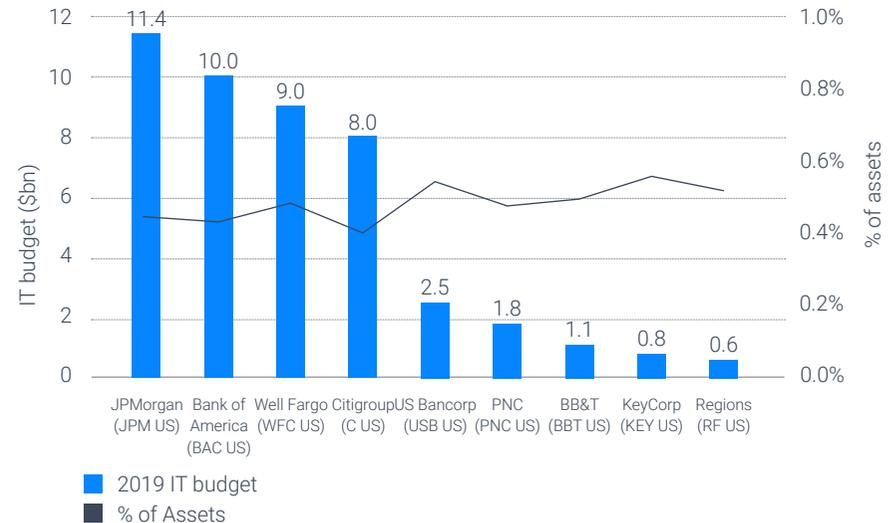
SOURCES:

UBS Evidence Lab Insider: IT survey suggests size matters, March 2019 / Temenos 2018 Annual report, AtonRâ Partners

BANKING SOFTWARE MARKET



2019 IT BUDGET OF US BANKS



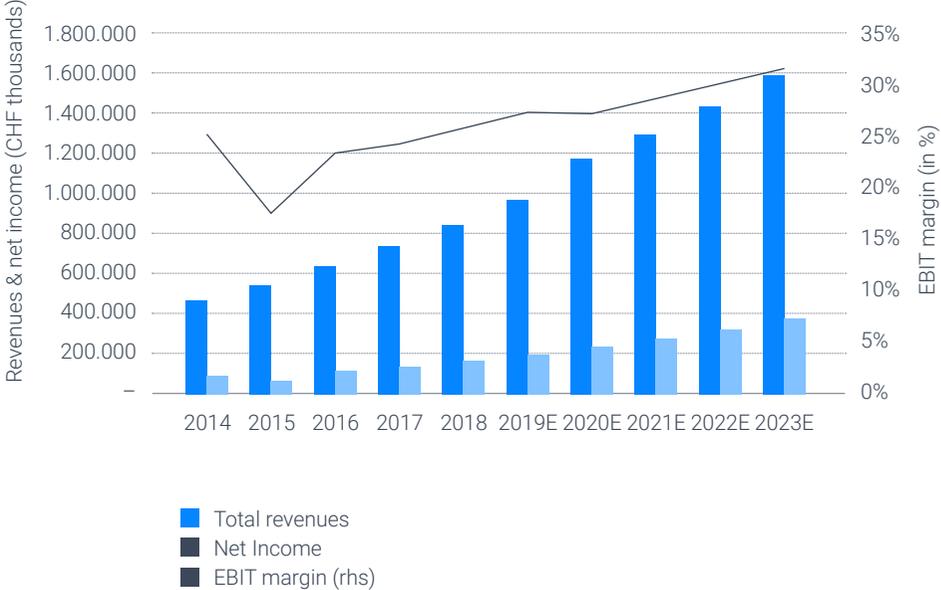
Temenos, the world's #1 banking software

- Among the pure players, **Temenos (TEMN SW)** offers one of the **most comprehensive product portfolios**.
 - The company has invested \$1.9bn in R&D between 1990 and 2018, or about 20% of revenue each year, twice the level of its peers.
 - A flexible solution with over 700 APIs developed to match the clients' needs.
- The company expects total revenues to grow at a **CAGR of 10-15%**, well above the third-party banking software market's 8% CAGR. Profitability is also on a rising trend.
 - With a market share of 16% on core banking systems and 5% on other financial programs, the company has still room to grow.
 - Temenos is winning more new customers than its competitors. Recent wins include **PayPal (PYPL US)**, **KuniFin (non listed)** in Finland, or **TSB Bank (non listed)** in New Zealand.
- The **acquisition of Kony** (non listed) announced end August 2019, will significantly increase revenues and market presence in the U.S.
 - Kony is the #1 digital banking Software-as-a-Service (SaaS) provider in the U.S., and will enhance Temenos' digital front-office platform, Temenos Infinity.
- **Quarterly bumps** cannot be ruled out. In its Q3 2019 results, Temenos confirmed its guidance, despite lower software licensing revenues (+7% Y/Y vs +15% expected).
 - The shift to software-as-a-service (SaaS) (+93% Y/Y) may hurt the top line initially, but will provide better visibility down the road.
 - Investors should focus on the long-term potential of the company, keeping in mind the steady migration of financial institutions to packaged software.

Quick facts

- Based in Geneva, Switzerland
- Approx. 5,800 employees
- Founded in 1993, listed since 2001
- World's #1 banking software
- More than 3,000 clients in 150 countries, including 41 of the top 50 banks

TEMENOS FINANCIALS



SOURCES:
AtonRā Partners, Temenos 2018 Annual Report

A Fragmented Competitive Landscape

Despite its leading position in the banking software industry, Temenos must face competition from different kind of players.

International Players

- Revenues estimated in the range of \$400-700mn on core banking software. Indian companies have a strong presence in APAC.
- Core banking software is not the primary source of revenues for these large companies. If profitability decreases, the banking software activities will be shut down.



U.S. legacy players

- Inorganic growth favored in the past: These companies have different core banking offerings, which slows down innovation.



Regional players

- Focus on small area, not adapted for international groups;
- Lagging innovation, these companies often copy what the larger developers do.



International Pure Players

Temenos has a larger client base and is more open – easy integration of APIs.



New Entrants

- Cloud-based solutions, no need to deal with legacy systems.
- Currently not able to match requirements of tier-1 and tier-2 banks – too sophisticated.
- Focus on frontier markets and microfinance organizations.
- Eventually M&A targets.



NON-EXHAUSTIVE LIST OF BANKING SOFTWARE PROVIDERS

Catalysts:

- **Disruptive technology.** Payments and trade finance transactions are moving to distributed ledger technology. Millennials bank on their smartphones. Artificial intelligence fights money laundering. For banks, it is an adapt or die situation.
- **New regulations.** Basel III, Mifid II, FIDLEG, AEOI, etc. are introducing new requirements and standards that banks cannot comply with by using their legacy software.
- **Legacy software.** Banks are still using software developed decades ago. Their replacement will boost the software industry.
- **Newcomers.** N26, Revolut, or Robinhood are shaking up the banking sector but are also increasing the total addressable market, notably the unbanked. Legacy banks must invest in technology if they want to remain competitive.

Risks:

- **Research & Development.** By using third-party packages, banks are transferring part of the innovation to the software developers. The latter need to invest substantial amount in R&D to maintain a competitive advantage and to offer what the banks and the end-users need.
- **Low barriers to entry in the software industry.** Open standards and architectures are a threat.
- **Cybersecurity.** Financial institutions deal with sensitive data. Data theft could cause reputational damage to the software developers.

Bottom line:

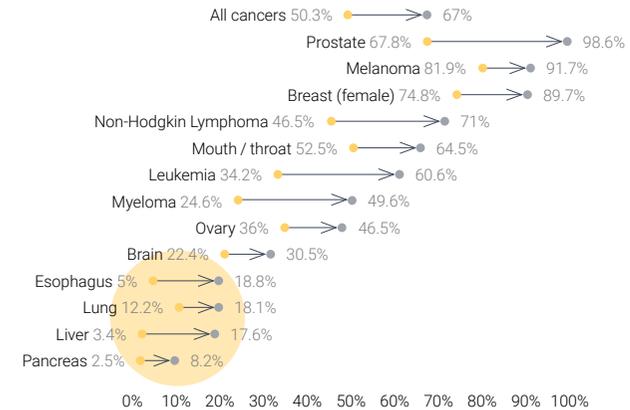
- Banks face an existential crisis and must undergo significant IT investments to remain competitive.
- The banking software industry represents an interesting investment opportunity, given the expected double-digit growth rates for the market leaders. Strong visibility on long-term earnings (thanks to recurring revenues) is a significant catalyst.
- We favor Temenos following the acquisition of Kony, a U.S. cloud-based solution provider.

HARD-TO-TREAT CANCERS: THE FIGHT HAS JUST BEGUN!

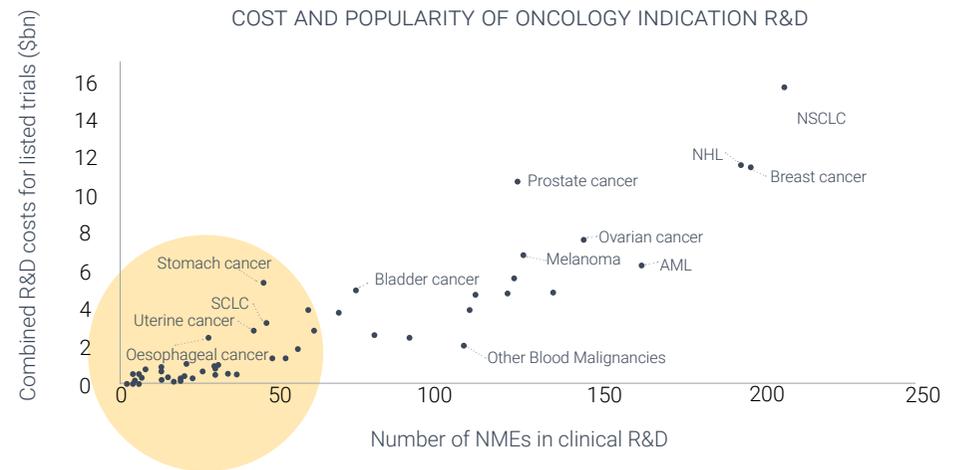
Cancer-fighting continues to offer appealing investment opportunities

- The war against cancer is not over, even if some battles have been won.
 - Cancer incidence and **absolute number of deaths keep rising**: cancer-related deaths have gone from 5.7mn in 1990 to 8.9mn in 2016.
- Over the last forty years, the survival rate has doubled – unfortunately, **unequally among cancers**.
 - In recent years, there have been several success stories about improved survival rates.
 - In four types of cancer, though, **survival rates have barely improved**: lung, pancreatic, esophageal cancers, and brain tumors.
- There has been little work on difficult-to-treat cancers, and only a few drugs have been developed in this area.
 - Recent discoveries about new mechanisms of action and targets have **boosted interest**.
- Oncology is the largest segment** in the biotech & pharma sector – according to Evaluate Pharma, oncology sales in 2018 represented 14.3% of the \$864bn total market.
- In this crowded space, companies working on "niche" cancers with innovative therapies show a real **competitive advantage and higher expected growth** than conventional oncology companies.

FIVE-YEAR CANCER SURVIVAL RATES IN THE USA



This five-year interval indicates the percentage of people who live longer than five years following diagnosis.



SOURCES:
 TBDI | JNCI: Journal of the National Cancer Institute | ASCO: American Society of Clinical Oncology
 Cancer.net | EvaluatePharma Vision | https://www.evaluate.com/sites/default/files/cancer%20cost%20and%20pop_0.PNG
<https://ourworldindata.org/uploads/2018/03/Five-year-cancer-survival-rates-USA-v2-01-750x550.png>

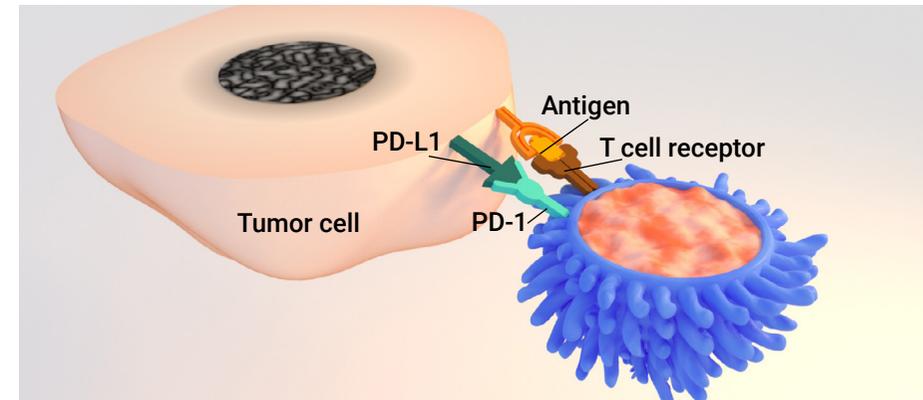
Different types, different fights!

- A **"too-late" diagnosis** is the first reason why some cancers are difficult to treat.
 - The pancreas and esophagus are hidden behind other organs, and their respective tumors are hard to spot.
 - Small-cell lung cancer **cells spread very quickly** outside the lungs (metastasize).
- A **low immune response from "cold tumors"** is the second reason.
 - Researchers classify tumors as hot or cold.
 - "Hot" tumors (e.g., melanoma) produce unusual antigens that the T-cells (i.e., immune-defense cells) can more easily recognize and attack.
 - "Cold" tumors (e.g., pancreatic cancer) don't express antigens, therefore cause a low immune response and make checkpoint inhibitors (currently the most promising development in immuno-oncology) way less effective.
- The key is to turn "cold tumors" into "hot tumors" through new immuno-oncology strategies that stimulate the immune response and make checkpoint inhibitors effective again.

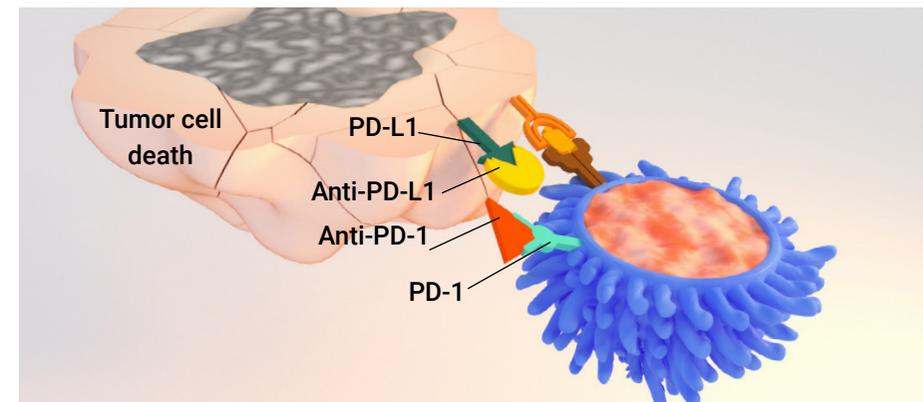
SOURCE:
<https://siteman.wustl.edu/wp-content/uploads/ncipdq-media/CDR0000774646.jpg>

HOW DO CHECKPOINT INHIBITORS WORK?

PD-L1 / PD-1 binding inhibits T cell killing of tumor cell



Blocking PD-L1 or PD-1 allows T cell killing of tumor cell



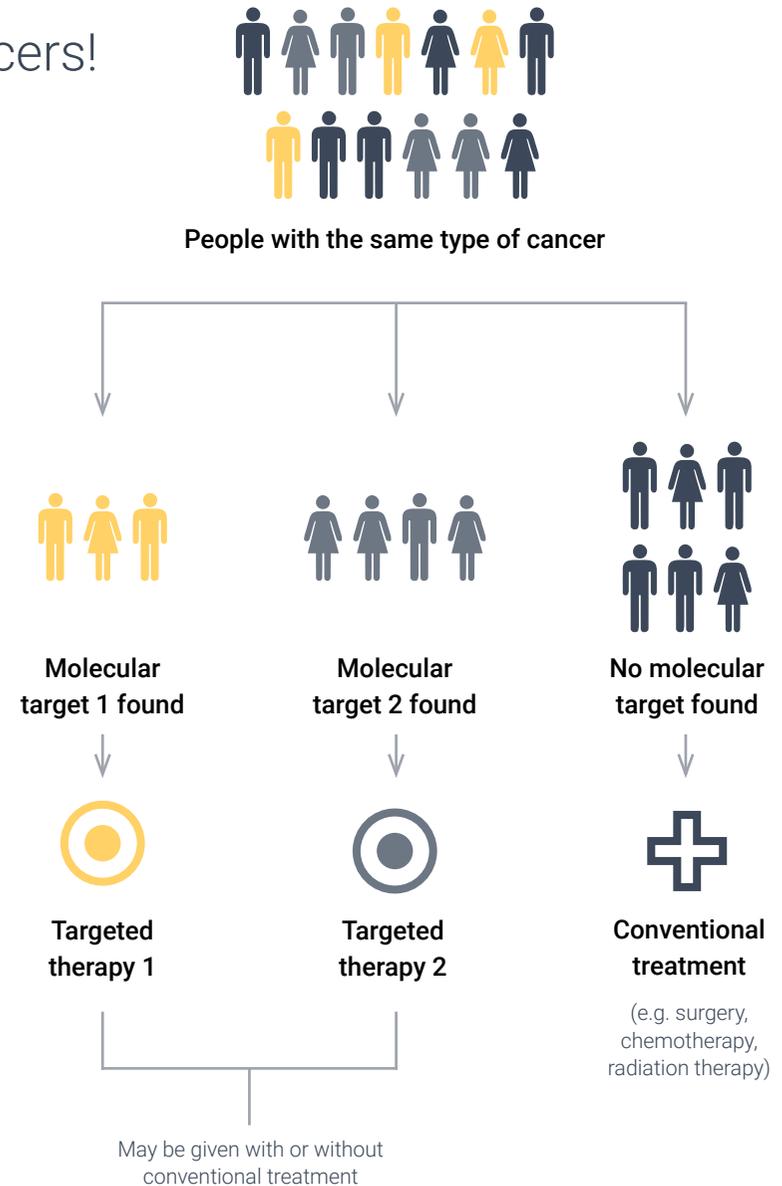
Combining immuno-oncology strategies with checkpoint inhibitors

Vaccines	Designed to stimulate an immune response, encouraging the immune system to attack cancer cells	Moderna (MRNA US), BioNTech (BNTX US) , Translate Bio (TBIO US), CureVac (Not listed)
Adoptive cell therapy	CAR-T cell: Adoptive cell therapy takes a patient's own immune cells, expands or otherwise modifies them, and then reintroduces them to the patient, where they can seek out and eliminate cancer cells.	Celgene (CELG US), Mustang Biotech (MBO US), Bluebird Bio (BLUE US)
Immunomodulateur	Control the "brakes" and "gas pedals" of the immune system.	Incyte (INCY US), Ionis, Heat Biologics (HTBX US), Boehringer Ingelheim (Not listed)
Oncolytic virus therapy	Uses modified viruses that can infect tumor cells and cause them to self-destruct. This can attract the attention of immune cells to eliminate the main tumor.	Amgen (AMGN US), Transgene (TNG FR), PsiOxus (Not listed), Replimune (REPL US), Turnstone Biologics (Not listed)
Bispecific Antibodies	Engineered hybrid molecules with two distinct binding domains. By forcing tumor cells and T cells together, bispecifics can incite an immune attack on cancer.	Amgen (AMGN US), Roche (ROG SW), MacroGenics (MGNX US), Regeneron Pharmaceutical (REGN US), Xencor (XNCR US)

SOURCES:
TBDI | <https://www.cancer.gov>

Targeted Therapies: The Hope To Beat ALL cancers!

- With hard-to-treat cancers, a **key issue is early detection**: once the disease spreads to other organs, it is often too late. Understanding how different types of cancer cells grow and spread across the body is essential.
 - Improvement of **diagnosis tools (genetic tests)** will increase the number of patients diagnosed in difficult-to-treat cancers.
- Targeted therapies identify and target **tumor-specific genetic mutations**.
 - Mutations in a gene called **KRAS** characterize some pancreatic and esophageal cancers subtypes. The mutated gene sends signals that lead to abnormal cell division. Mirati **Therapeutics (MRTX US)**, Amgen (**AMGN US**), and Novartis (**NOVN SW**) have compounds inhibiting KRAS mutated gene.
 - The **TP53 mutated gene** is vastly present in pancreatic, small cell lung, ovarian, breast and esophageal cancers. **Aprea Therapeutics (APRE US)**, which did its IPO in of October 2019, targets the P53 protein.
 - Hard-to-treat cancers with specific genetic mutations will benefit from the development of “**tissue agnostic**” treatments (based on a common gene mutation across different tumors rather than the primary location). **Larotrectinib**, developed by **Loxo Oncology** (acquired by **Elli Lilly (LLY US)**) was approved in 2018 for several indications, including difficult cancers.



SOURCE:
<https://www.cancerouncil.com.au/wp-content/uploads/2018/06/targeted-therapies-diagram.png>

HARD-TO-TREAT CANCERS: THE FIGHT HAS JUST BEGUN!

Catalysts:

- **A top priority.** Due to high medical need, hard-to-treat cancers benefit from a strong inflow of financial resources.
- **A better diagnosis.** The mapping of difficult-to-treat cancer genes associated with genetic tests will help to identify new drug targets and increase the number of diagnosed patients.
- **High M&A activity.** To enhance the efficacy of treatments on these types of cancers, the best approach is combination therapies between innovative and existing drugs. The need to collaborate between companies leads to more M&A and partnerships.
- **Adaptive trials.** New oncology clinical trials are designed to adapt to improved understanding of cancer genetics and could extend existing indications to hard-to-treat cancers.
 - In basket trials, for example, drugs are being evaluated on cancers that have a similar genetic mutation rather than the same location.

Risks:

- **Plenty of innovative but uncertain approaches.** Trials could be stopped due to unpredictable clinical outcomes.
- **Difficult patient recruitment.** During clinical trials, patients retention is complicated by the low survival rates in these types of cancers.
- **A competitive therapeutic area.** The oncology field is a crowded space with many compounds currently in development.

Bottom line:

- Cancer **prevalence is expected to double** over the next two decades, and, although **survival rates have improved**, some cancers remain very challenging to treat because of their location in the body and other specificities.
- Biotech companies are now turning on cancers with an unmet need and where there is **still room for improvement**.
 - **Exciting opportunities** in targeted therapies and new immuno-oncology agents are emerging among several biotechnology companies.
- We focus on biotechnology companies like **Blueprint Medicines (BPMC US)** and **Moderna (MRNA US)**, which develop molecules in new indications with less competition. Their products could be on the market within the next 2 to 5 years.
- We are also investing in companies manufacturing genetic tests like **Invitae (NVTA US)**, that are helping the **early diagnosis** of cancer.

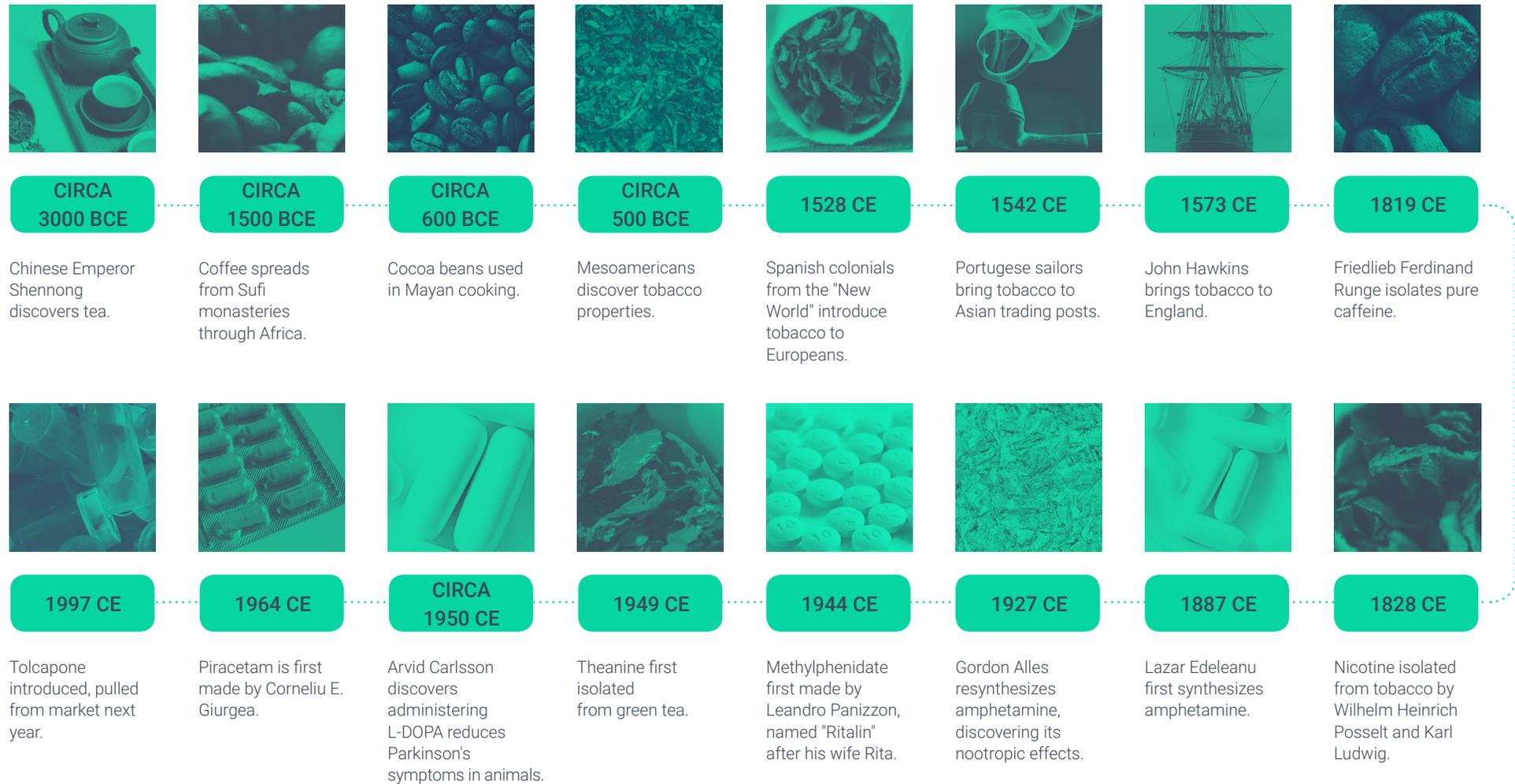
NOOTROPICS: A BOOST TO OUR BRAIN POWER

What Are Nootropics?

- In the fast-growing **brain enhancement market**, we identified natural nootropics as an interesting opportunity for the larger pharma companies willing to enter this market. This market is dominated by privately owned players.
- **The term "nootropics" was coined in the 1970s** by chemist Corneliu E. Giurge. He was trying to invent a sleeping pill but instead ended up synthesizing a substance, piracetam, able to modulate cognitive function, that he called nootropic.
- The term **nootropics** refers to chemicals able to **enhance cognitive functions** such as concentration, memory, motivation, productivity, creativity, etc.
- Nootropics are often classified in two categories:
 - **Natural nootropics:** Usually sold on their own or as dietary supplements (a blend of different brain enhancers available in various forms including powder, pills, liquid, capsules and snacks). Some examples include Lion's Mane, Caffeine, L-theanine, Panax ginseng, Ginkgo biloba, Bacopa monnieri, and Rhodiola rosea, CBD, Tryptophan, and Huperzine.
 - **Prescribed smart drugs:** Substances approved for the treatment of different brain disorders such as Alzheimer's, Attention Deficit Hyperactivity Disorder (ADHD) and sleep disorders. Modafinil and Adrafinil by **TEVA Pharmaceuticals (TEVA:US)**, Ritalin by **Novartis AG (NOVN:SW)**, and Aderall by **Shire PCL (SHP:LN)**.



Notable moments in nootropic history

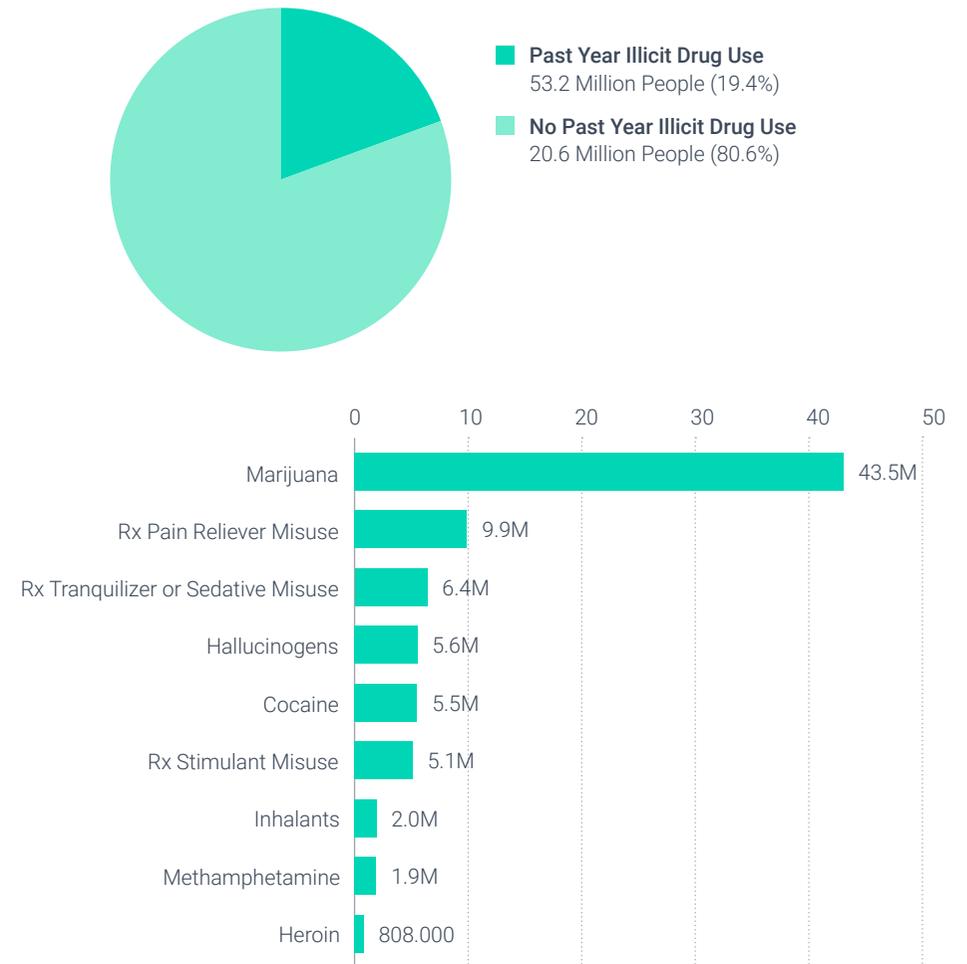


SOURCE:
<https://keepbizzy.com/wp-content/uploads/2019/05/History-of-Nootropics.jpg>

Potential & limits

- Natural nootropics have been rising in popularity among healthy individuals.
- They appeal mainly to students, chief executives and athletes, willing to boost creativity and productivity in a competitive environment.
- As of 2017, 1.8mn of Americans use ginseng and more than 296mn consume caffeine each day.
- Prescribed smart drugs have a more powerful effect, and a growing number of people is turning to these substances.
- As of 2018, according to the American Journal of Psychiatry, prescribed smart drugs were used by 16 million Americans over the age of 18 and approximately 5mn people aged 12 or older were using them illegally.
- Prescribed smart drugs have strong side effects and they should be taken only by a selected sick population for whom the benefits outweigh the potential risks.
- Most of natural nootropics have been consumed for hundreds of years and, at low doses, rarely caused side effects. Problems have arisen when these substances were taken in combination with non compatible pharmaceutical drugs or when contaminated with heavy metals.
 - Today most of the companies selling natural nootropics **are in compliance** with Good Manufacturing Practices (GMP).
 - Small pilot trials have shown natural nootropics' ability to improve cognitive function without the negative side effects of prescription smart drugs, but companies **still need to provide reliable research results** to prove efficacy and long term effects.

PAST YEAR ILLICIT DRUG USE AMONG PEOPLE AGED 12 OR OLDER: 2018



SOURCE:

https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/NSDUHffrBriefingSlides2018_w-final-cover.pdf

<https://pubchem.ncbi.nlm.nih.gov/compound/L-Theanine>

https://www.researchgate.net/publication/312205756_Structures_biological_activities_and_industrial_applications_of_the_polysaccharides_from_Hericium_erinaceus_Lion's_Mane_mushroom_A_review

Catalysts:

- **A rising trend among healthy people.** Nootropics are increasingly used for academic, professional and athletic success.
- **Easy accessibility and relatively low price.** Natural nootropics sold as dietary supplements for lower than 100\$ per month, are easily available online.
- **Increasing consumer spending on wellness products.** The increasing interest in wellness products is expected to boost the product demand.
- **Large-scale research.** Solid data demonstrating product's efficacy and long term effects could help dissipate concerns.
- **Agreements with large retailers.** Agreements with large retailers, such as Walmart and Amazon are allowing nootropics companies to reach mass audience.

Risks:

- **Lack of solid research.** The brain circuits involved in human cognition are very complicated and not fully understood. This makes difficult to prove nootropics' clinical value and safety.
 - Nootropics' benefit is believed to be linked to a placebo effect.
- **Lack of intellectual property protection.** Nootropics companies will need to build their intellectual property in order to have an edge on their competitors.
- **Nootropics supplements are not regulated.** Some companies have been identified as having misleading ingredients and illegal marketing, increasing the already existing skepticism over these products.
 - Federal Trade Commission is currently penalizing nootropics businesses for disclosing unproved scientific data of their products .

Bottom line:

- Some scientific studies have proved **natural nootropics' efficacy and short term effects.**
 - However, large scale trials and solid intellectual property are necessary for this market to take off.
- Global nootropics supplements **market is huge and potentially limitless** as these substances are not regulated.
 - According to Market Insider, it is expected to reach **\$11bn by 2024 at a CAGR of 20%** (2016–2024).
- **Companies** in this sector are still private and might be for sure on the target list of larger pharma or nutrients companies.
 - Some nootropics players we monitor are **Neurohacker Collective** (not listed), **TruBrain** (not listed), **Koios Beverage** (not listed), **Cognitive Clarity** (not listed), **Nootrobox** (not listed)

“DE-AMERICANIZATION” OF THE CHINESE TECH INDUSTRY

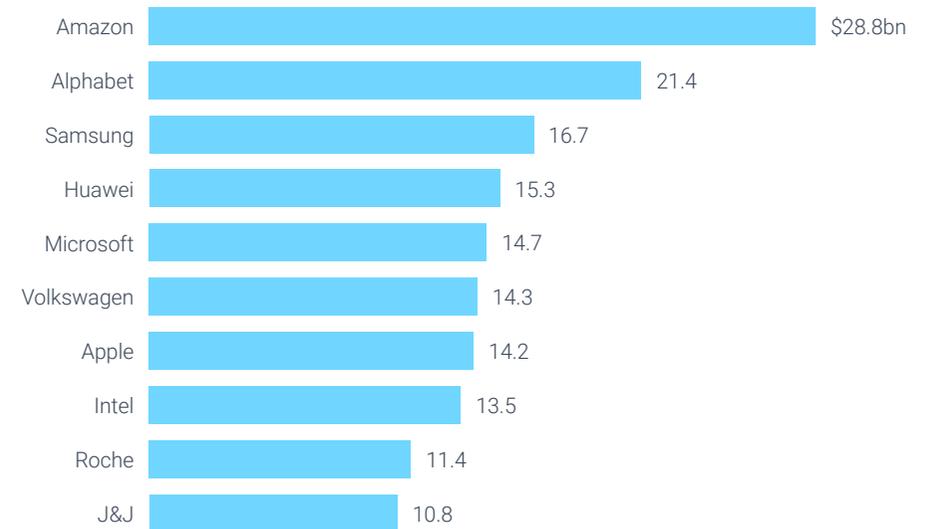
Is China Closing The Technological Gap With The United States?

- “Made in China 2025” is the official plan laid out by Chinese authorities to ensure the country becomes independent in terms of overall technology – and the first results are showing.
 - The Council of Foreign Relations (CFR), a U.S.-based think tank, reported that China is taking the lead in technology-rich fields like Artificial Intelligence (AI), robotics, energy storage, 5G cellular network, and possibly biotechnology.
 - By the end of 2018, Chinese companies filed over 1/3 of worldwide applications for major patents concerning 5G technology.
 - According to the MIT Technology Review, China has produced more research papers on deep learning per year than any other nation
 - Five of the top global machine-learning universities are in China.
- According to Bloomberg, in 2018, Chinese **Huawei (not listed)** ranked 4th in global R&D spending, behind only **Amazon (AMZN US)**, **Alphabet (GOOGL US)**, and **Samsung (5930 KS)**.
 - Huawei’s R&D spending was >\$15bn, having doubled over the last five years.

SOURCES:

<https://www.cfr.org/>
<https://asia.nikkei.com/Spotlight/5G-networks/China-in-pole-position-for-5G-era-with-a-third-of-key-patents>
<https://multimedia.scmp.com/news/china/article/2166148/china-2025-artificial-intelligence/index.html>
<https://mit-insights.ai/region/china/>
<https://www.bloomberg.com/news/articles/2019-04-25/huawei-s-r-d-spending-balloons-as-u-s-tensions-flare-over-5g>

INVESTMENT IN INNOVATION – R&D EXPENSES 2018

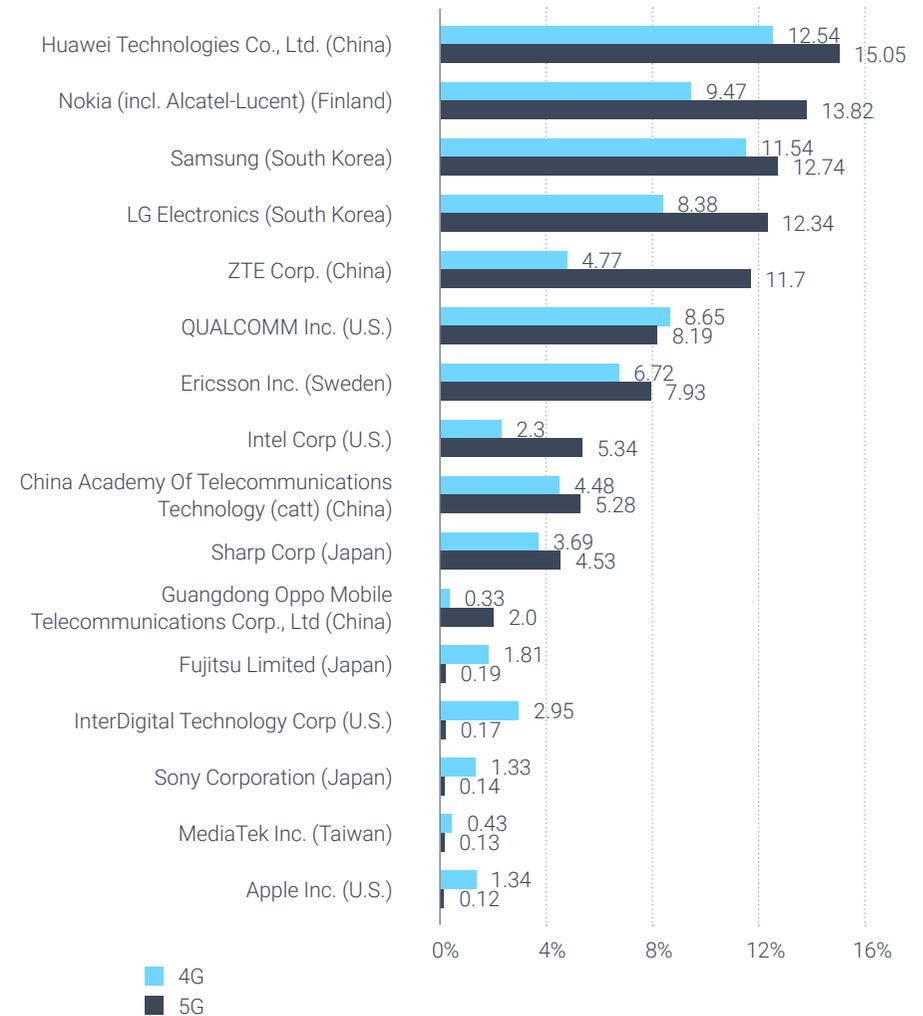


Amazon leads world in R&D spending, China's Huawei jumps to fourth.

China’s focus is on the semiconductors industry

- The "Made in China" strategic plan targets to increase self-sufficiency in integrated circuits' (IC) production to 40% in 2020 and 70% by 2025.
- Chinese government established the China Integrated Circuit Industry Investment Fund (CICIIF, or "Big Fund") to promote developments in semiconductor design and manufacturing.
 - Beijing envisioned spending more than \$150bn over ten years.
 - In the first round, the Big Fund invested in more than 70 projects and companies, including **Tongfu Microelectronics (002156 CH)**, a maker of ICs, **JCET (600584:CH)**, a world leader in packaging and testing, and **SMIC (981 HK)**, mainland China's largest foundry.
 - New investments will likely be more focused on applications in the downstream supply chain of the semiconductor industry, such as chip design, advanced materials, and tools and equipment.
- The Chinese Big Fund is not targeting R&D as such, but rather expanding fab capacity, and aiming at increasing sales volumes and thus potential future R&D expenses.
 - Huawei has already responded to the trade war by pumping up its 2019 R&D budget to nearly \$18bn, a 20% increase over 2018.
- Despite all this, the total R&D spending of Chinese companies still lags significantly behind that of the U.S. ones.

KEY PATENT HOLDERS FOR 4G AND 5G TECHNOLOGIES (% OF TOTAL FILINGS)



SOURCE: <https://asia.nikkei.com/Spotlight/5G-networks/China-in-pole-position-for-5G-era-with-a-third-of-key-patents>

Semiconductor and semiconductor equipment top 5 investments by private equity firms

M&A (2014–2018)		Announcement	
Target	Buyer	Date	Gross Transaction Value (\$M)
Trina Solar Ltd.	Shanghai Xingsheng Equity Investment & Management Co. Ltd.	12/14/15	2,480.6
Sanan Optoelectronics Co. Ltd	National Integrated Circuit Industry Investment Fund Co. Ltd.	06/15/15	779.4
Montage Technology Group Ltd.	Shanghai Pudong Science and Technology Investment Co. Ltd.; China Electronics Investment Holdings Ltd.	03/10/14	700.1
Shenzhen Goodbx Technology Co. Ltd.	Huaxin Investment Management Co. Ltd.	11/22/17	427.9
GigaDevice Semiconductor (Beijing) Inc.	Shaanx International Trust Co. Ltd.; National Integrated Circuit Industry Investment Fund Co. Ltd.	08/29/17	362.4

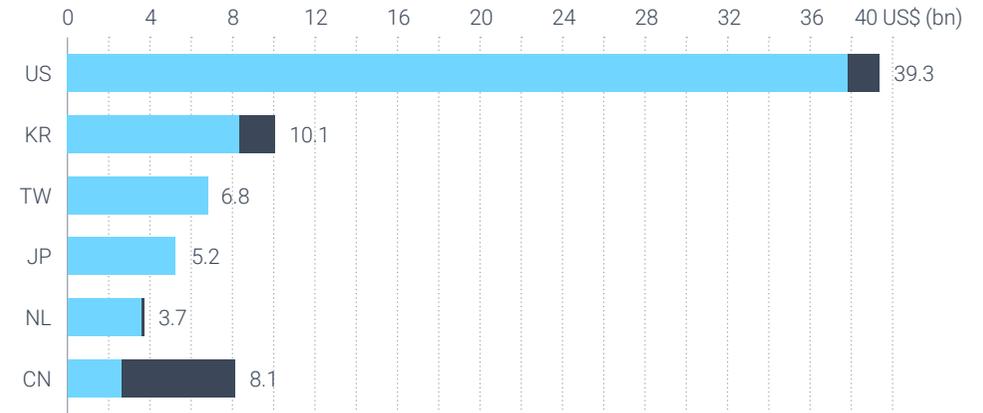
PRIVATE PLACEMENTS (2014–2018)		Announcement	
Target	Investor	Date	Transaction Size (\$M)
TSI NG HUA UNIGROUP CO. Ltd	China Development Bank; Huaxin Investment Management Co. Ltd.	03/28/17	22,524.2
Semiconductor Manufacturing North China (Beijing) Corp.	Semiconductor Manufacturing International Corp.; Semiconductor Manufacturing International (Beijing) Corp.; Beijing E-Town International Investment & Development Co. Ltd.; Huaxin Investment Management Co. Ltd.; SMIC Holdings Corp.	08/10/17	2,400.0
TSINGHUA UNIGROUP CO. Ltd	Huaxin Investment Management Co. Ltd.	02/13/15	1,602.5
Beijing Yandong Microelectronic Co. Ltd.	Beijing Electronics Holding Co. Ltd.; Beijing Electronics Zone Investment and Development Co. Ltd.; Beijing E-Town International Investment F21 Development Co. Ltd.; National Integrated Circuit Industry Investment Fund Co. Ltd.; Yancheng High-Tech Zone Investment Group Co. Ltd.; Beijing Jing Guorui State-owned Enterprise Reform and Development Fund	03/28/18	582.3
Jiangsu Changjiang Electronics Technology Co. Ltd.	Siltech Semiconductor (Shanghai) Corp. Ltd.; National Integrated Circuit Industry Investment Fund Co. Ltd.; Xing Yin Investment Co. Ltd.; Wuxi Jintou Capital Management Co. Ltd.; Suzhou Mochuang Enterprise Management Co. Ltd.	09/28/17	528.8

DATA COMPILED FEB. 26, 2019. GROSS TRANSACTION VALUE = SUM OR TOTAL CONSIDERATION TO SHAREHOLDERS, TOTAL OTHER CONSIDERATION, TOTAL EAMOUT/CONTINGENT PAYMENTS, TOTAL RIGHTS / WARRANTS / OPTIONS, NET ASSUMED LIABILITIES, ADJUSTMENT SIZE CASH AND SHORT-TERM INVESTMENTS | ANALYSIS INCLUDES ALL ANNOUNCED AND COMPLETED PRIVATE PLACEMENTS AND M&A ACTIVITY IN THE CHINESE SEMICONDUCTOR AND SEMICONDUCTOR EQUIPMENT INDUSTRY BY PRIVATE EQUITY AND VENTURE CAPITAL FIRMS FROM JAN. 1, 2014, TO DEC. 31, 2018. | HISTORICAL CONVERSION RATE USED. | SOURCE: S&PGLOBAL MARKET INTELLIGENCE

SOURCE:
<https://www.spglobal.com/marketintelligence/en/news-insights/trending/oqa4mdnwsjfv7y3auyd1aq2>

Industry and Government Spending on Semiconductor R&D

US	Intel, Qualcomm, Broadcom, Nvidia, Micron, Applied Materials, Texas Instruments, AMD, Lam Research, Marvell, Xilinx, ON Semi, KLA, Maxim Integrated, Cypress, Teradyne, Amkor (17)
KR	Samsung, SK Hynix (2)
TW	TSMC, ASE Technology Holding, MediaTek, UMC, Realtek, Novatek, Winbond, Nanya (8)
JP	Renesas, Sony Semiconductor Solutions, Toshiba Memory, Tokyo Electron, Rohm Semiconductor, Advantest, Dainippon Screen (7)
NL	ASML, NXP, ASM International (3)
CN	HiSilicon, SMIC, UNISOC, JCET, Goodix, TFME, Tianshui Huatian, NAURA, HHGrace, GigaDevice, AMEC (11)



	US\$ bn / yr	US	KR	TW	JP	NL	CN	TOTAL
Industry	R&D expenses	37.8	8.4	6.8	5.2	3.6	2.6	64.4
	Sales	243.3	113.4	66.2	49.6	22.7	20.3	506.5
	R&D / Sales	16%	7%	10%	10%	16%	13%	13%
Government	Funding	1.5	1.7	N/A	N/A	0.1	5.5	8.8
Total R&D	(at least)	39.3	10.1	6.8	5.2	3.7	8.1	73.2

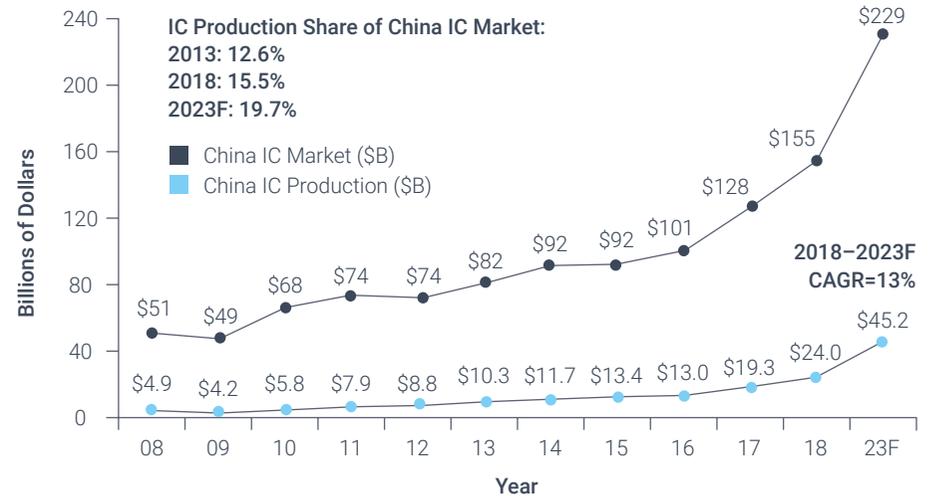
SOURCES:

- <https://semiwiki.com/general/274582-china-winning-the-future-of-the-semiconductor-industry>
- <https://www.cbinsights.com/investor/china-integrated-circuit-industry-investment-fund>
- <https://www.dealstreetasia.com/stories/china-ic-fund-second-funding-146994/>
- <https://semiwiki.com/general/274582-china-winning-the-future-of-the-semiconductor-industry/>

Plenty to catch up with!

- Domestic chip production in China is still lagging behind the long-term target.
 - In 2018, according to IC Insight, total chip production in China by Chinese headquartered companies accounted for only 4.2% of domestic demand.
- China needs fabs of foreign companies to reach its target of domestic production.
 - Including foreign companies' units manufactured in China, total domestic chip production rises to 15.5%.
- On the other hand, these companies need their revenues from China to be able to invest in R&D and keep innovating.
 - Combined revenues made in China by the leading semiconductor in 2018 has been 2.3x those from the U.S.

CHINA IC MARKET VS. CHINA IC PRODUCTION TRENDS



CHINA'S SEMICONDUCTOR TECHNOLOGY GAP WITH LEADING INTERNATIONAL SEMICONDUCTOR FIRMS, 1979–2018

Sales	Qualcomm 22.7		Micron 30.4		Broadcom 20.8		NXP 9.4		Texas Instr 15.8		Nvidia 11.7		Intel 70.8		SK Hynix 36.2		Total 217.8	
	(bn US\$)	US\$	%	US\$	%	US\$	%	US\$	%	US\$	%	US\$	%	US\$	%	US\$	%	US\$
China	15.1	67	17.4	57	10.3	49	3.4	36	7.0	44	2.8	24	18.8	27	14.1	39	88.9	41
US	0.60	3	3.6	12	2.7	13	0.9	10	2.3	14	1.5	13	14.3	20	12.8	35	38.7	18

YEAR	DOMESTIC CHINESE TECHNOLOGY	YEARS BEHIND
1979	25 mm to 30 mm wafers	16
1986	5 micron	14
1995	3 micron	19
1998	0.8 micron	10
2003	0.13 micron	1 to 2
2012	40 nm	1 to 2
2018	28 nm	1 to 2

SOURCE:
<https://semiwiki.com/general/274178-us-china-decoupling-and-the-semiconductor-industry-who-gets-hurt/>
<https://www.electronicweek.com/news/business/china-chip-competitiveness-decades-behind-industry-leaders-2019-06/>
<https://semiwiki.com/general/274582-china-winning-the-future-of-the-semiconductor-industry/>
https://www.usitc.gov/publications/332/journals/chinese_semiconductor_industrial_policy_prospects_for_success_jice_aug_2019.pdf

Catalysts:

- **Increased cooperation with other advanced economies.** Huawei has already begun developing relationships with suppliers in Japan, South Korea, and Europe to offset the fallout from losing U.S. suppliers.
- **Attracting foreign talents.** China is establishing itself as the place to be for young talent in AI and advanced tech, taking over Silicon Valley. This is likely to spur innovation growth.

Risks:

- **Investment management.** The Chinese semiconductor industrial plans lacked a clear implementation strategy and have been hampered by bureaucratic red-tape. Despite the announcements by the government, the underlying bureaucratic structure is still well in place.
- **Persistent lack of highly skilled labor.** China's ability to take advantage of foreign acquisitions, joint ventures with leading manufacturers and large R&D budgets have been hampered by the shortcomings of its labor force. Education has improved, but it may take longer for the effects to spread wide enough.

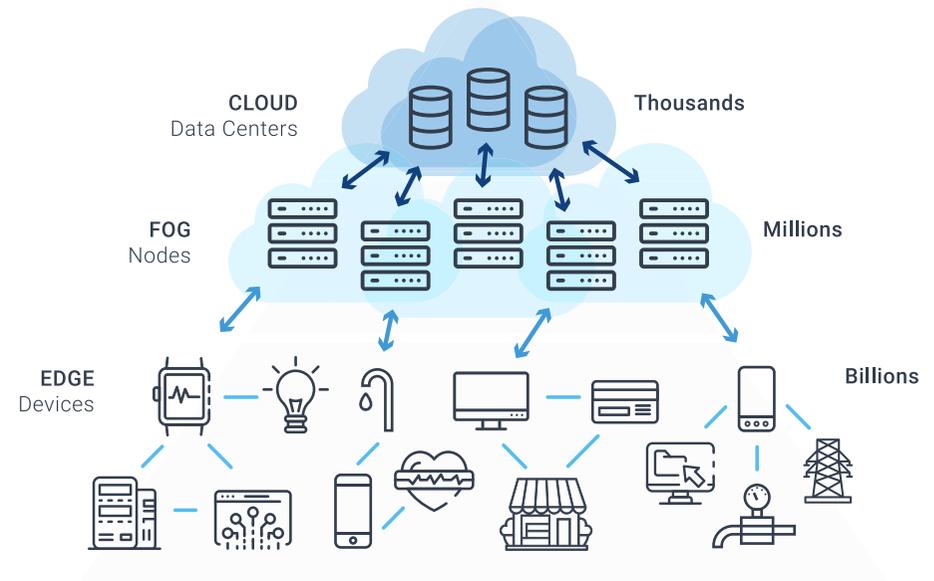
Bottom line:

- As the de-coupling of America's and China's economies accelerates, numbers are suggesting that the U.S. leadership in many technologies is seriously challenged.
- The blacklisting of Huawei in early 2019 has shifted China's focus on domestic innovation capacity from a long term objective to an urgent priority.
- China is thought to be three-to-five years behind leading chip producers, but through significant investments and increased R&D spending, it is determined to create a closed-loop semiconductor manufacturing ecosystem that is self-sufficient at every stage of the manufacturing process.
- If China manages to break the ties with American technology and fly on its wings, the repercussions may be wide-ranging – we are keeping a close eye on this trend and have direct exposure to some Chinese names in our portfolios.

POWERING ARTIFICIAL INTELLIGENCE

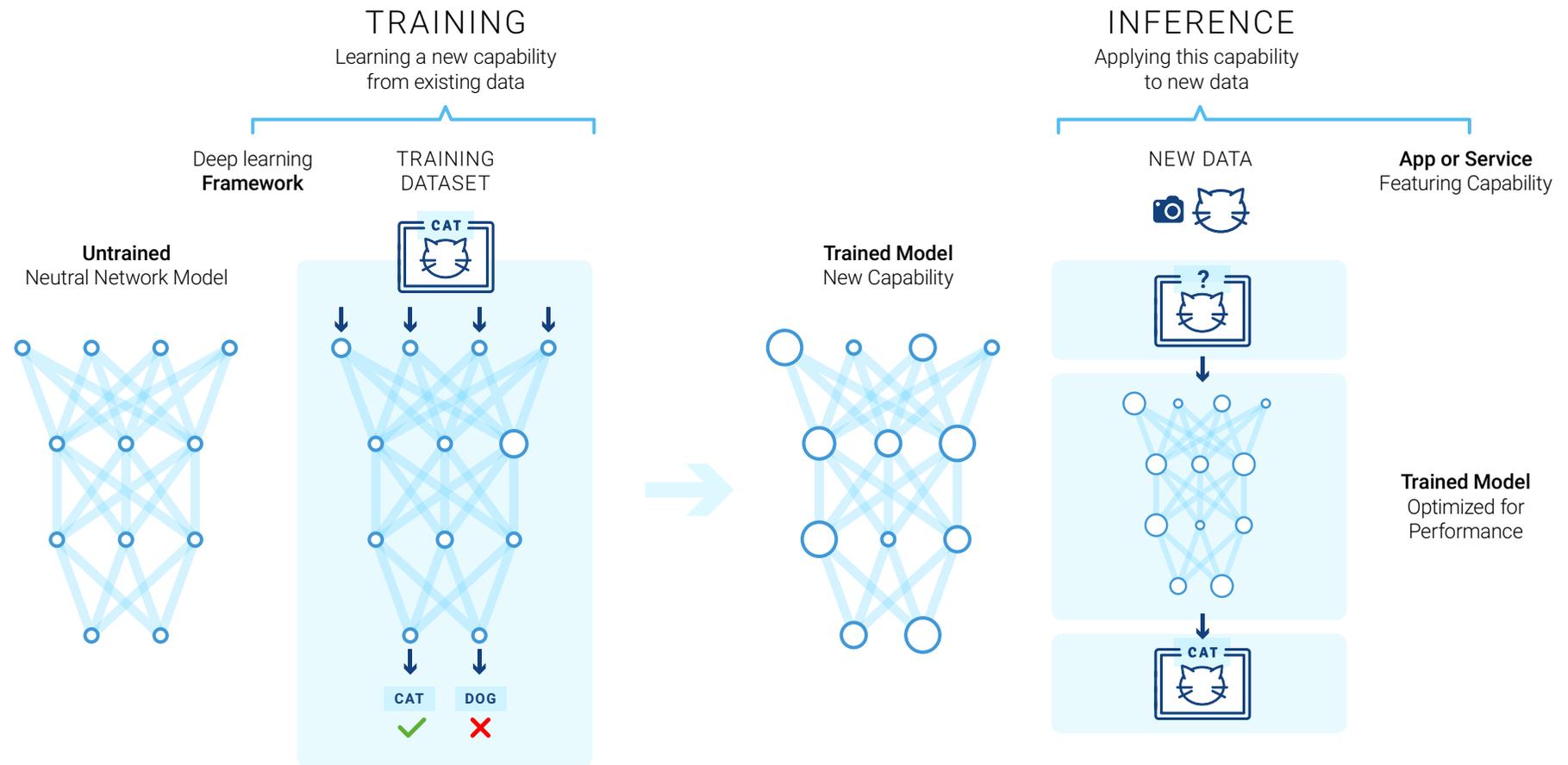
AI: different tasks, different requirements

- AI has become a buzz word being used in any context, ranging from Agricultural applications, to finance, social media or governmental institutions
- AI often appears as a black box that “somehow” enhances human capabilities, optimizes processes, or accelerates decision making.
- Inside that black box, though, there are recognizable elements that address **specific tasks**.
 - Like children, machines need to learn (**training**). They create their learning model with external help (supervised learning) or without it (unsupervised learning).
 - Once the learning process is completed, the machine is ready to prove what it is capable of (**inference**).
- Training and inference are two distinct steps and may occur in different physical places: either **on the cloud** or on the device itself (**edge computing**) but also in different kinds of processors (chipsets).
- This can happen for different reasons: privacy, latency, need for computing power, etc.
 - **Training** requires a lot of data and a lot of computing power.
 - **Inference** is driven by latency, which means that given an input (for instance, a pedestrian crossing the road), the machine needs to make a decision (stopping the car) in the shortest possible time.



SOURCE:
<https://erpinnews.com/fog-computing-vs-edge-computing>

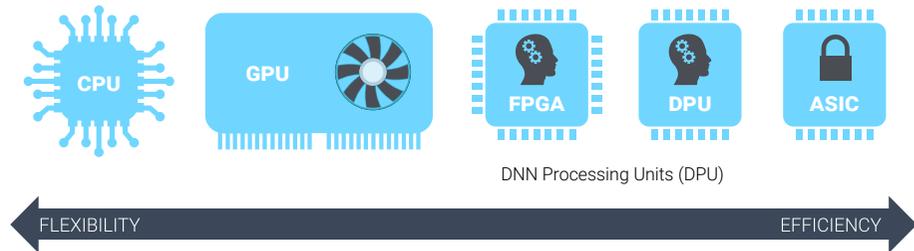
Deep learning



SOURCE:
<https://blogs.nvidia.com/blog/2016/08/22/difference-deep-learning-training-inference-ai/>

No chip to rule them all

- High throughput and low latency carry different requirements that derive from the different purposes they have been designed for: there is no one-solution-fits-all.
- As computing needs present various challenges, different types of chipsets have been developed to provide appropriate solutions.
 - Each one is presenting pros and cons, as listed in the attached table.



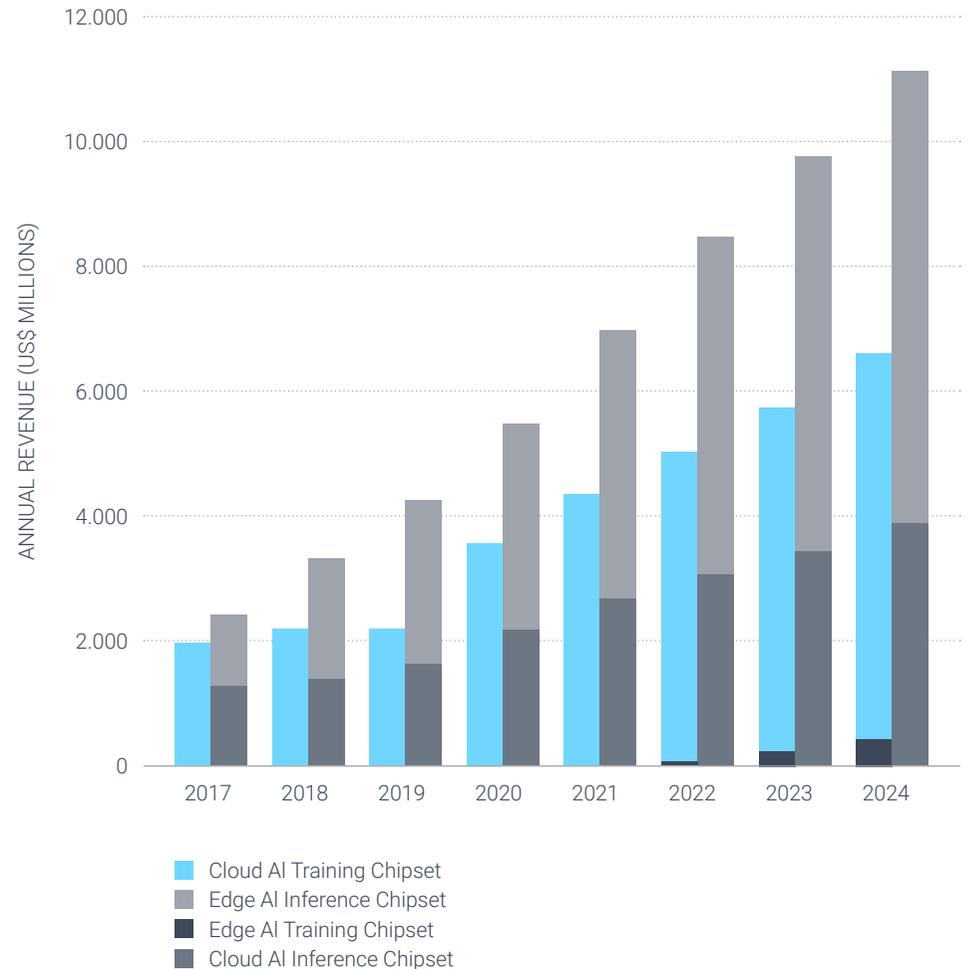
CHIP	PROS	CONS	TRAINING RANK	INFERENCE RANK	COMPANIES
CPU Central Processing Unit	The brain of servers and PCs, general-purpose, good for inference	Serial processing limits its use for training as it is less efficient than parallel computing	–	–	Intel, AMD
GPU Graphic Processing Unit	Highly parallel, very efficient for training, high performance, uses popular AI framework	Inefficient if not fully utilized, scalability, lower perf / watt than FPGA	1	4	Nvidia AMD
FPGA Field Programmable Gate Array	Excellent for prototyping reconfigurable functionality, good for changing workloads, efficient	Difficult to program, no major AI framework, costly alternative to ASIC	2	2	Xilinx, Intel, Lattice Semiconductor
DPU Deep Neural Network Processing Unit	Like CPU but with more parallel computing, very cost-efficient solution for edge applications	Lower number of parallel computing elements, not ideal for high power computing (HPC)	3	3	Google (TPU), Intel (VPU)
ASIC Applied Specific Integrated Circuit	Top performance, most energy efficient, fully customizable	Expensive, requires high volume, not flexible, fits one use case only	4	1	Intel, Broadcom, ST, NXP

SOURCE:
<https://towardsdatascience.com/benchmarking-hardware-for-cnn-inference-in-2018-1d58268de12a>

Two different playgrounds, and one is more appealing

- The slowdown in silicon performance (end of Moore’s law) has resulted in the development of an ecosystem of different architectures and chipsets on the cloud and at the edge. These two markets are growing at different paces.
- The cloud ecosystem is dominated by large firms: **Intel (INTC:US)**, **AMD (AMD:US)**, **NVIDIA (NVDA:US)**, and FPGA leaders, such as **Xilinx (XLNX:US)**. In 2018 chips sales accounted for \$4.2bn.
- The edge landscape is still very fragmented and accounted for \$1.9bn last year, but is growing fast (expected CAGR of 31% over 2018-2025). Players in this field are **Lattice Semiconductor (LSCC:US)**, **Ambarella (AMBA:US)**, **ARM (owned by Softbank, 9984:JP)**, **Thinci (not listed)** and **Graphcore (not listed)** each one developing chips for specific applications or markets.
- Among these sectors, those where AI edge chipset are expected to dominate are:
 - **Advanced driver-assistance systems (ADAS)** – have already started to deploy dedicated edge chipsets, used in cars, as they become increasingly autonomous.
 - **Smart appliances, smart homes, and smart cities** – all using embedded AI chipsets to satisfy the requirements of low latency and low power.
 - **Robotics and other industrial devices** – represent a **high volume market** for edge chipsets that will deploy on-premises the models trained on the cloud.

TOTAL ANNUAL REVENUE FROM AI CHIPSET SALES BY AI INFERENCE AND TRAINING WORLD MARKETS, FORECAST: 2017 TO 2024



SOURCES:

<https://www.eetimes.com>

<https://m.eet.com/media/1313554/InferenceandTrainingRevenueChart.JPG>

Catalysts:

- **IoT (edge inference).** Expected to be the largest field of use for low power FPGAs and ASIC, as they offer a complementary solution to common problems such as low power requirements, latency, and in situ operation for privacy issues.
- **5G infrastructure.** Crucial in the growth of AI chips, especially for FPGA, which is already widely used, and in the medium to long future for the ASIC.
- **Datacenters.** A significant driver for all kinds of chipsets, as AI will be deployed across every type of IT infrastructure.
- **Autonomous Vehicles.** Inherently stringent safety requirements will trigger the adoption of one chip technology (likely ASIC) in the long term.

Risks:

- **High development costs.** Likely to hinder the take-off of certain types of chipsets, notably FPGA and ASIC.
- **The software stack remains obscure.** Lack of understanding is delaying the adoption of certain chipsets, like FPGA, despite efforts to create an AI framework by the leading producers (Vitis for Xilinx and SensAI for Lattice Semiconductor),
- **Oligopolistic market.** Concentration in the hands of a few big tech companies may hinder the innovation and development of new players.

Bottom line:

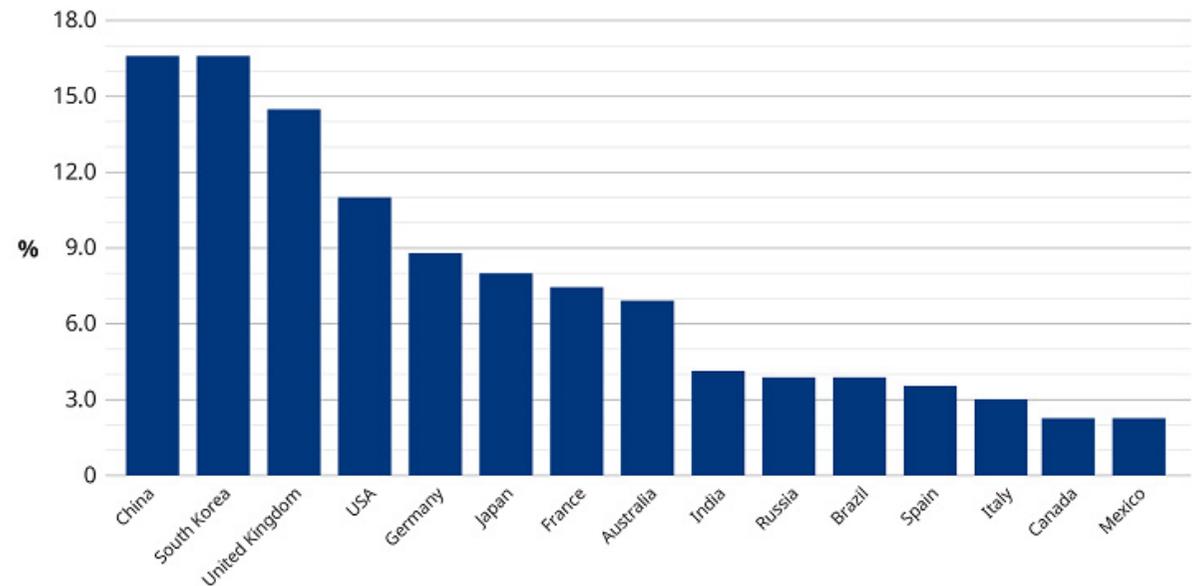
- There is **no single solution to power AI**, as different chipsets respond to different requirements, like intensive computation, power consumption, and low latency.
- While the cloud infrastructure has already been developing for some time, **AI at the edge is still in its infancy.**
- The Edge represents the **sweet spot for AI**, as it is where AI de facto will happen and will get into our lives, driven by IoT and other smart devices. It is also the segment that is experiencing the **fastest pace of growth**, and where most of the investable ideas are to be found.
- We play the AI at the edge theme through our exposure to **Lattice Semiconductor (LSCC:US)**.

CHARTS FOR THOUGHTS

E-commerce penetration by country in 2016

- China is the worldwide leader in online B2C penetration rate.
 - Online sales growth is driven by tier 3 and tier 4 cities, which are smaller than internationally renowned tier 1 & 2 cities like Beijing, Shanghai or Shenzhen, but still have populations in the millions
 - According to Bain's research, already in 2015 almost 55% of Chinese consumers were doing online shopping through their mobile phones
- Total online payments in 2016 were already an estimated \$5.5tn or about 50x the amount in the U.S.
 - The leaders in this market are Tencent and Alibaba, whose payment platforms are Tenpay and Alipay, respectively
- But the real treasure in this business is data – and as the Chinese consumer is leading the way in going digital, so Chinese companies are leading the way in exploiting the wealth of data that comes along.
 - Not surprisingly, China is quickly overtaking the U.S. in "big data"-related domains like AI, cloud, computing and processing power, etc.

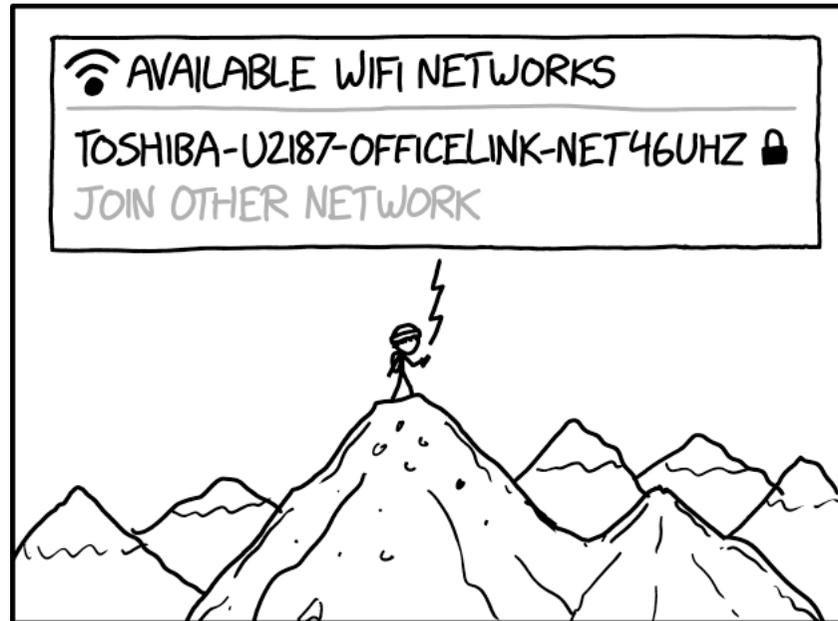
E-commerce penetration by country in 2016
(% of B2C retail sales)



Source: Euromonitor, January 2017

SOURCE:
wBain & Co, <https://www.bain.com/insights/chinas-e-commerce-the-new-branding-game/>

CASUAL FRIDAY



TECH TRIVIA: NO ONE ACTUALLY KNOWS WHAT DEVICES PRODUCE THOSE CRYPTIC WIFI NETWORKS. THEY JUST APPEAR AT RANDOM ACROSS THE EARTH'S SURFACE.

SOURCE:
<https://xkcd.com/2199/>

Invest Beyond The Ordinary

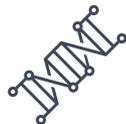
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