Long-term Strategy and Innovation for Mitigation of Global Warming

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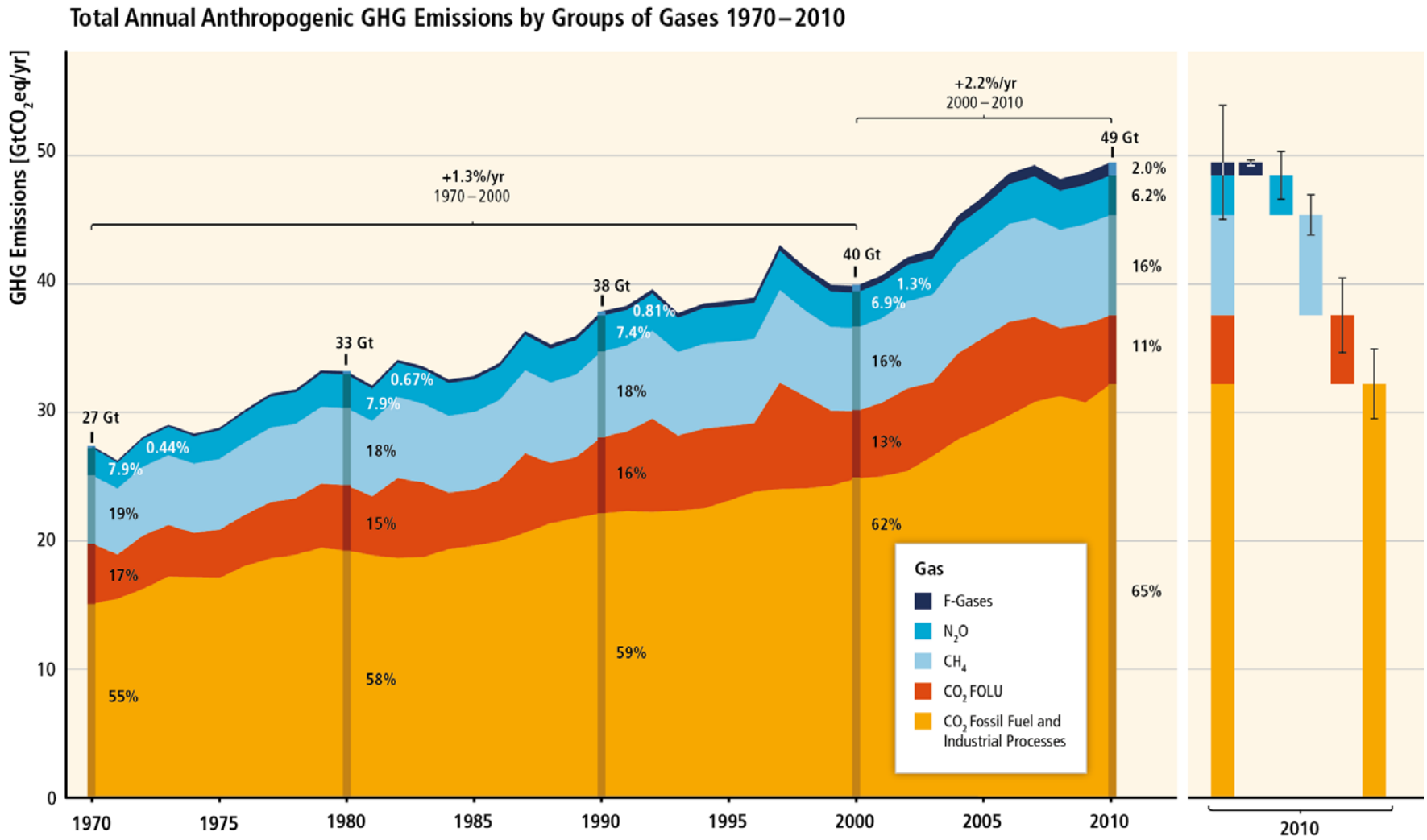
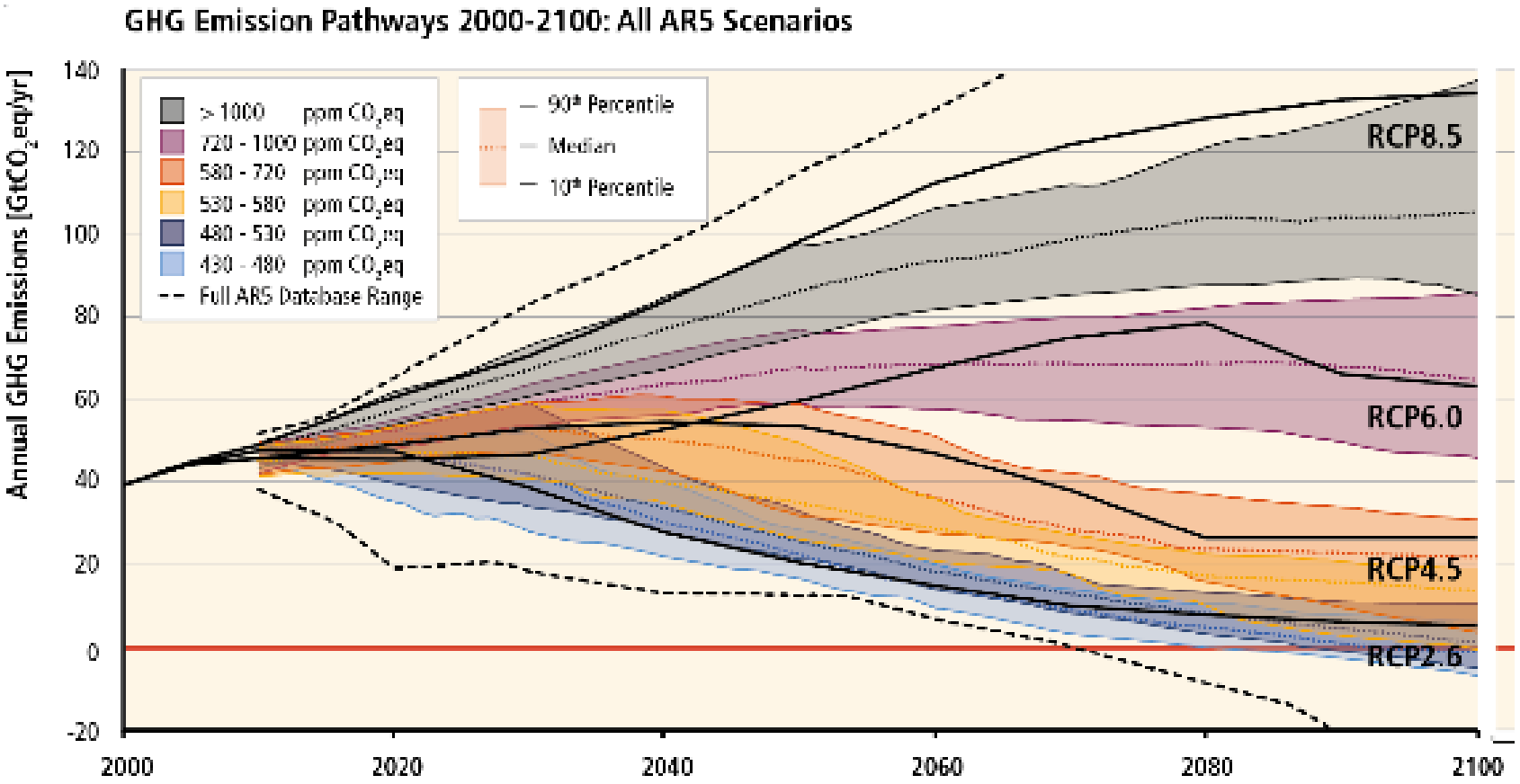
GHGs emissions increasing



(IPCC 2014, AR5 WG3)

Massive Cut Required



(IPCC 2014, AR5 WG3)

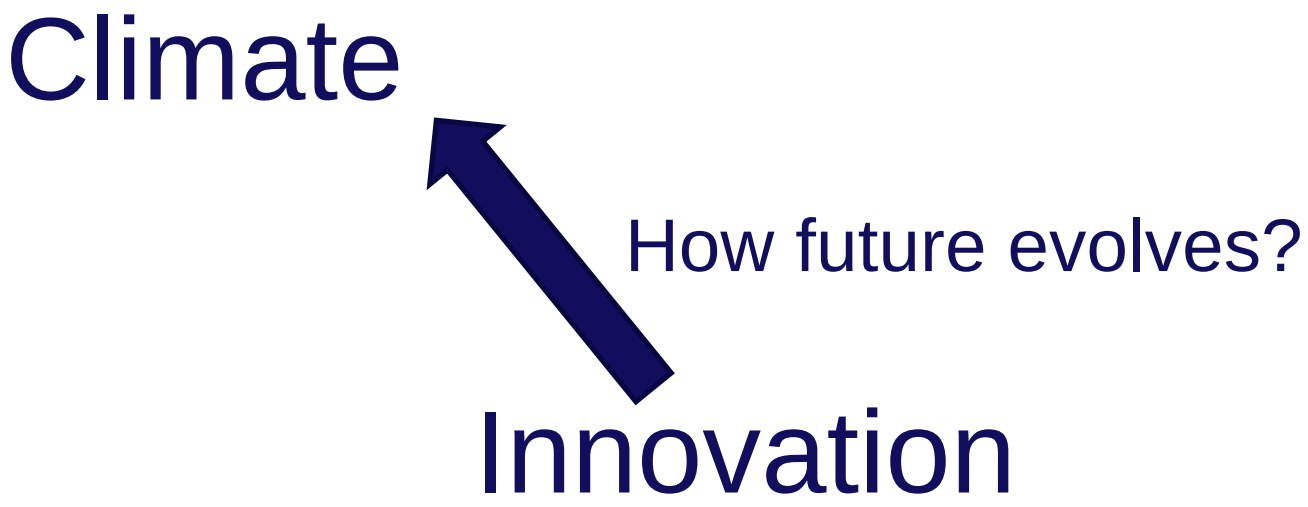
Top-down view

Climate

Policy Requirement

Innovation

Bottom-up view



Key Question

How can we get affordable

“Innovative Climate Technologies”

(PV, EV, etc…)

for massive GHG cut?

Definitions

Innovation =

Discovery, Invention + Diffusion

(Ohashi, H. 2014)

Innovation plans & visions by Gov. of Japan

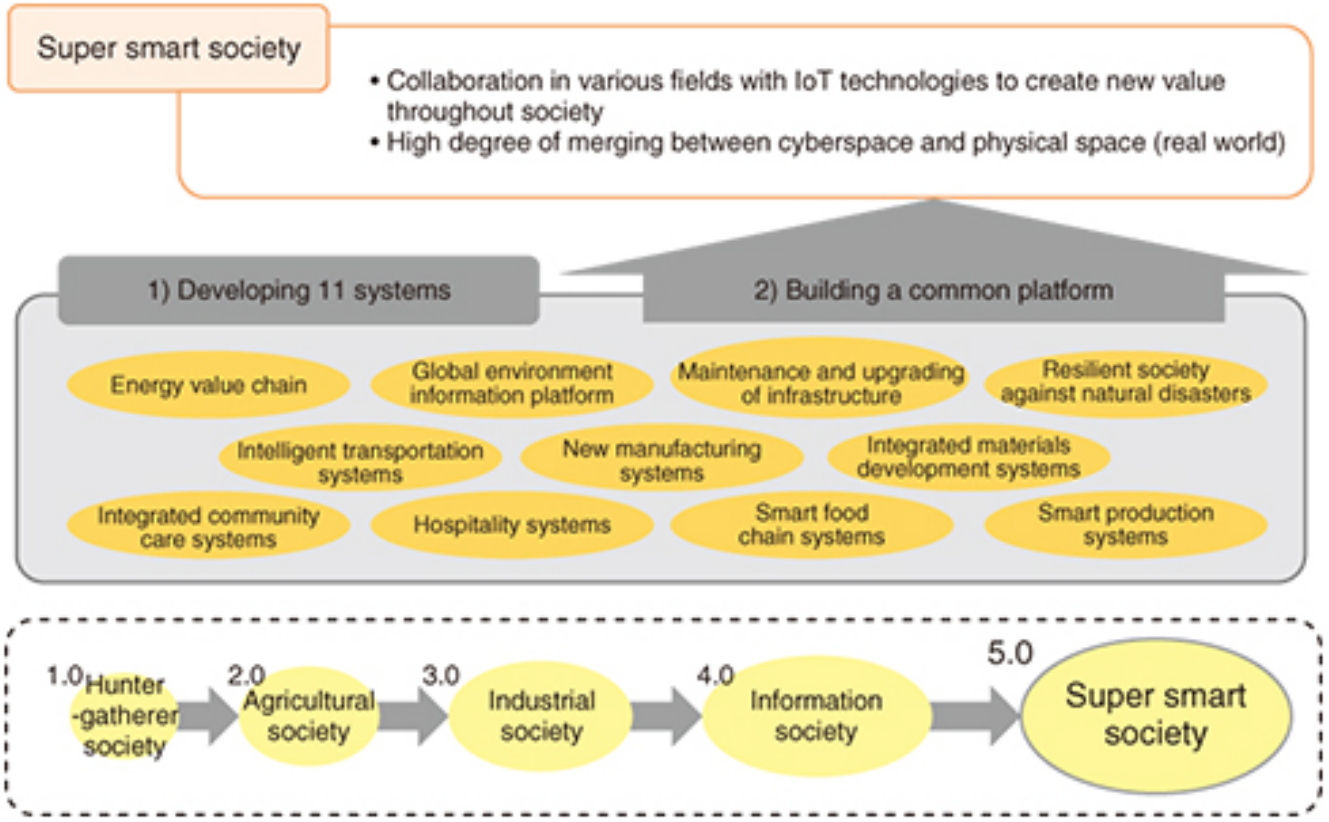
National Energy & Environmental Strategy for Tech. Innovation toward 2050 (NESTI 2050; Cabinet Office))

- R&D program for innovative climate techs
- Key techs:
  - ✓ Energy generation (PV, geothermal)
  - ✓ Energy storage (battery)
  - ✓ Energy efficiency (process, material)
  - ✓ Carbon Capture & Use (CCU)
  - ✓ ICT for energy systems (AI, big data, IOT)
  - ✓ Materials/devices for energy systems (superconductor, power electronics, censor)
- System Integration Technologies

http://www.meti.go.jp/committee/summary/0004000/pdf/045_05_00.pdf

Society 5.0 (Cabinet Office)

Vision of “smart society” for *all* sectors



https://www.ntt-review.jp/archive_html/201604/images/fa1_fig08.jpg

New Industiral Structure Vision (METI)

ICT Technology		Big Data		Goods and services
Common platform technology (AI, IoT, robotics etc.)	Financial technology	Transactions, financial markets	=	Robo-Advisor (asset management), Credit by trading data, etc.
	Drug discovery technology	Health and medical data	=	Personalized medicines, Personalized cosmetic and beauty services etc.
	Bioinformatics Genome editing	Biological data	=	New drug discovery, new species crop, advanced materials manufacturing, bio-energy, etc.
	Energy load device control technology	Customer data	=	Energy demand response, monitoring services, etc.
	Production control technology	Accidents and near-miss data	=	Early detection of abnormality, enhancement of insurance and credit rating etc.

http://www.meti.go.jp/committee/sankoushin/shin_sangyoukouzou/pdf/008_05_01.pdf

Vision for Prospective AI Technologies and Applications (NEDO)

- Vision of AI
- ✓ For three periods: -2020, 2020s, 2030-
- ✓ Many applications: machine learning, image cognition, robotics, self-driving, natural language, …

NEDO HP http://www.nedo.go.jp/content/100782828.pdf

Learning “climate innovation” with an example: AI

AI beats human at *Go* match

Googleの人工知能が囲碁でプロ棋士を破る（2016年1月）

NHK NEWSWEB

トップページ ＞ 科学・医療ニュース一覧 ＞ グーグルが最新人工知能使い囲碁ソフト開発 プロに勝利

ニュース詳細

グーグルが最新人工知能使い囲碁ソフト開発 プロに勝利

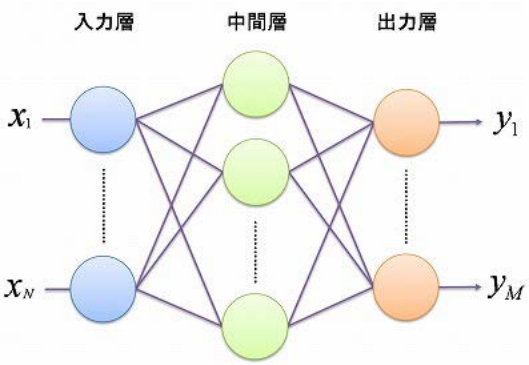
1月28日 3時00分

アメリカのＩＴ企業、グーグルの研究グループが最新の人工知能を使った囲碁のコンピューターソフトを開発し、人間のプロ棋士に勝利したと発表しました。囲碁でコンピューターが人間のプロに勝つのは初めてです。

これはアメリカのＩＴ企業、グーグルの研究グループが２８日発行のイギリスの科学雑誌「ネイチャー」に論文を発表したものです。
囲碁は、将棋やチェスと比べて打てる手の数が桁違いに多いことから計算が複雑で、コンピューターが人間のプロの実力に追いつくにはこの先、１０年以上かかるとされてきました。
論文によりますとグループが開発した囲碁ソフト「ＡｌｐｈａＧｏ」には膨大な可能性を計算して打ち手を探す従来の方法に加え、「ディープラーニング」と呼ばれるコンピューターがみずから学習する最新の技術が使われているということです。
そのうえで、碁石の位置データに基づいた戦況の見極めと、次に打つ手の選択を２種類の別々の人工知能を組み合わせて計算することで、より強い手を見つけ出す能力が格段に高まったということです。
グループによりますと、中国出身のプロ棋士と対局し、「ＡｌｐｈａＧｏ」は５戦全勝したということで、囲碁でコンピューターが人間のプロ棋士に勝つのは初めてだということです。
グループではことし３月には世界のトッププロ棋士の１人で韓国のイ・セドル九段と対局することにしています。
今回の成果についてグループでは「人工知能の開発に囲碁は最適なゲームだ。今後、この人工知能の技術を気象災害の予測から医療まで実社会のさまざまな場面に役立つものにしていきたい」としています。

Deep learning of AI
by combination of existing techs

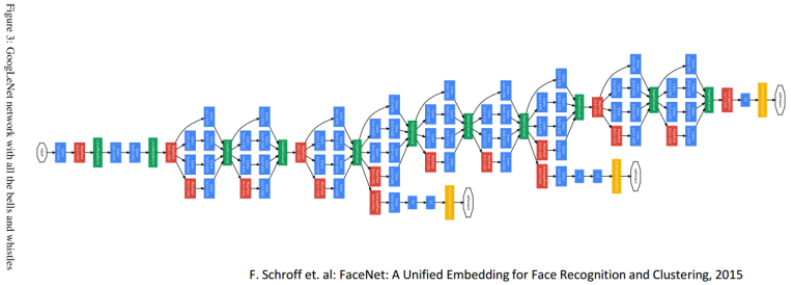
Kevin Kelly 2016 *Inevitable*



1. Percepton
(old AI)

2. Big data on Web
(to train AI)

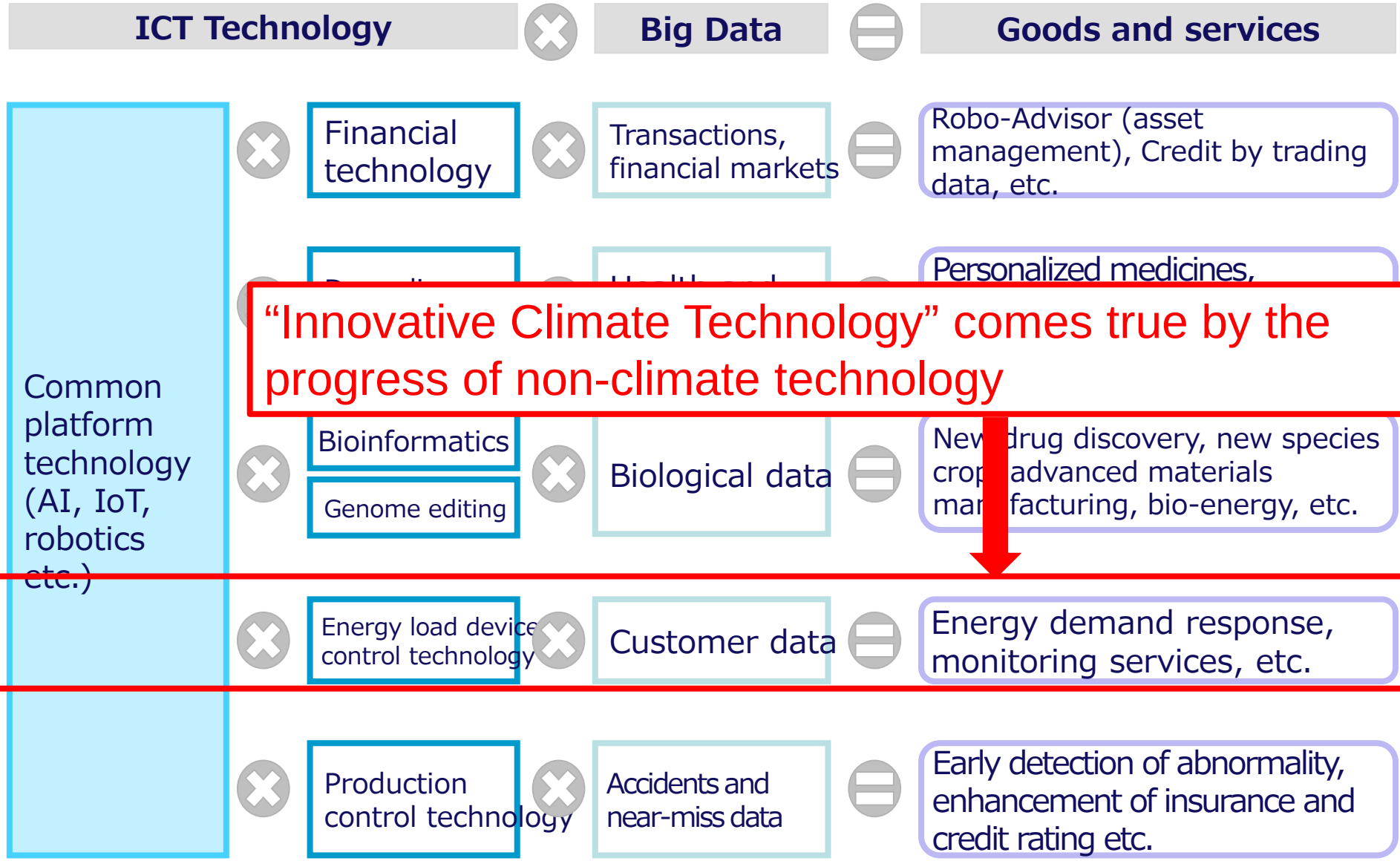
3. GPU
Graphic processing for games



Deep Learning (AI)

http://ifs.nog.cc/fishwin.hp.infoseek.co.jp/hp/etc/soft_computing/mlp.html http://matome.naver.jp/odai/2139450632745180701 http://tamagogohan.fool.jp/onlinegame/game/eternalcity2/eternalcity2.ht

New Industiral Structure Vision (METI)



新産業構造ビジョン http://www.meti.go.jp/committee/sankoushin/shin_sangyoukouzou/pdf/008_05_01.pdf (note addedd)

The Lesson from AI example

Climate tech

= combination of non-climate techs

You can not cut emissions by AI

without developing AI first

Different Time Span:
Chance to solve global warming

Progress of X (=ICTs..):

rapid & accelerating

… 2030? 2050?

Innovation time span << climate time span

(2020, 2030) (2050, 2100)

With new techs, more will be happy to cut more emissions.

Understanding innovation in general

Characteristics of Innovation

- New techs = combination of existing techs

  “new combination (Schumpeter)”

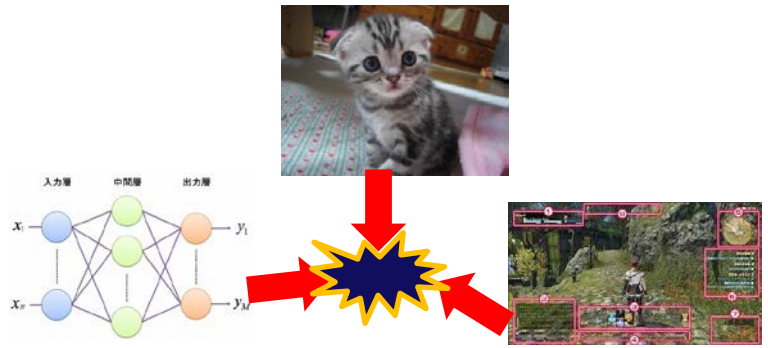
  “Ideas have a sex (Ridley)”

Innovation:

1) is cumulative
2) accelerates
3) occurs when “adjacent possible”

Adjacent Possibility

- An innovation emerges not out of thin air, but requires accumulation of other innovations
  - ✓ Eg.1 Deep-learning enabled by three techs
  - ✓ Eg.2 Youtube enabled by broadband
- A set of technologies makes it *adjacent possible* for a certain new technology to emerge



Simultaneous Inventions, Multiple Discoveries

Inventions/discovery/innovation are *inevitable* once they become adjacent possible

Thus they occur simultaneously and independently, often in competition

1. Newton and Leibniz both discovered differential calculous
2. Three mathematician invented decimals
3. At least 6 persons invented thermometer
4. Several inventors for typewriter
5. Five “original” inventors of steamship

…

(Kelly 2014); https://en.wikipedia.org/wiki/Multiple_discovery

Power of Market for Innovation

- "I, Pencil“(Read 1958)

  A pencil details the complexity of its own creation, listing its components (cedar, graphite, …), and the numerous people involved.

- Market has the power to combine fragmented information to produce, invent, and innovate, in unpredictable manner.

- Vigorous economic activities are the key to innovation

Conclusion

- Rapid development of general science & technology. Opportunity to solve climate problem.
- Climate policy must be compatible with economic growth to foster general/ climate tech development for the *climate* sake
- Role of the government for innovative climate techs
  - 1) keep macro-economy good, 2)invest in basic research in general, 3) invest in dedicated climate tech programs.