

Introduction to Bioengineering
BIOE/ENGR.80
Stanford University

Spring 2020 Class Slides

Day 26
5 June 2020

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Week 9 look ahead

CONCEPT
SKILL

Planet health

People health

Political health

Introduction to Bioengineering
BIOE/ENGR.80
Stanford University

Spring 2020 Class Slides

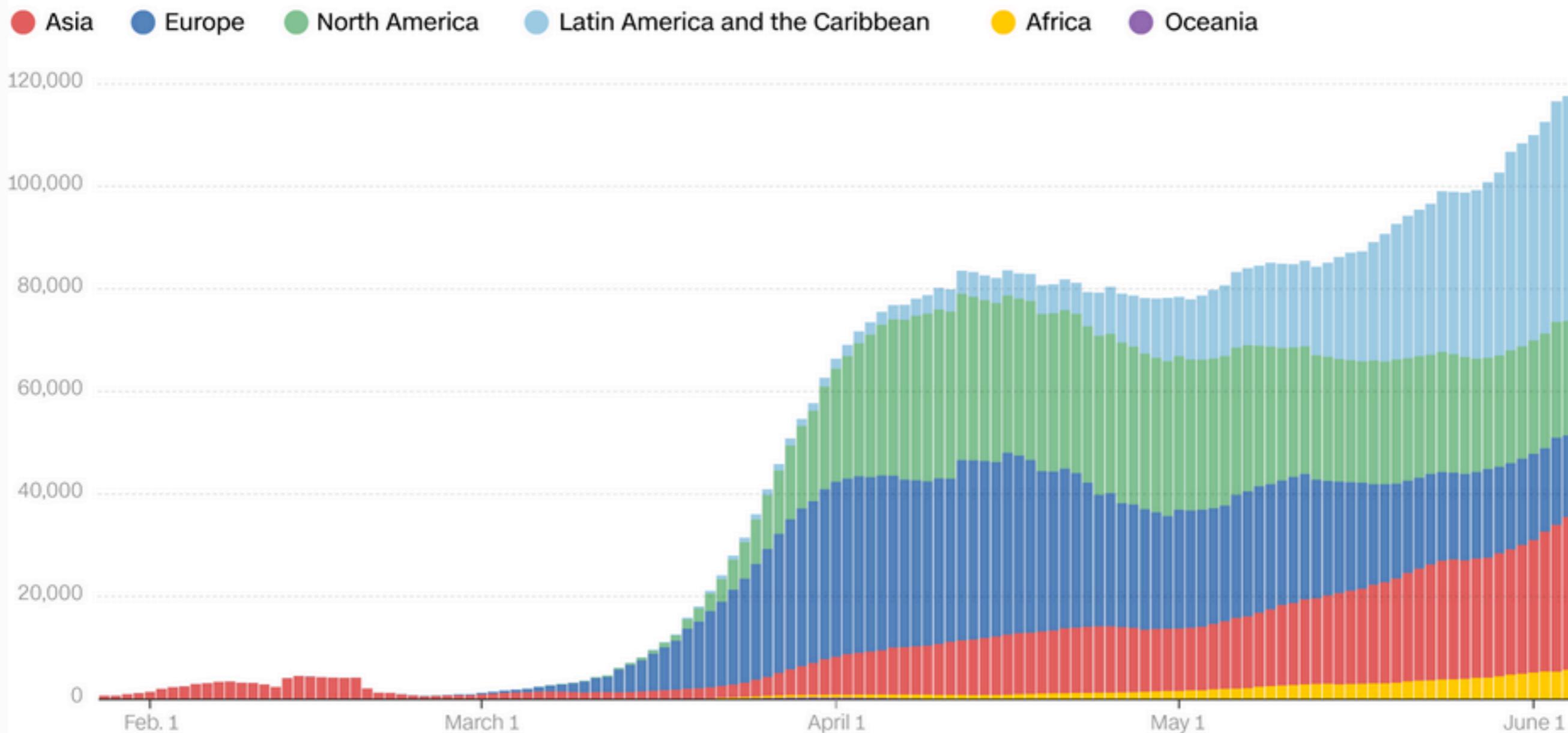
Day 6
17 April 2020

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<Parsing & “Playing” Politics>

New cases top 100K daily

The average number of new Covid-19 cases is increasing by more than 100,000 a day, propelled by new cases in the Caribbean, Latin and South America.



Note: Data based on rolling, seven-day averages.

Regions are based on United Nations definitions. Americas have been broken down into subregions (Latin America and the Caribbean and North America).



Last updated: June 5, 2020 at 7:00 a.m. ET

Source: Johns Hopkins University Center for Systems Science and Engineering

Graphic: Sergio Hernandez, Byron Manley, Mark Oliver and Henrik Pettersson, CNN



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Resources and Support



STANFORD CAMPUS VIRTUAL COMMUNITY
VIGIL FOR BLACK LIVES
FRIDAY, JUNE 5TH @ 5PM PST

Livestream the Stanford Community Vigil for Black Lives at 5 PM PST June 5, 2020

Political

“... the set of activities that are associated with the governance of a country, state or area. It involves making decisions that apply to groups of members and achieving and exercising positions of governance—organized control over a human community.”

Health

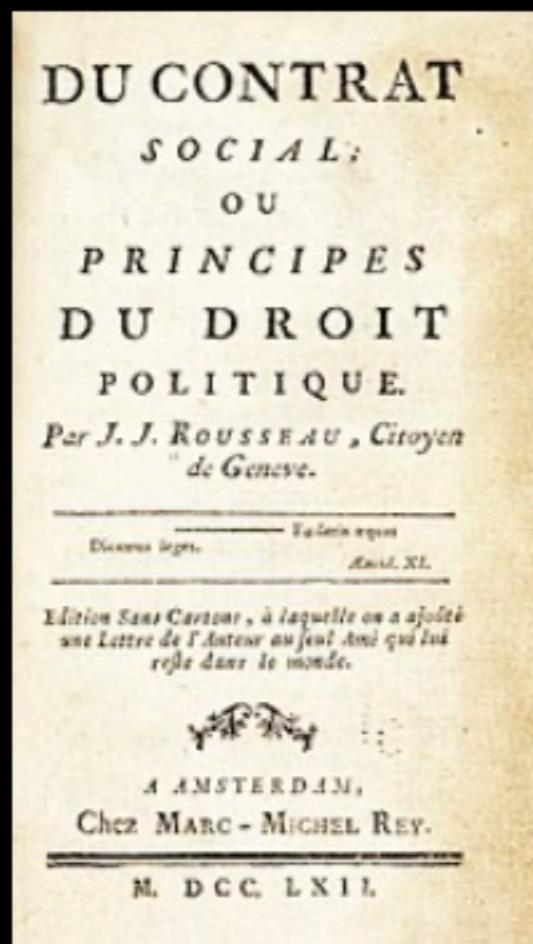
“a condition in which someone or something is thriving or doing well.”

<https://en.wikipedia.org/wiki/Politics>

<https://www.merriam-webster.com/dictionary/health>

Social Contract

“a theory or model that originated during the Age of Enlightenment and usually concerns the legitimacy of the authority of the state over the individual. Social contract arguments typically posit that individuals have consented, either explicitly or tacitly, to surrender some of their freedoms and submit to the authority (of the ruler, or to the decision of a majority) in exchange for protection of their remaining rights or maintenance of the social order.”



What capacities should be available to all citizens?

within limits either small or overcharged, and steeped in the vices which that situation generates. A government adapted to such men would be one thing; but a very different one that for the Man of these states. Here every one may have land to labor for himself if he chuses; or, preferring the exercise of any other industry, may exact for it such compensation as not only to afford a comfortable subsistence, but wherewith to provide for a cessation from labor in old age. Every one, by his property, or by his satisfactory situation, is interested in the support of law and order. And such men may safely and advantageously reserve to themselves a wholesome controul over their public affairs, and a degree of freedom, which in the hands of the Canaille of the cities of Europe, would be instantly perverted to the demolition and destruction of every thing public and private. The history of the last 25. years of France, and of the last 40. years in America, nay of it's last 200. years, proves the truth of both parts of this observation.

But even in Europe a change has sensibly taken place in the mind of Man. Science had liberated the ideas of those who read and reflect, and the American example had kindled feelings of right in the people. An insurrection has consequently

**Jefferson to
Adams re:
“natural
aristocracy”
October 1813**

OP-ED CONTRIBUTORS

Recipe for Destruction

By RAY KURZWEIL and BILL JOY

Published: October 17, 2005

AFTER a decade of painstaking research, federal and university scientists have reconstructed the 1918 influenza virus that killed 50 million people worldwide. Like the flu viruses now raising alarm bells in Asia, the 1918 virus was a bird flu that jumped directly to humans, the scientists reported. To shed light on how the virus evolved, the United States Department of Health and Human Services published the full genome of the 1918 influenza virus on the Internet in the GenBank database.



This is extremely foolish. The genome is essentially the design of a weapon of mass destruction. No responsible scientist would advocate publishing precise designs for an atomic bomb, and in two ways revealing the sequence for the flu virus is even more dangerous.

First, it would be easier to create and release this highly destructive virus from the genetic data than it would be to build and detonate an atomic bomb given only its design, as you don't need rare raw materials like plutonium or enriched

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1918 Flu and Responsible Science

The influenza pandemic of 1918 is estimated to have caused 50 million deaths worldwide; 675,000 in the United States. The reconstruction of the 1918 virus by the synthesis of all eight subunits and the generation of infectious virus are described on p. 77 of this issue.¹ and the sequences of the final three gene segments of the virus are described in a concurrent *Nature* paper.² Predictably, but alarmingly, this virus is more lethal to mice than any other influenza strain, suggesting that this property of the 1918 virus has been recovered in the published sequence. The good news is that we now have the sequence of this virus, perhaps permitting the development of new therapies and vaccines to protect against another such pandemic. The concern is that a terrorist group or a careless investigator could convert this new knowledge into another pandemic.

Should the sequence of the 1918 virus have been published, given its potential use by terrorists? The dual-use nature of biological information has been debated widely since September 11, 2001. In 2003, a committee of the U.S. National Academies chaired by Gerald Fink considered this issue, weighing the benefits against the risks of restricting the publication of such biological information. They outlined the tradeoff between erring on the side of prudence, thus potentially hindering the progress of critical science, and erring on the side of disclosure, thus potentially aiding terrorists. The U.S. National Science Advisory Board for Biosecurity (NSABB) was established to advise governmental agencies and the scientific community on policies relative to public disclosure. This board has begun to deliberate, but the questions are complex, as typified by these papers on the 1918 virus. It is reassuring that the NSABB was asked to consider these papers before publication and concluded that the scientific benefit of the future use of this information far outweighs the potential risk of misuse. People may be reassured that the system is working, because agencies representing the public, the scientific community, and the publishing journals were involved in the decision.

I firmly believe that allowing the publication of this information was the correct decision in terms of both national security and public health. It is impossible to forecast how scientific observations might stimulate others to create new treatments or procedures to control future pandemics. For example, in the *Nature* article, sequence comparisons suggest that the 1918 virus was generated not by incremental changes in the polymerase genes, but by the movement of these genes, in total, from an avian source into a human influenza virus. The availability of these sequences will permit identification of their avian origin and should show why this particular set of genes was selected. Similarly, the results in the *Science* article suggest that the cleavage of a protein on the surface of the 1918 virus, a step critical for viral infection, may occur by a previously unknown mechanism—a hint that could lead to new drugs for inhibiting this step and thus preventing future pandemic eruptions.

Influenza is highly infectious, and a new strain could spread around the world in a matter of months, if not weeks. The public needs confidence that the 1918 virus will not escape from research labs. All of the described experiments were done in a Biosafety Level 3 laboratory, a high-containment environment recommended by the U.S. Centers for Disease Control and Prevention and the National Institutes of Health on an interim basis, whose use should become a permanent requirement for such experiments. Current evidence suggests that some available drugs and possible future vaccines could suppress infections by the 1918 virus. Given the prospect of another natural influenza pandemic, the recent decision by the U.S. administration to stockpile antivirals for influenza treatment seems wise. Finally, although a sequence of the 1918 virus has been determined and is highly virulent in mice, this may not be the specific form of the virus that caused the pandemic of 1918. An article in the same issue of *Nature*² reports the existence of sequence variation in a natural population of influenza virus; yet we have only one sequence for the 1918 pandemic strain, and the reconstructed virus described in the *Science* article was built into the backbone of a laboratory strain. Because a pandemic infection is dependent on many unknown properties, there is no certainty that the reconstructed 1918 virus is capable of causing a pandemic.



Philip A. Sharp

Philip A. Sharp is Institute Professor at the Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, USA.

PHOTO: GENE KREBS

Xinampa's vision at a glance

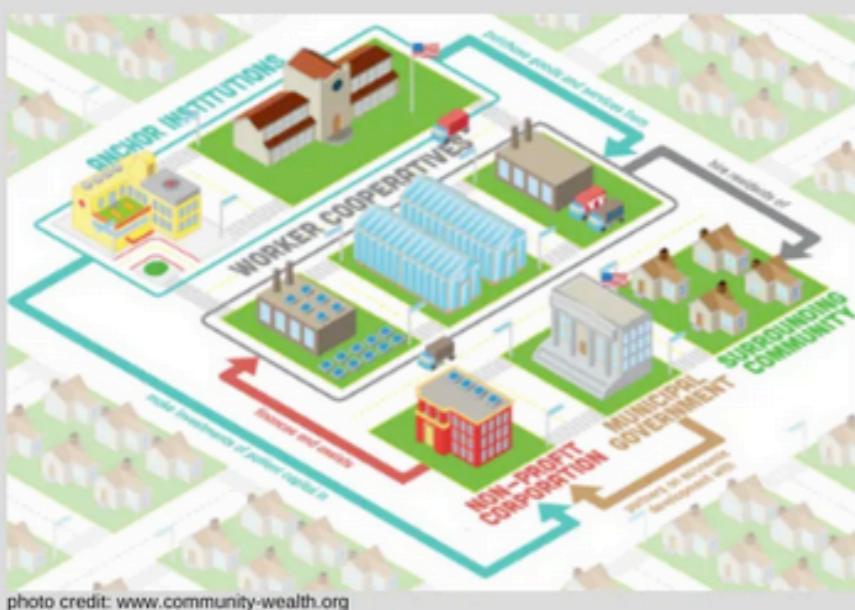


photo credit: www.community-wealth.org

- SCIENTIFIC AND ENGINEERING NONPROFIT
- BIOTECH ECOSYSTEM, BIOECONOMY, CIRCULAR ECONOMY FOR OUR REGION
- DEVELOP A PUBLIC INTEREST TECHNOLOGY ECOSYSTEM
- RESTRUCTURE AMERICAN ECONOMICS AND SCIENCE THROUGH COMMUNITY LABS
- SALINAS MODEL OF COMMUNITY WEALTH DEVELOPMENT
E.g. the first public health biotechnology cooperative



Ana Ibarra



Rolando Perez



Increasing compute
Increasing DNA read
Increasing DNA write

Equity?
Meaning?
Citizenship?



John Maynard Keynes,
Economic Possibilities for our
Grandchildren
(1930)*

I

We are suffering just now from a bad attack of economic pessimism. It is common to hear people say that the epoch of enormous economic progress which characterised the nineteenth century is over; that the rapid improvement in the standard of life is now going to slow down --at any rate in Great Britain; that a decline in prosperity is more likely than an improvement in the decade which lies ahead of us.

I believe that this is a wildly mistaken interpretation of what is happening to us. We are suffering, not from the rheumatics of old age, but from the growing-pains of over-rapid changes, from the painfulness of readjustment between one economic period and another. The increase of technical efficiency has been taking place faster than we can deal with the problem of labour absorption; the improvement in the standard of life has been a little too quick; the banking and monetary system of the world has been preventing the rate of interest from falling as fast as equilibrium requires. And even so, the waste and confusion which ensue relate to not more than $7\frac{1}{2}$ per cent of the national income; we are muddling away one and sixpence in the £, and have only 18s. 6d., when we might, if we were more sensible, have £1 ; yet, nevertheless, the 18s. 6d. mounts up to as much as the £1 would have been five or six years ago. We forget that in 1929 the physical output of the industry of Great Britain was greater than ever before, and that the net surplus of our foreign balance available for new foreign investment, after paying for all our imports, was greater last year than that of any other country, being indeed 50 per cent greater than the corresponding surplus of the United States. Or again-if it is to be a matter of comparisons-suppose that we were to reduce our wages by a half, repudiate four fifths of the national debt, and hoard our surplus wealth in barren gold instead of lending it at 6 per cent or more, we should resemble the now much-envied France. But would it be an improvement?

“I have a ~~plan~~ dream!”



What dream might we share?

Enable humanity to provide for itself

Stabilize & recover natural biodiversity

Take infectious & other diseases off the table

Enable a culture of citizenship

Understand life via building



All aspects enabled by (i.e., require) bioengineering

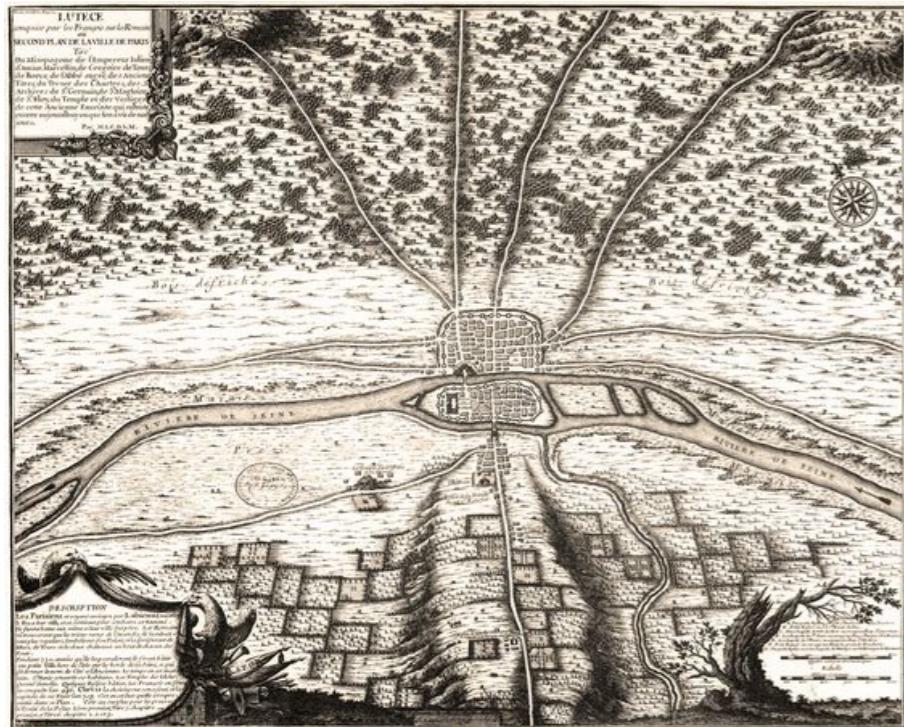
>1% global literacy rate & empowerment

Design anywhere; grow/build anywhere

ROE >1 for affordable & sustainable energy

**Energy,
Information,
& Matter mostly local
& all limiting...**

**Energy,
Information,
& Matter all networked
& none limiting...**



Paris ~500AD



Paris ~2025AD

Consider ROE, not just ROI



The Stanford Solar Generating Station in Kern County, Calif., will provide more than 50 percent of the campus's electricity when it comes on line later this month. (*Image credit: L.A. Cicero*)

I.e., how long to get my Joules back?

Photovoltaic ROE >> 1

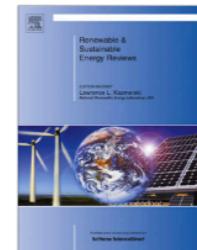
Renewable and Sustainable Energy Reviews 47 (2015) 133–141



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Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser



Energy payback time (EPBT) and energy return on energy invested (EROI) of solar photovoltaic systems: A systematic review and meta-analysis



Khagendra P. Bhandari^b, Jennifer M. Collier^a, Randy J. Ellingson^b, Defne S. Apul^{a,*}

^a Department of Civil Engineering, University of Toledo, 2801 W. Bancroft, Toledo, OH 43606, United States

^b Department of Physics and Astronomy, University of Toledo, 2801 W. Bancroft, Toledo, OH 43606, United States

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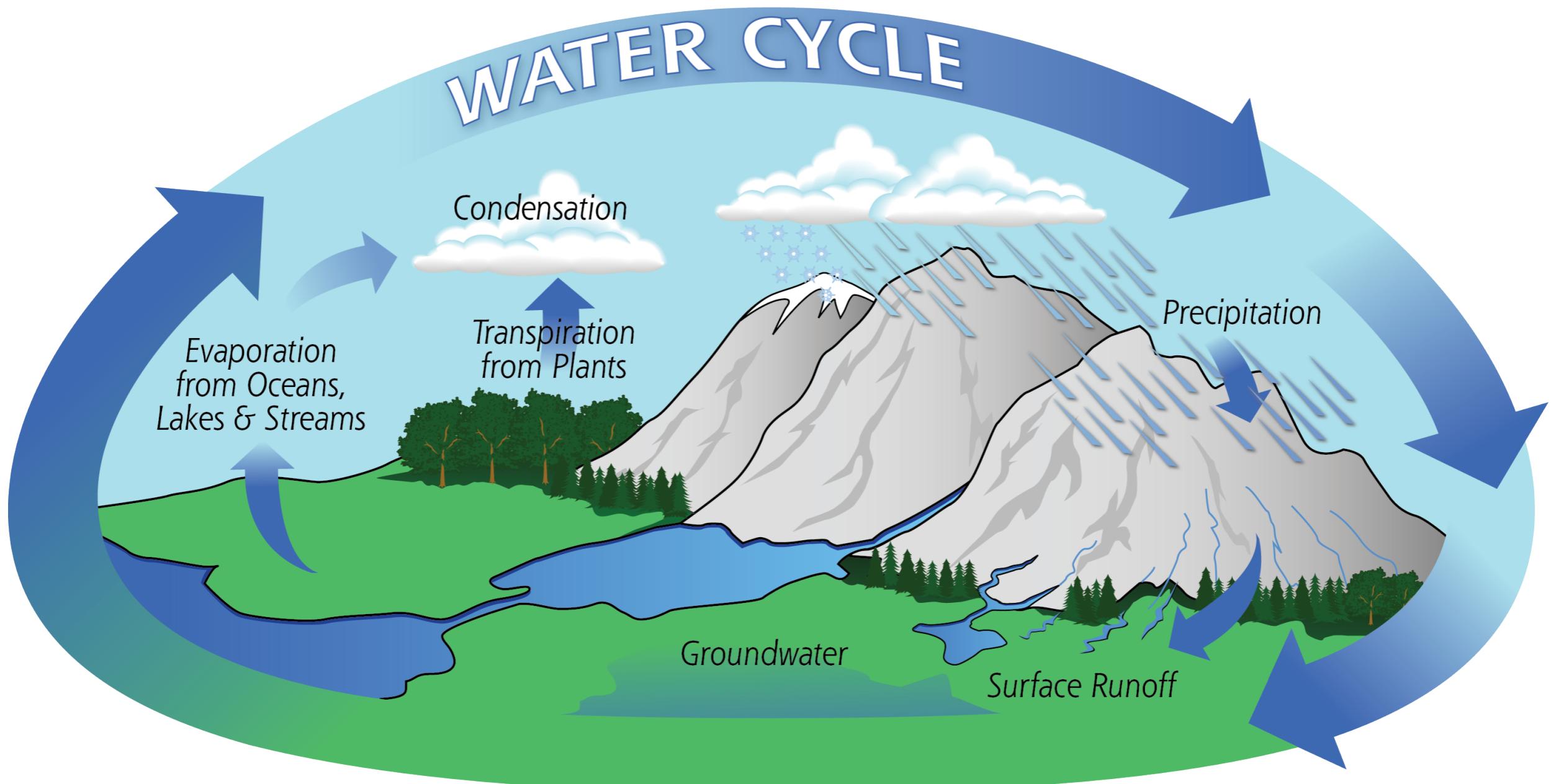
Embedded energy

ABSTRACT

There is a fast growing interest in better understanding the energy performance of PV technologies as evidenced by a large number of recent studies published on this topic. The goal of this study was to do a systematic review and a meta-analysis of the embedded energy, energy payback time (EPBT), and energy return on energy invested (EROI) metrics for the crystalline Si and thin film PV technologies published in 2000–2013. A total of 232 references were collected of which 11 and 23 passed our screening for EPBT/EROI and embedded energy analysis, respectively. Several parameters were harmonized to the following values: Performance ratio (0.75), system lifetime (30 years), insolation ($1700 \text{ kWh m}^{-2} \text{ yr}^{-1}$), module efficiency (13.0% mono-Si; 12.3% poly-Si; 6.3% a:Si; 10.9% CdTe; 11.5% CIGS). The embedded energy had a more than 10-fold variation due to the variation in BOS embedded energy, geographical location and LCA data sources. The harmonization narrowed the range of the published EPBT values. The mean harmonized EPBT varied from 1.0 to 4.1 years; from lowest to highest, the module types ranked in the following order: cadmium telluride (CdTe), copper indium gallium diselenide (CIGS), amorphous silicon (a:Si), poly-crystalline silicon (poly-Si), and mono-crystalline silicon (mono-Si). The mean harmonized EROI varied from 8.7 to 34.2. Across different types of PV, the variation in embedded energy was greater than the variation in efficiency and performance ratio suggesting that the relative ranking of the EPBT of different PV technology today and in the future depends primarily on their embedded energy and not their efficiency.

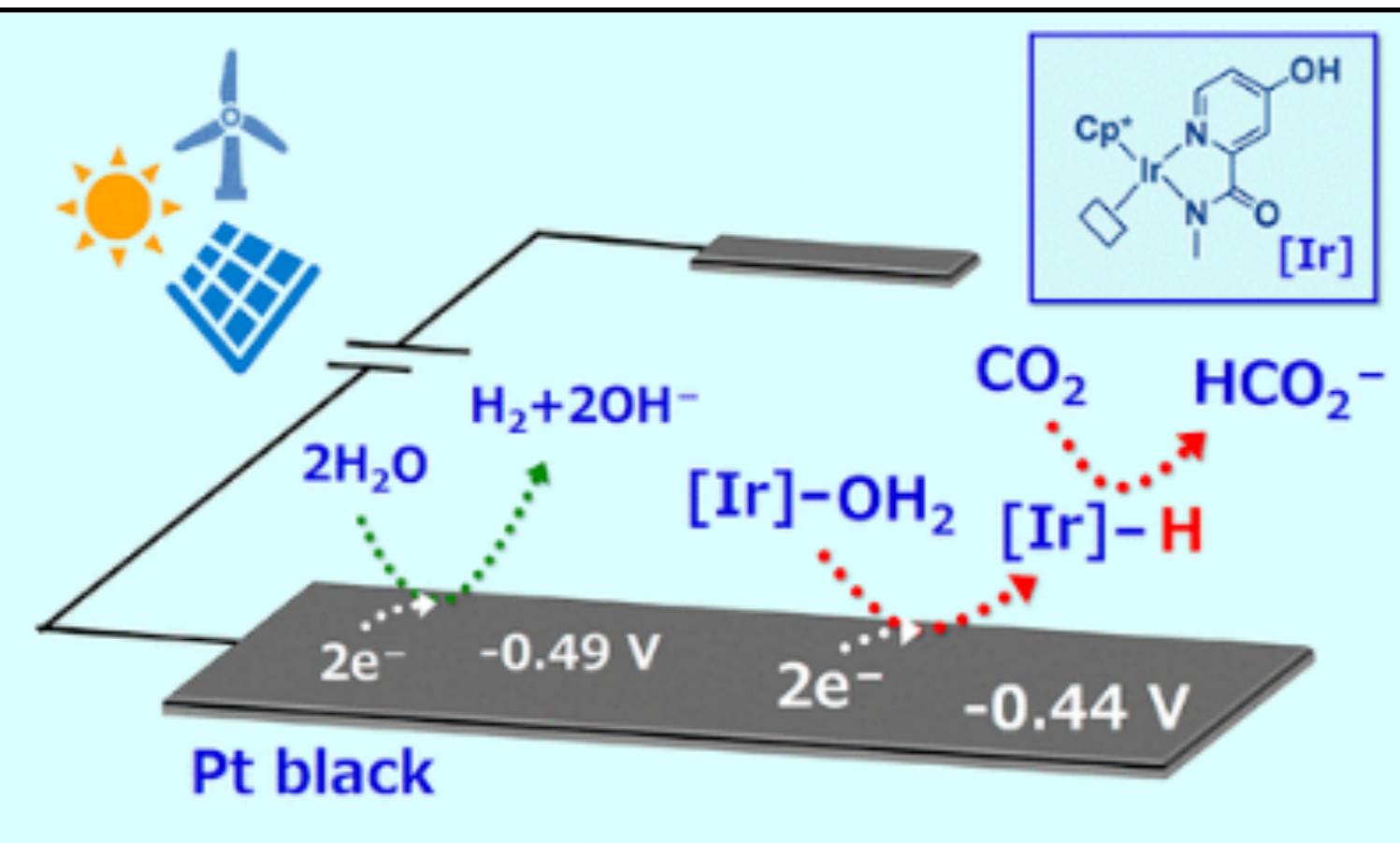
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How much energy to run a synthetic fresh water system for all of Earth's landmass?



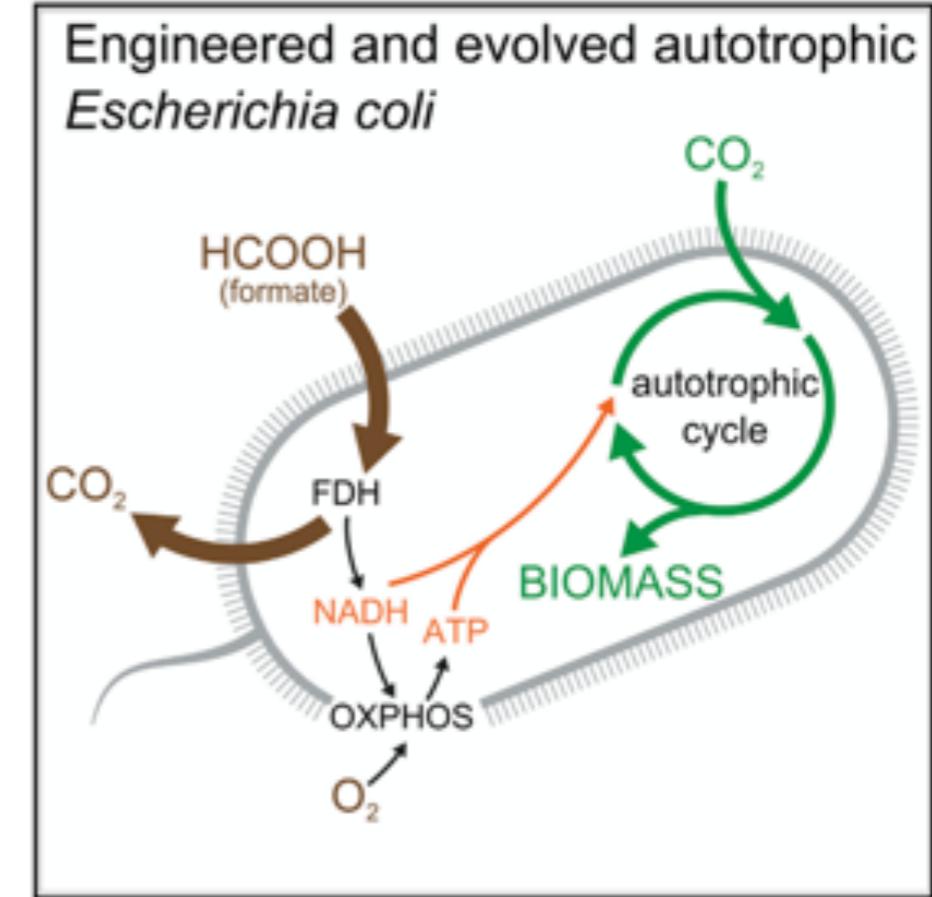
I.e., reverse osmosis + pumping to 1000m average elevation?

From electricity to formate, from formate to bio-stuff



**Electroreduction of Carbon Dioxide to Formate
by Homogeneous Ir Catalysts in Water**

Ryoichi Kanega*, Naoya Onishi, Lin Wang and Yuichiro Himeda*

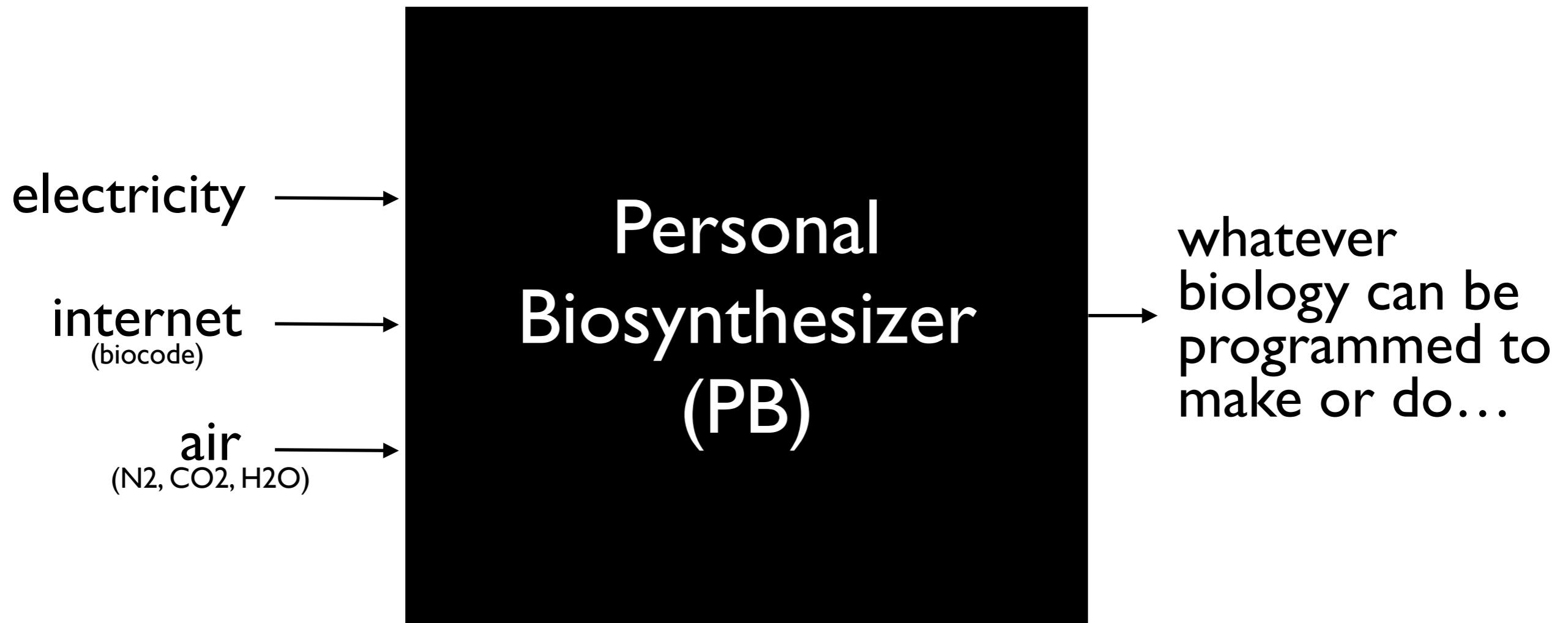


Gleizer et al., 2019, Cell 179, 1255–1263
November 27, 2019 © 2019
<https://doi.org/10.1016/j.cell.2019.11.009>

~1 kWh electricity = ~ 1 (to 30) grams biomass
~\\$0.11 = ~ 1 (to 30) courses of antibiotics

*electrobiosynthesis removes 90TW cap on building with biology

Q. How will this box change the world?



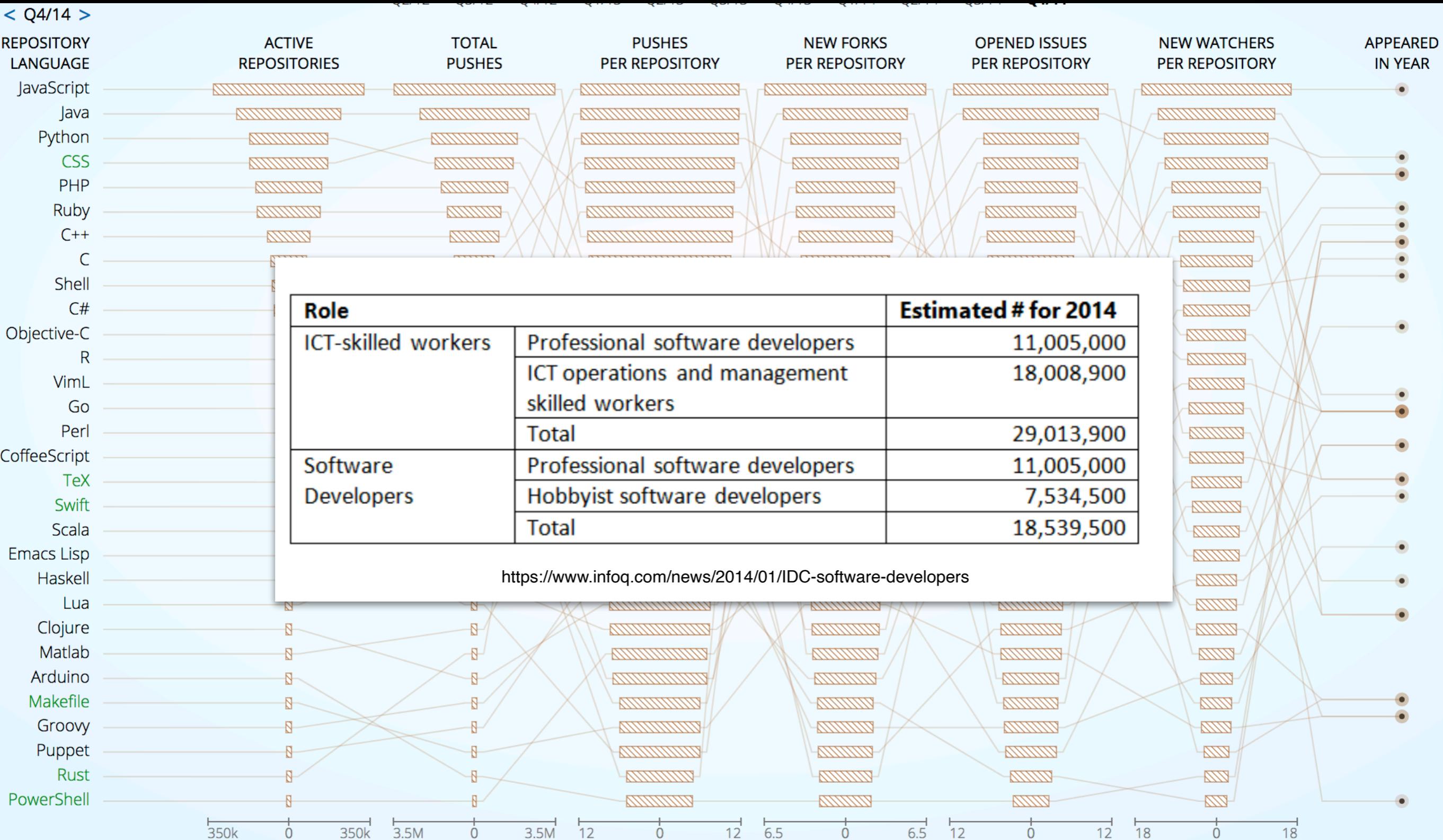
Q. What will the “PB” + the “bionet” lead to?

A. “design anywhere, grow everywhere”

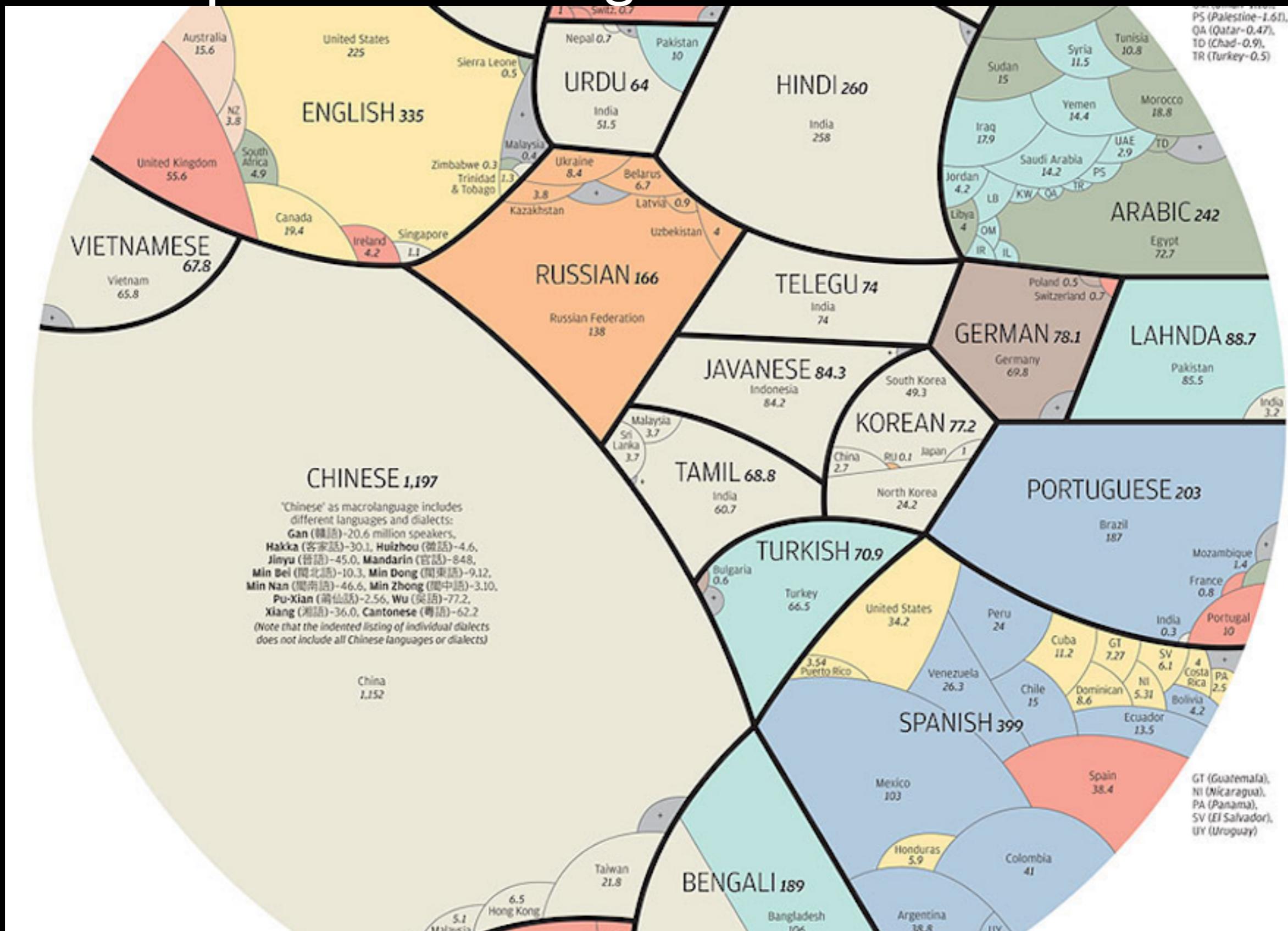
How many people should have the option of learning
to read & write DNA? Of bioengineering cells?



How many people should have the option of learning to read and write computer programs?



How many people should have the option of learning to read and write?



How do we govern the press? Speech?

Brandenburg v. Ohio

Court case



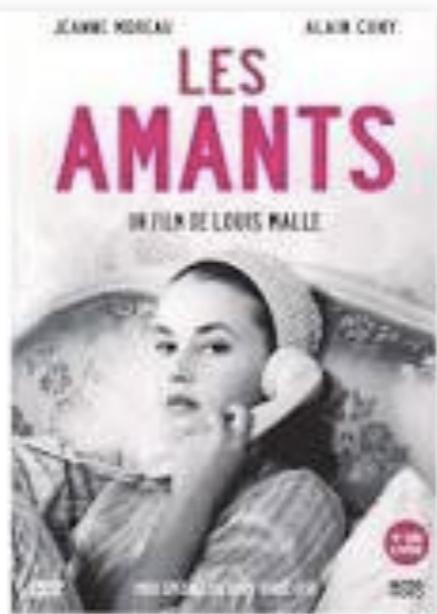
Brandenburg v. Ohio, 395 U.S. 444, was a landmark United States Supreme Court case based on the First Amendment to the U.S. Constitution. [Wikipedia](#)

End date: 1969

Ruling court: Supreme Court of the United States

“The Court held that government cannot punish inflammatory speech unless that speech is directed to inciting, **AND** is likely to incite, imminent lawless action.”

How do we govern the press? Speech?

Jacobellis v. Ohio 

Jacobellis v. Ohio, 378 U.S. 184, was a United States Supreme Court decision handed down in 1964 involving whether the state of Ohio could, consistent with the First Amendment, ban the showing of the ... [Wikipedia](#)

End date: 1964

Ruling court: Supreme Court of the United States

“I shall not today attempt further to define the kinds of material I understand to be embraced within that shorthand description ["hard-core pornography"], and perhaps I could never succeed in intelligibly doing so. **But I know it when I see it**, and the motion picture involved in this case is not that.” — USSC Justice Potter Stewart

A Mass Murder of, and for, the Internet

By [Kevin Roose](#)

March 15, 2019

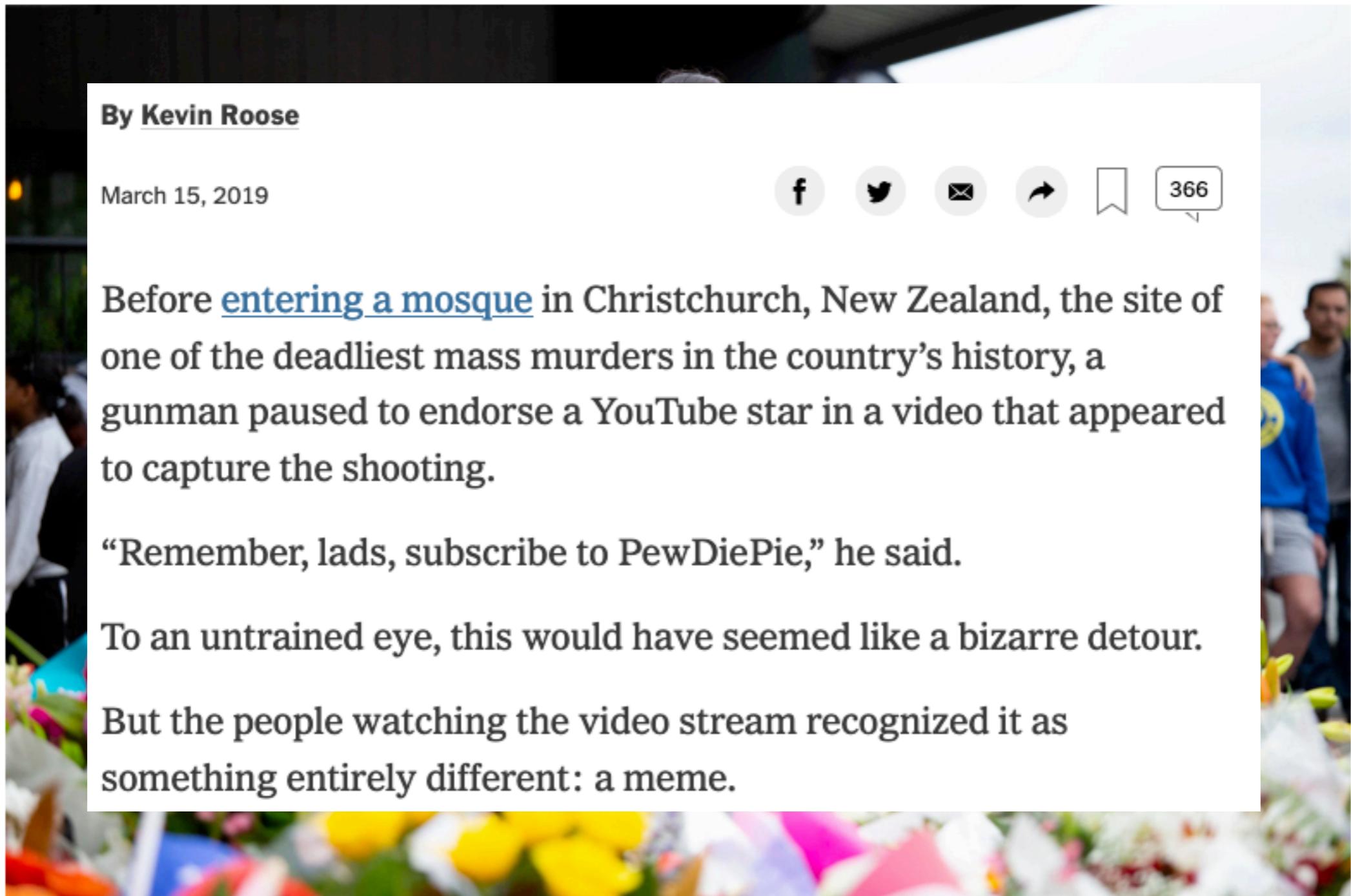


Before [entering a mosque](#) in Christchurch, New Zealand, the site of one of the deadliest mass murders in the country's history, a gunman paused to endorse a YouTube star in a video that appeared to capture the shooting.

"Remember, lads, subscribe to PewDiePie," he said.

To an untrained eye, this would have seemed like a bizarre detour.

But the people watching the video stream recognized it as something entirely different: a meme.



A prayer after leaving a tribute near Al Noor mosque in Christchurch, New Zealand, on Saturday. Forty-one people died there, the authorities said. Cornell Tukiri for The New York Times



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