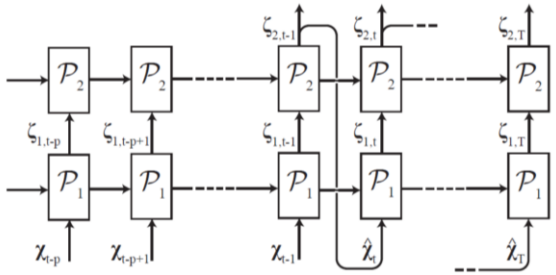
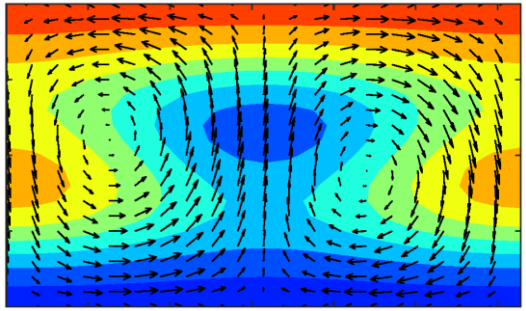
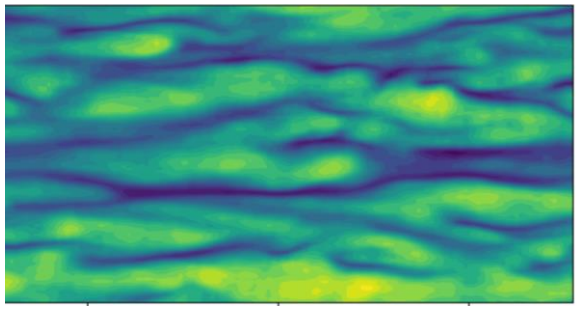
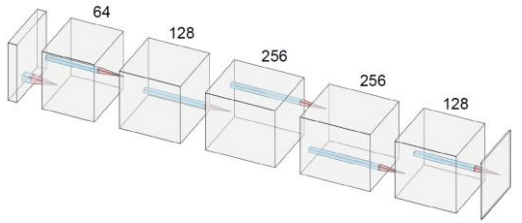
AI and Sustainability
The 4IR – Key issues in the post-pandemic era

Ricardo Vinuesa[1,2]









[1]SimEx/FLOW, KTH Engineering Mechanics, Stockholm, Sweden.

[2]Swedish e-Science Research Centre (SeRC), Stockholm, Sweden.

The Sustainable Development Goals (SDGs)

- 2**030 Agenda for Sustainable Development adopted by all United Nations Member States in 2015**

- Shared blueprint for peace and prosperity for people and the planet

- Recognize that **ending poverty and other deprivations must go hand-in-hand** with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling **climate change** and working to **preserve our oceans and forests**

- **17 different** Sustainable Development Goals (SDGs)**; 169** targets

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Motivation

- We want to answer the question: “Is there published evidence of **AI acting as an enabler or an inhibitor for each of the SDG targets**?”

Vinuesa et al., Nature Communications 11, 233 (2020)

Motivation

- We want to answer the question: “Is there published evidence of **AI acting as an enabler or an inhibitor for each of the SDG targets**?”
- We needed to assemble a **multi-disciplinary team** spanning the wide range of required areas of knowledge.

FLOW **Vinuesa et al., Nature Communications 11, 233 (2020)**

The team

R. Vinuesa
Fluid mechanics,
Applied AI

H. Azizpour
AI fundamentals

I. Leite
AI and social
interaction

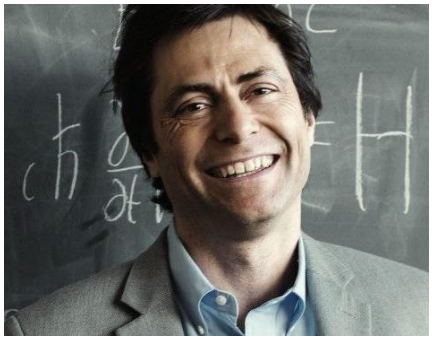
M. Balaam
Interaction
design

V. Dignnum
AI ethics

S. Domisch
Biodiversity

A. Felländer
AI ethics

S. D. Langhans
Freshwater
ecology



M. Tegmark
Cosmology,
Applied AI

F. F. Nerini
Energy systems,
sustainability

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Dividing the 17 SDGs into 3 main pillars

- We divided the 17 SDGs into 3 main categories (Stockholm Resilience Center, 2017; United Nations, 2019): **Society, Economy, and Environment.**

Vinuesa et al., Nature Communications 11, 233 (2020)

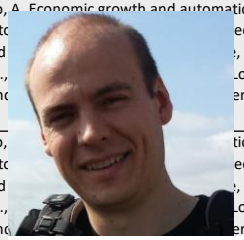
Consensus-based expert-elicitation process

	GOAL OR TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence of AI acting*		REASONING	REFERENCES FOUND
		AI ENABLER	*AI INHIBITOR*		
Goal 1: End poverty in all its forms everywhere. Main contributors: RV. Reviewers: MB.					
1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day			We identified in the literature studies suggesting that AI may be an inhibitor for this target, due to the potential increase in inequalities which would hinder the [illegible] to foster international collaboration (2).	(1) Nagano, A. Economic growth and automation risks in developing countries due to the transition to [illegible] Theory and [illegible] (2) Jean, N., [illegible] imagery and [illegible]
1.2	By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions			target, since it may lead to an increase of inequalities (1). Nevertheless, alternative views reflect that AI can enable this goal, through the use of satellite data to track areas of poverty and foster international collaboration (2); through the analysis of data from phone usage in order to predict income levels, with the aim of [illegible]	(1) Nagano, [illegible] transition to [illegible] Theory and [illegible] (2) Jean, N., [illegible] imagery and [illegible] (3) Sundsoy [illegible] mobile pho[illegible] Conference [illegible] 4) Brynjolfs[illegible] time of br[illegible] (5) Mossad, [illegible] index (SPI) u[illegible] (2018). (A)
1.3	Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable			AI may benefit the achievement of this target through the analysis of satellite data to track areas of poverty (1), or assessing data from phone usage to predict income levels and develop plans of action to avoid poverty (2). Some authors, however, claim that the advent of AI will increase economical inequalities, leaving the poor with even less resources (3). Although there is some preliminary research addressing the implementation of policies related to AI (4), this gives raise to a number of derived challenges (5).	(1) Jean, N., [illegible] imagery and [illegible] (2) Sundsoy [illegible] mobile pho[illegible] Conference [illegible] (3) Mokyr, J [illegible] Cures, Eds. [illegible] CEPR (2014) (4) Wang, W [illegible] In: Proceedi[illegible] Louis, US (2[illegible]

1 reference (inhibitor)

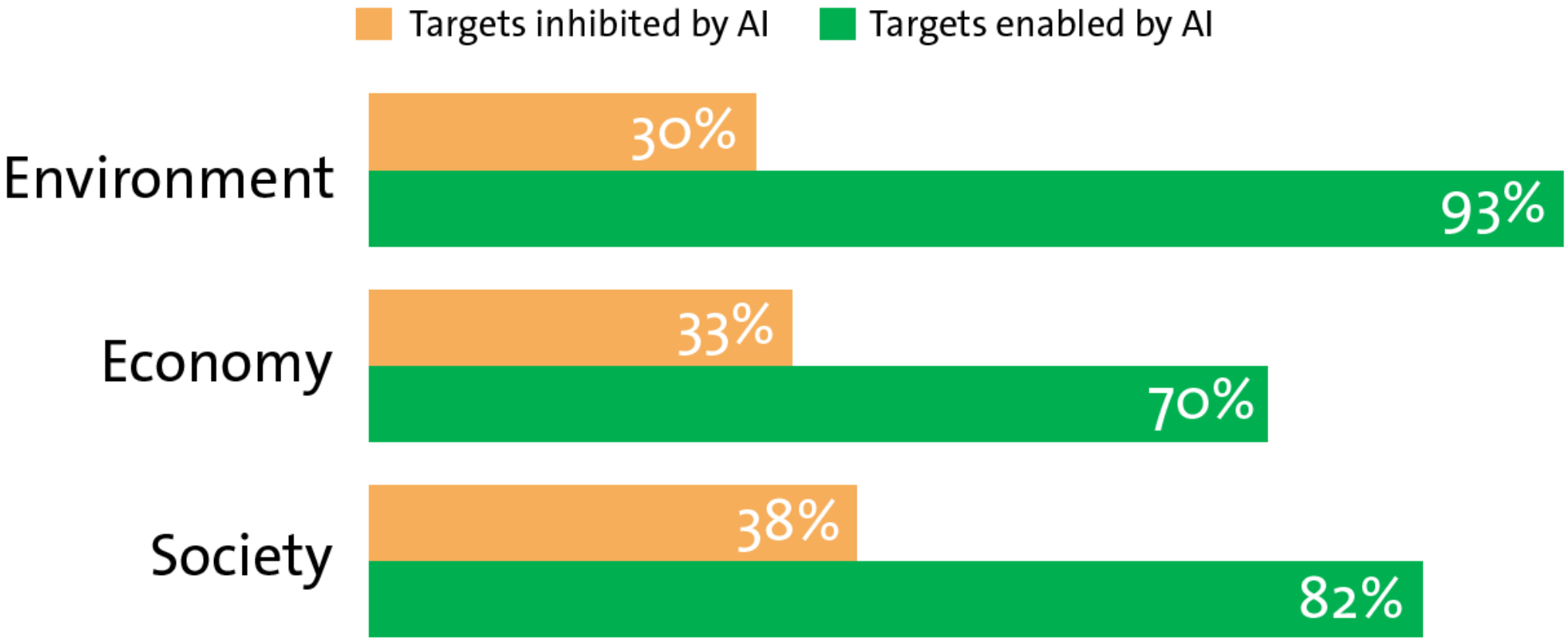
1 reference (enabler)

No evidence



Impact of AI on each of 169 targets

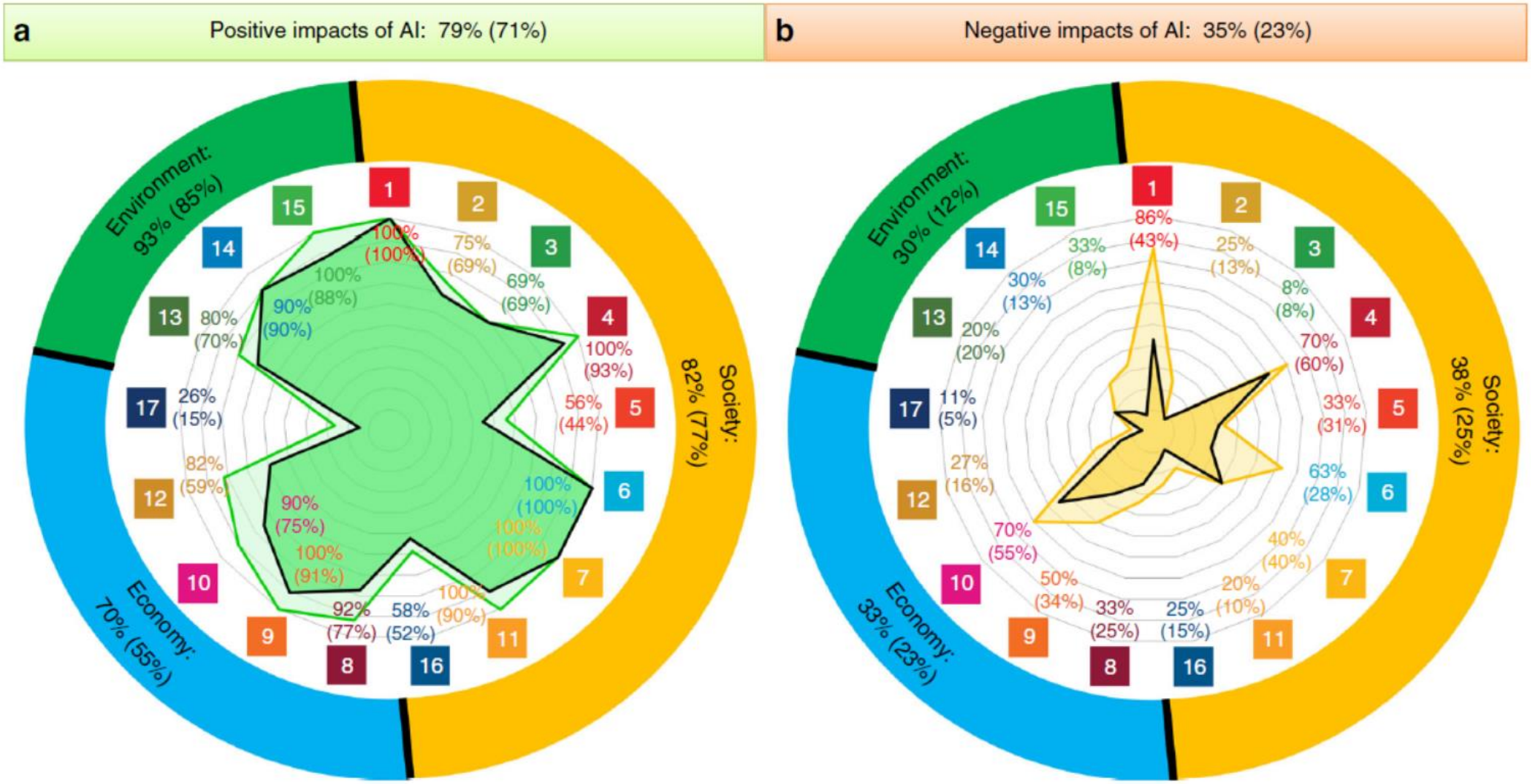
- We divided the 17 SDGs into 3 main categories (Stockholm Resilience Center, 2017; United Nations (2019): **Society, Economy, and Environment.**
- Percentage of targets where **positive (79%)** or **negative (35%)** impact of AI is documented:



Vinuesa et al., Nature Communications 11, 233 (2020)

Results

- **Environment and Society <u>higher reduction of negative</u>; Economy the opposite.**



Vinuesa et al., Nature Communications 11, 233 (2020)

Types of evidence

- References using sophisticated tools and data to refer to this particular issue and with the possibility to be generalized are of type (A). **1**
- Studies based on data to refer to this particular issue, but with limited generalizability, are of type (B). **0.75**
- Anecdotal qualitative studies and methods are of type (C). **0.5**
- Purely theoretical or speculative references are of type (D). **0.25**

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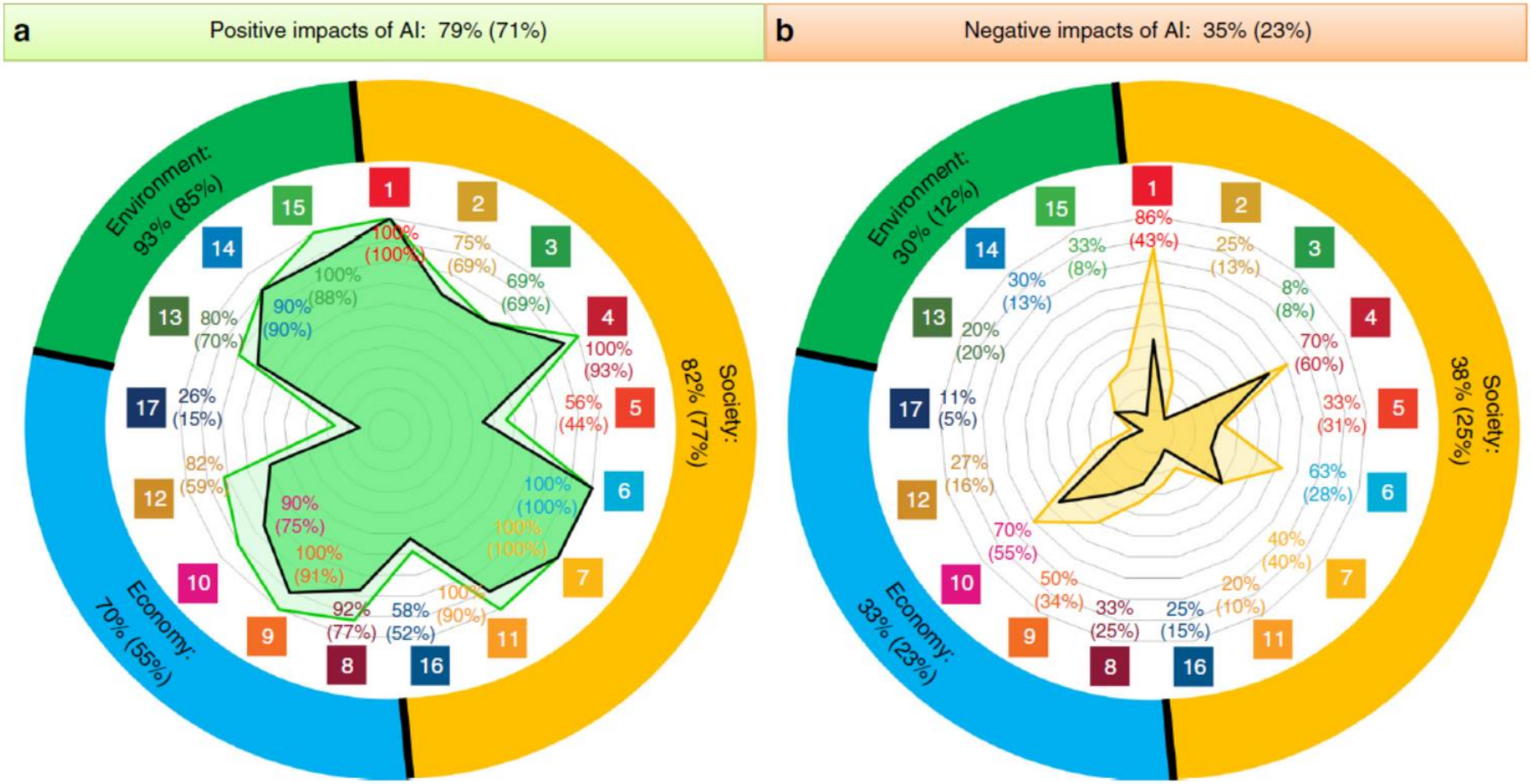
Types of evidence

- **Environment and Society higher reduction of negative; Economy the opposite.**



Vinuesa et al., Nature Communications 11, 233 (2020)

Some key results

- **POSITIVE:** AI-enabled technology which may help overcome current barriers (**satellite data** to track poverty, SDG1).

- **NEGATIVE:** Uneven opportunities to access AI resources may end up **increasing inequalities** (SDG 10).

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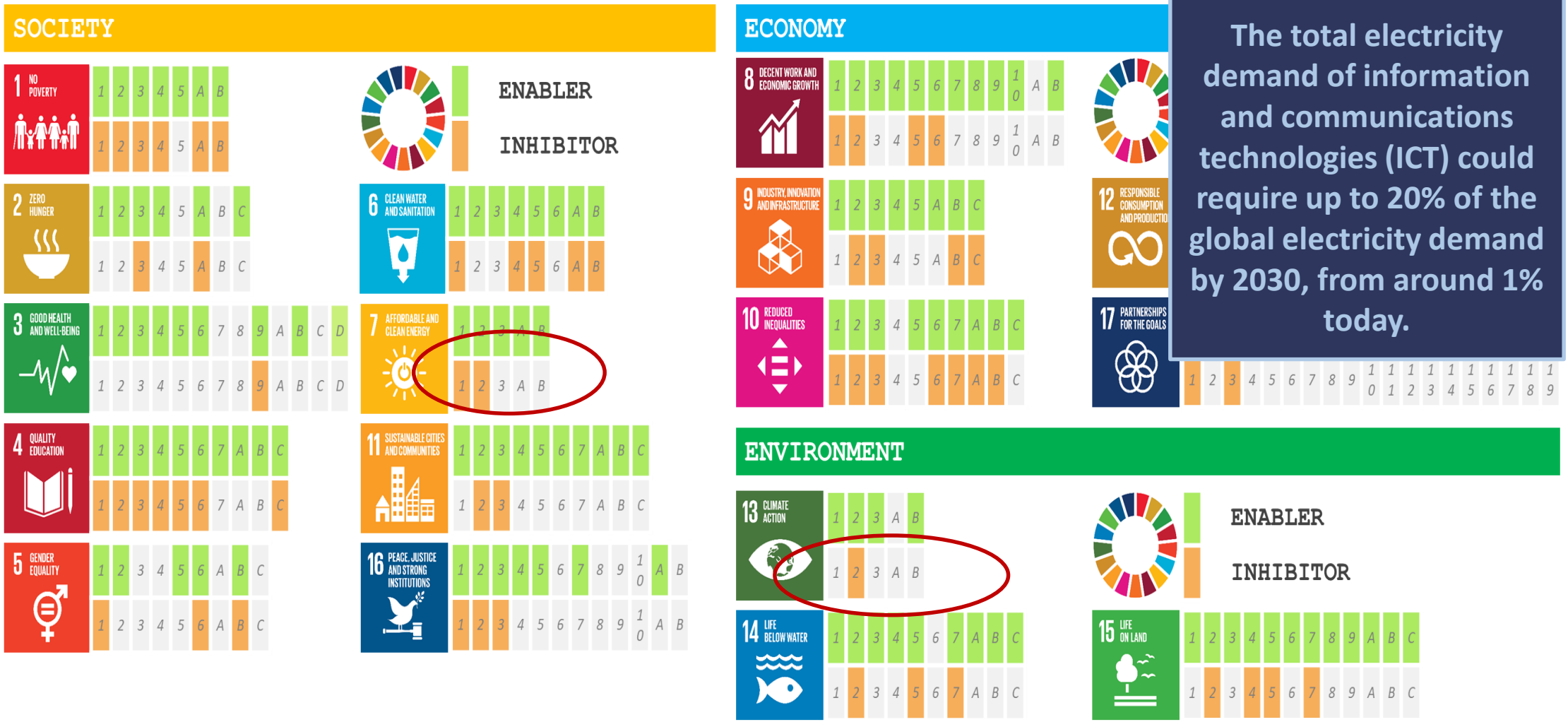
Other risks

- **NEGATIVE:** Political polarization, biased election outcomes, hatred for minorities and increased nationalism. If AI is developed in the absence of ethical scrutiny, it can further **polarize societies**.

- **Regulatory *oversight* should be preceded by regulatory *insight***, where policymakers have sufficient understanding of AI challenges to be able to formulate sound policy. Developing such insight is even more urgent than oversight, since policy formulated without understanding is likely to be ineffective at best and counterproductive at worst

Vinuesa et al., Nature Communications 11, 233 (2020)

Some key results



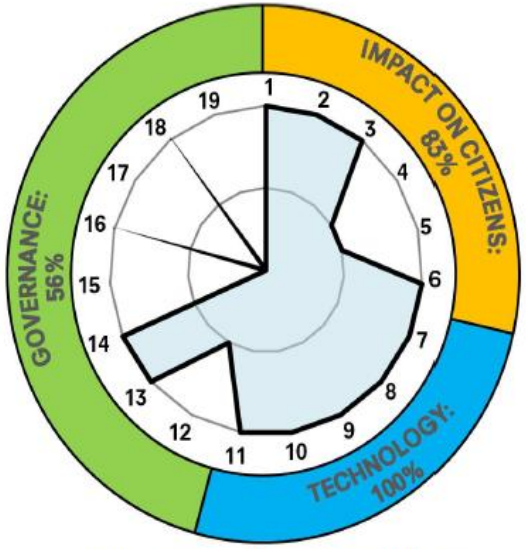
However, at the same time, AI can have large effects on the global energy demand.

The total electricity demand of information and communications technologies (ICT) could require up to 20% of the global electricity demand by 2030, from around 1% today.

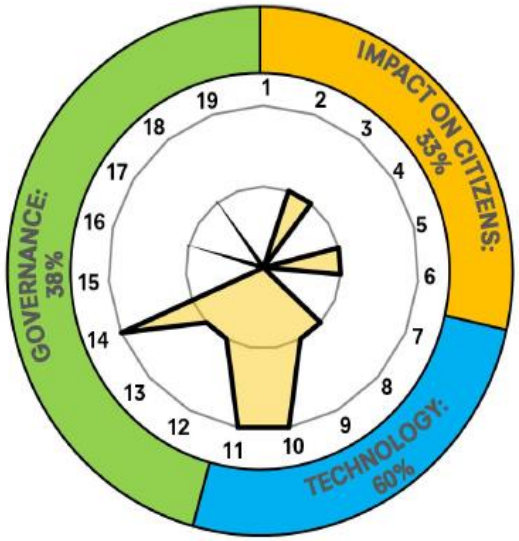
Vinuesa et al., Nature Communications 11, 233 (2020)

A socio-technical framework for digital contact tracing: A COVID-19 example of data-driven method

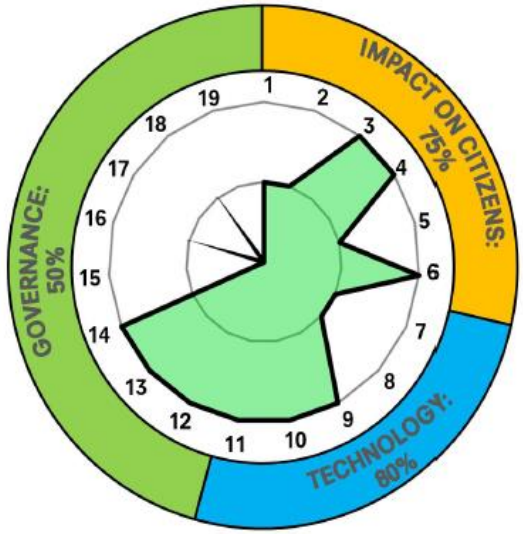
- **Digital contact tracing** has implications on SDGs 3 (on health) and 10 (inequalities).
- Avoid **centralized data gathering** and **AI-based predictions → DP-3T protocol.**
- Three apps under study, including the EDPB guidelines, **low scores in governance** (sunset clause, dual-use policy, right to contest).



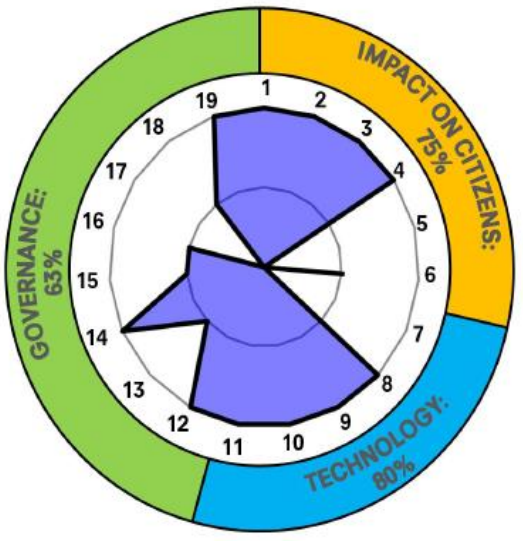
a) Stopp Corona [8] (76% compliance).



b) NHS COVID-19 [9] (42% compliance).



c) TraceTogether [10] (66% compliance).

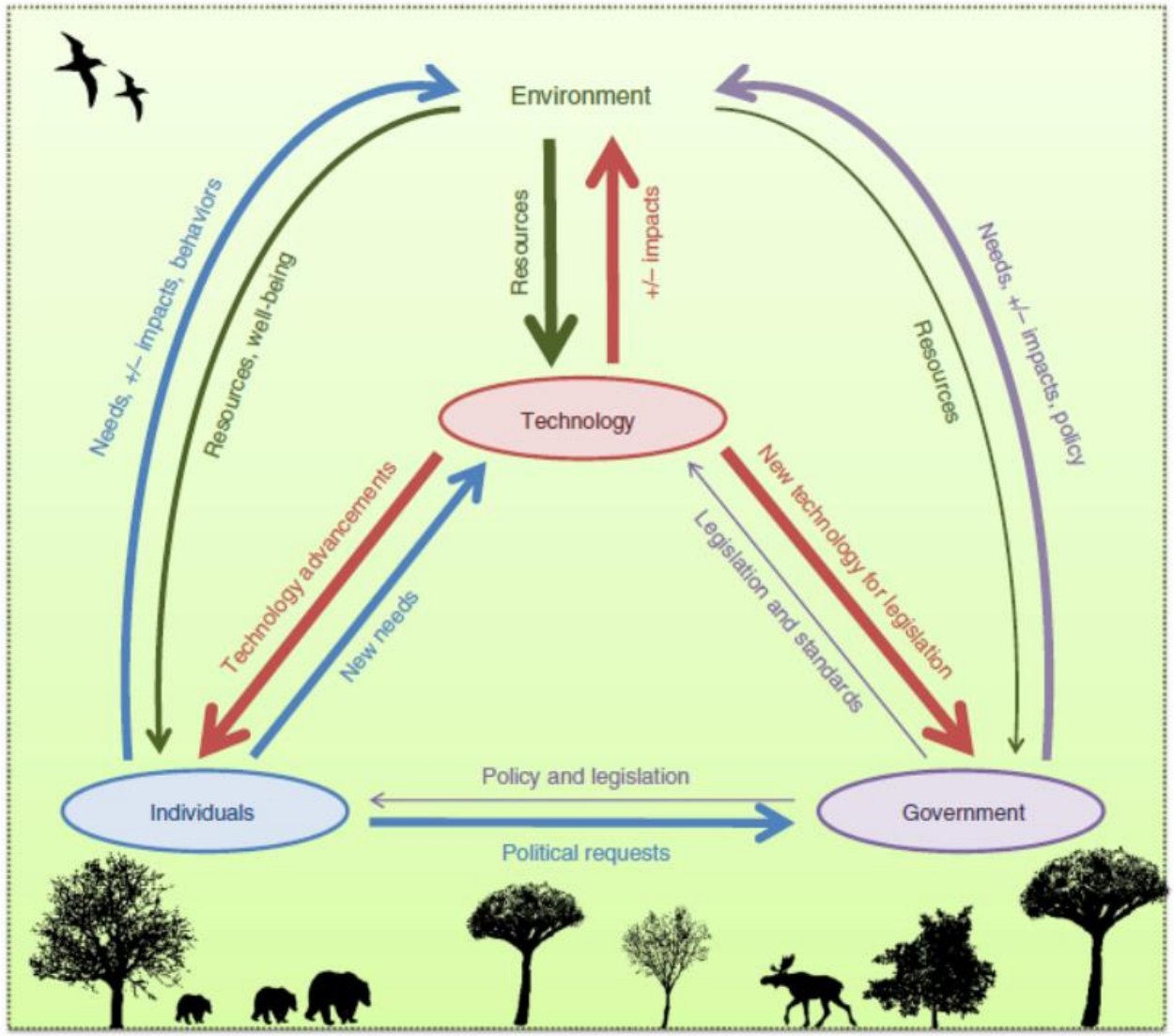


d) EDPB guidelines [4] (71% compliance).

Vinuesa et al., Results in Engineering 8, 100163 (2020).

Interaction of AI with society: Very fast development of technology

Thicker arrows = Faster change



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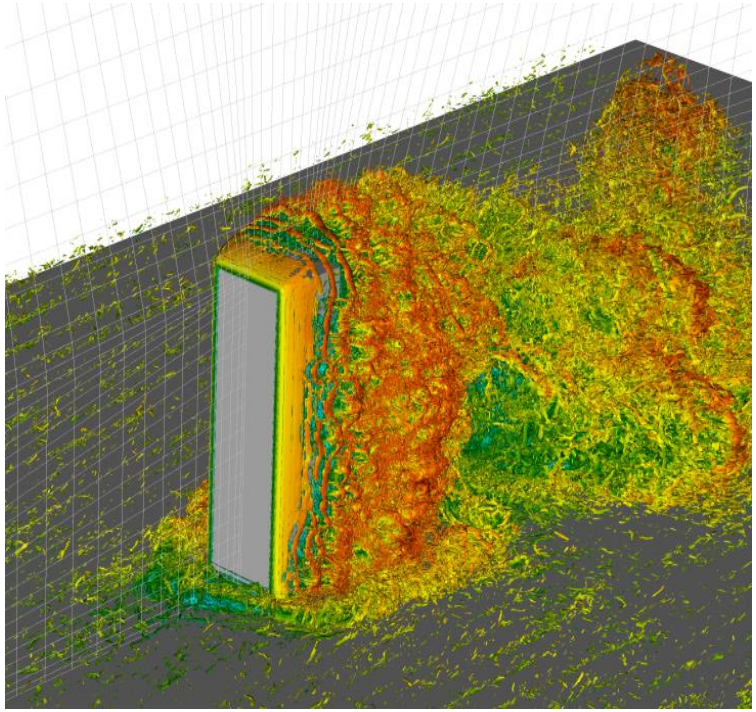
One application: SDG11 on sustainable cities

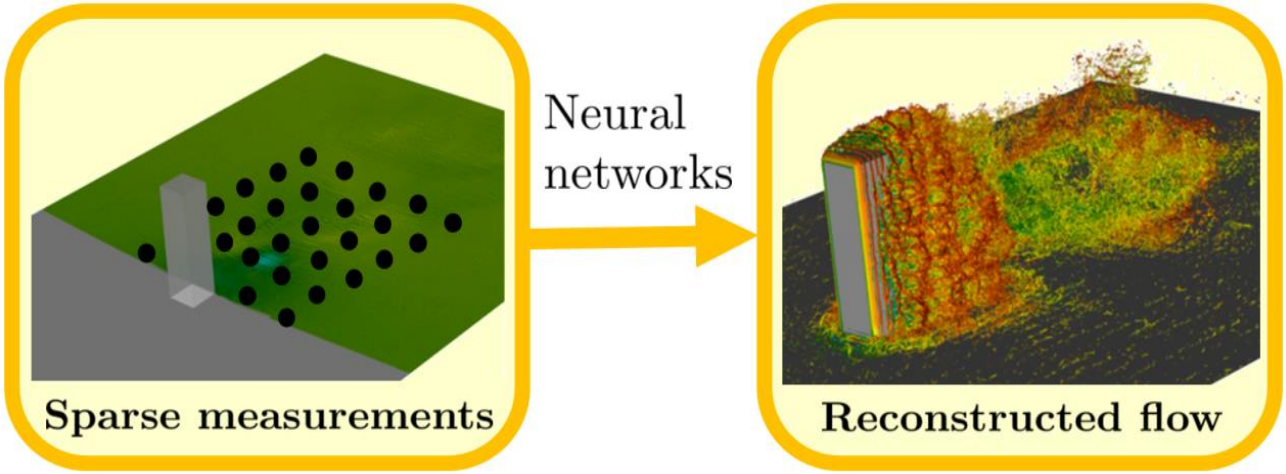
- **POSITIVE:** Positive impact of AI on all 10 targets within SDG 11 on sustainable cities. In particular, AI will be able to help us build more accurate and robust **technology to measure air pollution in cities**, which causes 800,000 deaths each year in Europe alone.

Vinuesa et al., Nature Communications 11, 233 (2020)

Non-intrusive sensing in urban flows

- Using highly detailed simulations, we can reproduce the **flow in complex urban** environments.
- Use AI to **improve pollution measurement**.





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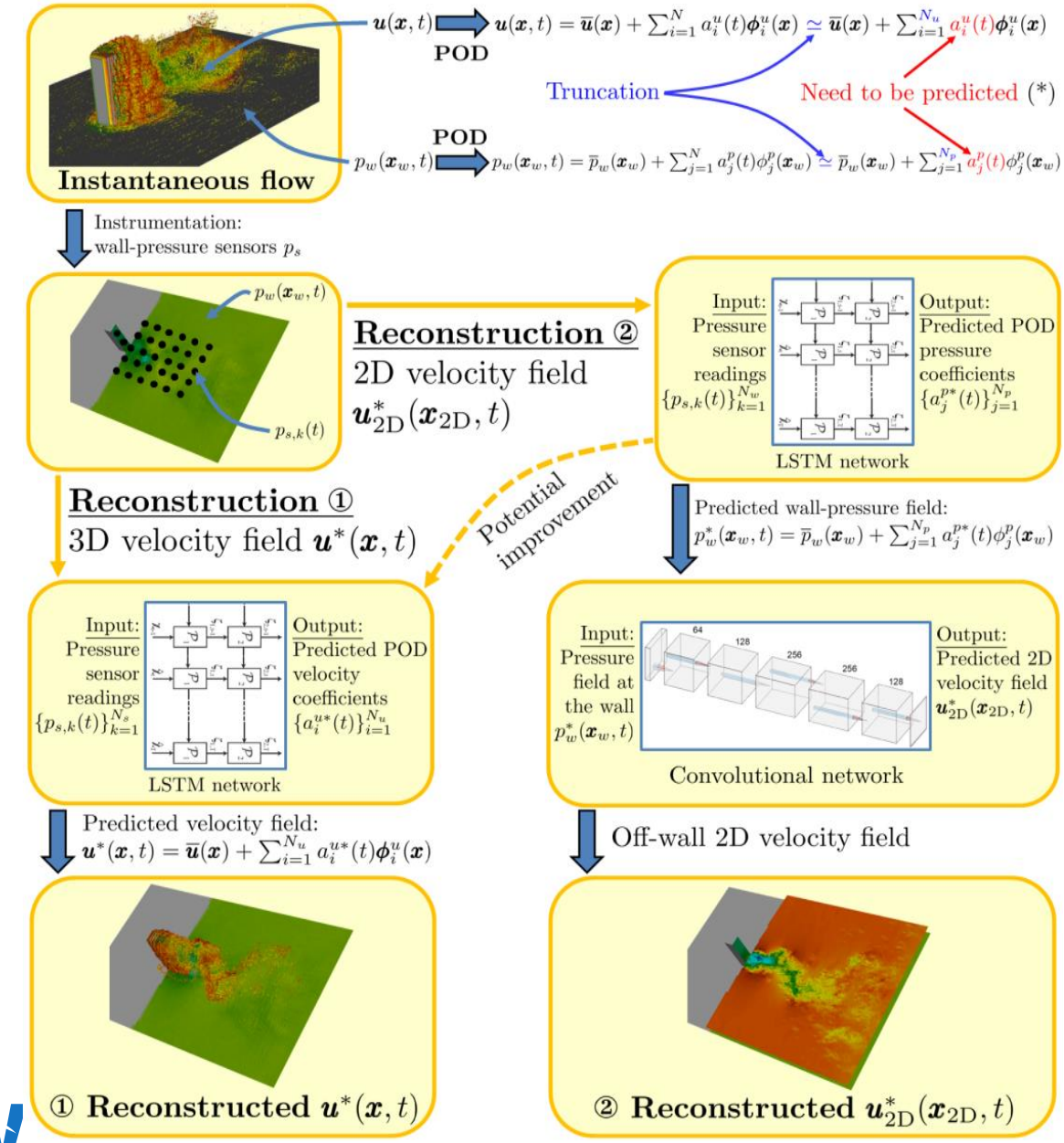
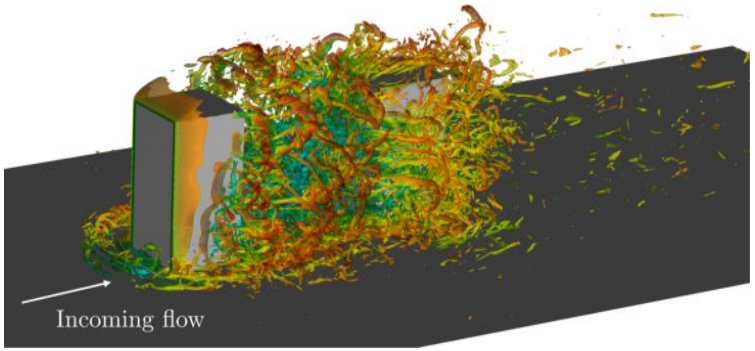
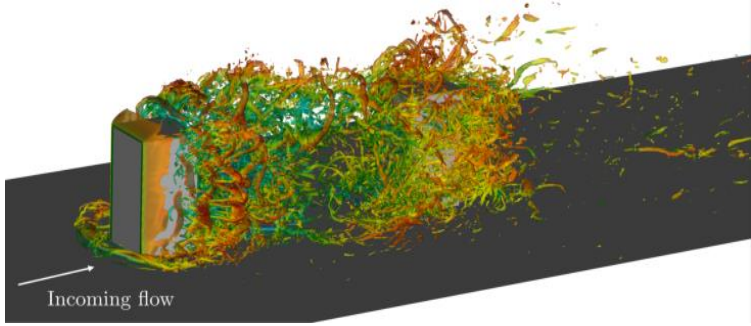
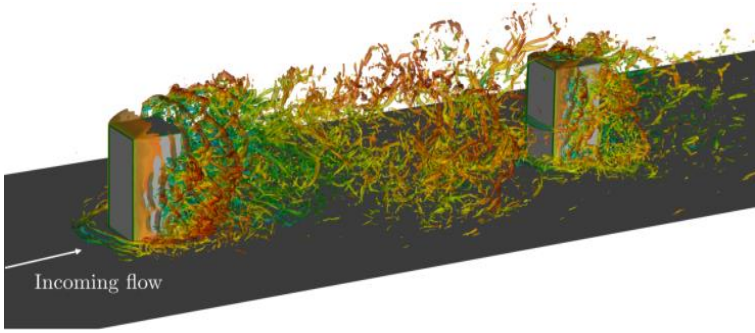
Non-intrusive sensing in urban flows









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Torres, Le Clainche and Vinuesa, Energies 14, 1310 (2021)

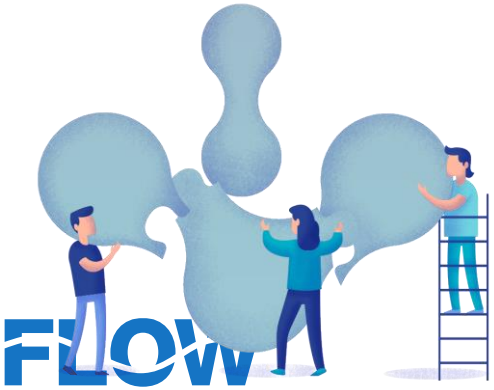
Summary and Conclusions

1. ***AI IS ALREADY AFFECTING EVERYONE´S LIVES***
   - **Positively**: e.g. smart grids and cities, e-health
   - **Negatively**: ´big nudging´, citizens scores

2. ***AND THAT WILL ONLY INCREASE, POTENTIALLY ENABLING AN AI-FUELED SUSTAINABLE DEVELOPMENT <u>BUT</u>***
   - Technology evolves **faster** than citizens and govenements
   - Large **research gaps** to manage the transition
   - **Vulnerability** of infrastructures

3. ***SUBSTANTIAL WORK IS NEEDED FOR OVERCOMING AI GAPS IN TRANSPARENCY, SAFETY AND ETHICAL STANDARDS***

Thank you for your attention!



AI-based technology

- **Perception** (e.g. face recognition)
- **Decision-making** (e.g. medical diagnosis; conservation planning)
- **Prediction** (e.g. weather forecast)
- **Automatic knowledge extraction and pattern recognition from data** (e.g. discovery of fake news circles in social media)
- **Interactive communication** (e.g. social robots or chat bots)
- **Logical, semantic reasoning**

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