CYBER-PHYSICAL SYSTEMS & CLIMATE CHANGE AGENDA:

ISSUES & LINKAGES FOR CONSIDERATION

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OUTLINE

- Intro to impact assessment and its changing context
- Initial scoping of environmental (and social) impacts of cyber-physical systems uptake
- Questions and next steps

IMPACT ASSESSMENT

IAIA: IA is a process of identifying the future consequences of a current or proposed action

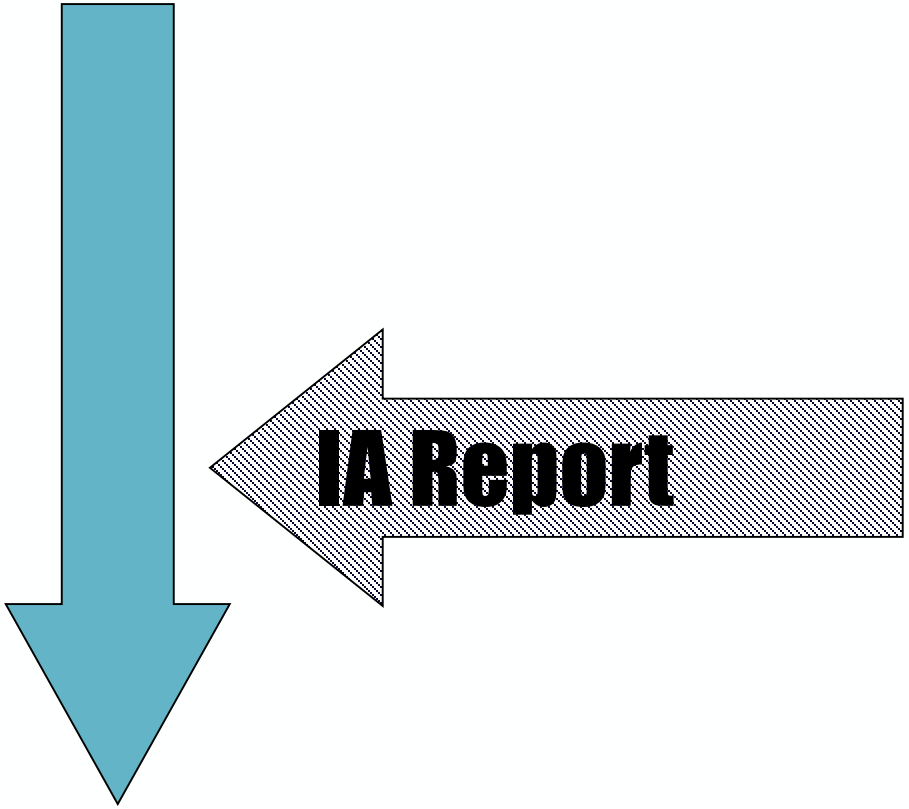
National Energy Policy (and its updates)

Regional energy plans, land-use plans, etc. (and their updates)

Power production projects, power grids, supporting infra, etc. (and their modifications)

EX-POST 'EX-ANTE' ASSESSMENT

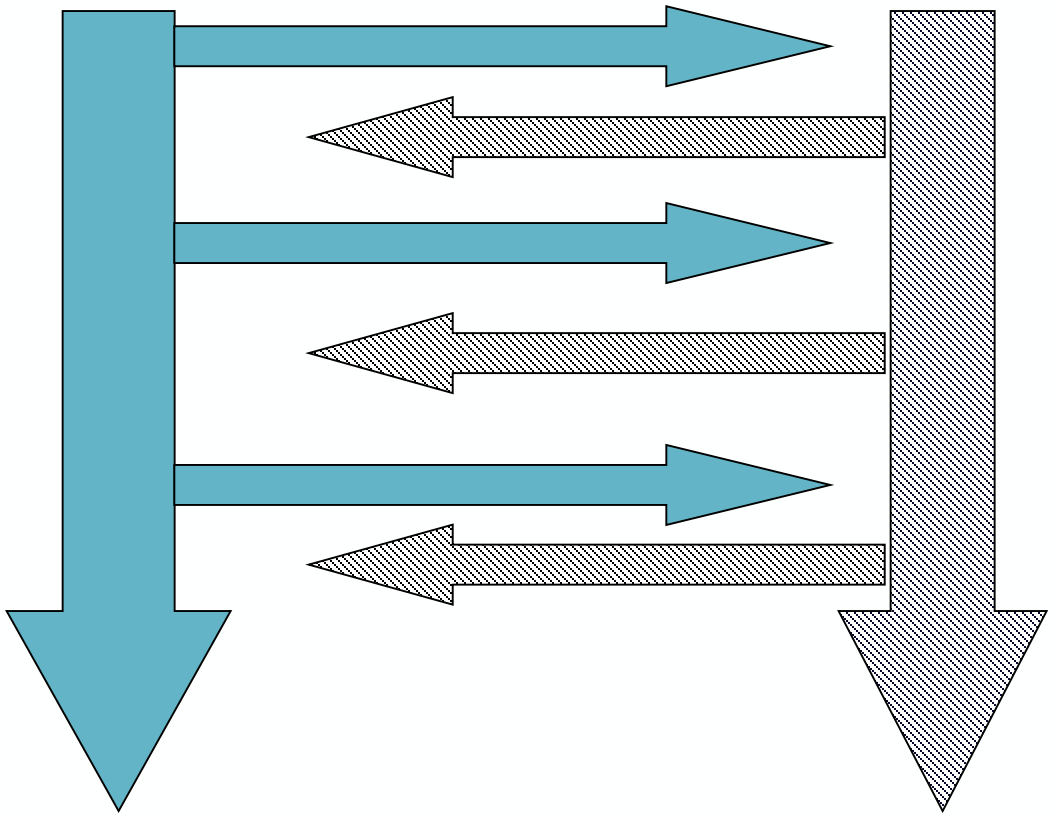
Planning Process **IA Process**



TOO LATE

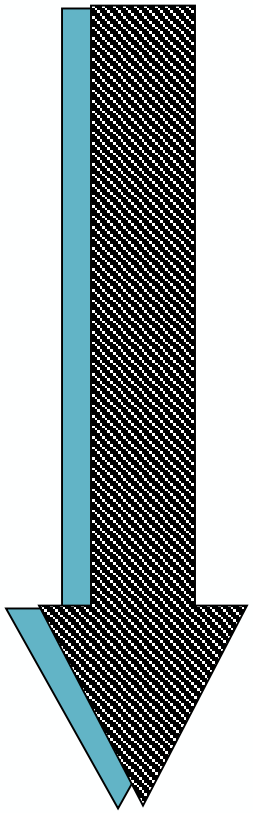
PARALLEL ASSESSMENT

Planning Process **IA Process**



FULLY INTEGRATED ASSESSMENT

Planning Process + IA Process indistinct



CHANGING CONTEXT

- Global mega-trends (climate change, biodiversity, land-use, resource use, etc.) shrink safe operating space for humanity
- driven through production and consumption patterns and decisions outside scope of traditional IA
- cyber-physical systems will shape future developments, yet escape IA obligations

EXPECTATIONS

- Industry 4.0 guarantees better products, more efficient production methods and bespoke industrial services
- …..virtual roof to satisfy the **mass customization demands of society**, reap the benefits of the internet revolution, and
- …..perhaps most importantly finally begin to **take the word sustainability seriously and treat resources with more respect**.

Roland Berger

Questions regarding emerging technologies

China's Electric Buses Save More Diesel Than All Electric Cars Combined

Tesla and other electric cars are great for the environment. However, they pale in comparison to electric buses. According to a report from Bloomberg New Energy Finance (BNEF), electric buses will save...

STRATEGIC ENVIRONMENTAL AND SOCIAL ASSESSMENT - SCOPING

- Prepared with Thomas Fischer, Riki Therivel, Barry Sadler & Ivana Šarić in 2017-2018

- Initial overview
- basic features of emerging technologies, their uptake forecasts,
- potentially significant environmental implications & uncertainties

- summary: bit.ly/sesaauto0
- full paper: bit.ly/sesaauto1

SCOPING

- **Screening & scoping – presentation of proposal and identification of key concerns (possibly initial objective-led appraisals/assessments)**
- Full assessment
  - **Issue-based studies: baseline analyses, assessment of impacts & implications, consideration of alternatives & mitigation & enhancement measures)**
  - **Integrated presentation (cumulative & synergistic impacts, analysis of options, priority recommendations)**
- Review by relevant authorities and public
- Decision-making
- IA follow-up (monitoring & mgmt., tiering, flanking measures, etc.)

APPROACH USED

Review of literature (no consultations):

- Additive manufacturing
- Industrial robotics
- Autonomous transport
- Internet of Things
- Artificial Intelligence

Env. impacts eventually clustered into basic categories:

- GHG emissions,
- non-GHG emissions,
- resource use (incl. waste) and
- ecosystem use

PLEASE FORGIVE POTENTIAL NAIVETY

WE DID NOT KNOW ABOUT TECHNOLOGY ASSESSMENT PROCESSES WHEN WE STARTED ….

3D printing - recycled plastics

Source: Dezeen.com

ENV/CC BENEFITS

- **more responsive** modes of **production**
- decentralized production near consumers and **reduces transport demands**
- novel designs that can be more **energy-efficient and functional**
- easy prototyping and **lower energy demand in low production runs**
- **less waste** during the production proces

ENV/CC RISKS

- **higher energy consumption** in case of production of large quantities of products (depending on choice of 3D printers and their actual set-up)
- **energy requirements** for production of **filamnets**
- waste generated though **overconsumption** in case of affordable 3D products
- **new chalenges for recycling** of composite materials

Advanced industrial robotics: Robots and co-bots

Source: Inverse.com

ENV/CC BENEFITS

- automated **demand-responsive production**
- opportunities for **digitized environmental monitoring and management** and potentially also for environmental accounting systems
- **reduced** human **exposure** to potentially **hazardous jobs**
- use in **smart recycling systems**

ENV/CC RISKS

- **increased total energy intensity** of operations (depending on energy efficiency and their cooling requirements)

- Increasing productivity and near-zero marginal cost of production may prompt business approches that **encourage consumption** (rebound effect)

Autonomous vehicles

Source: Wired.com

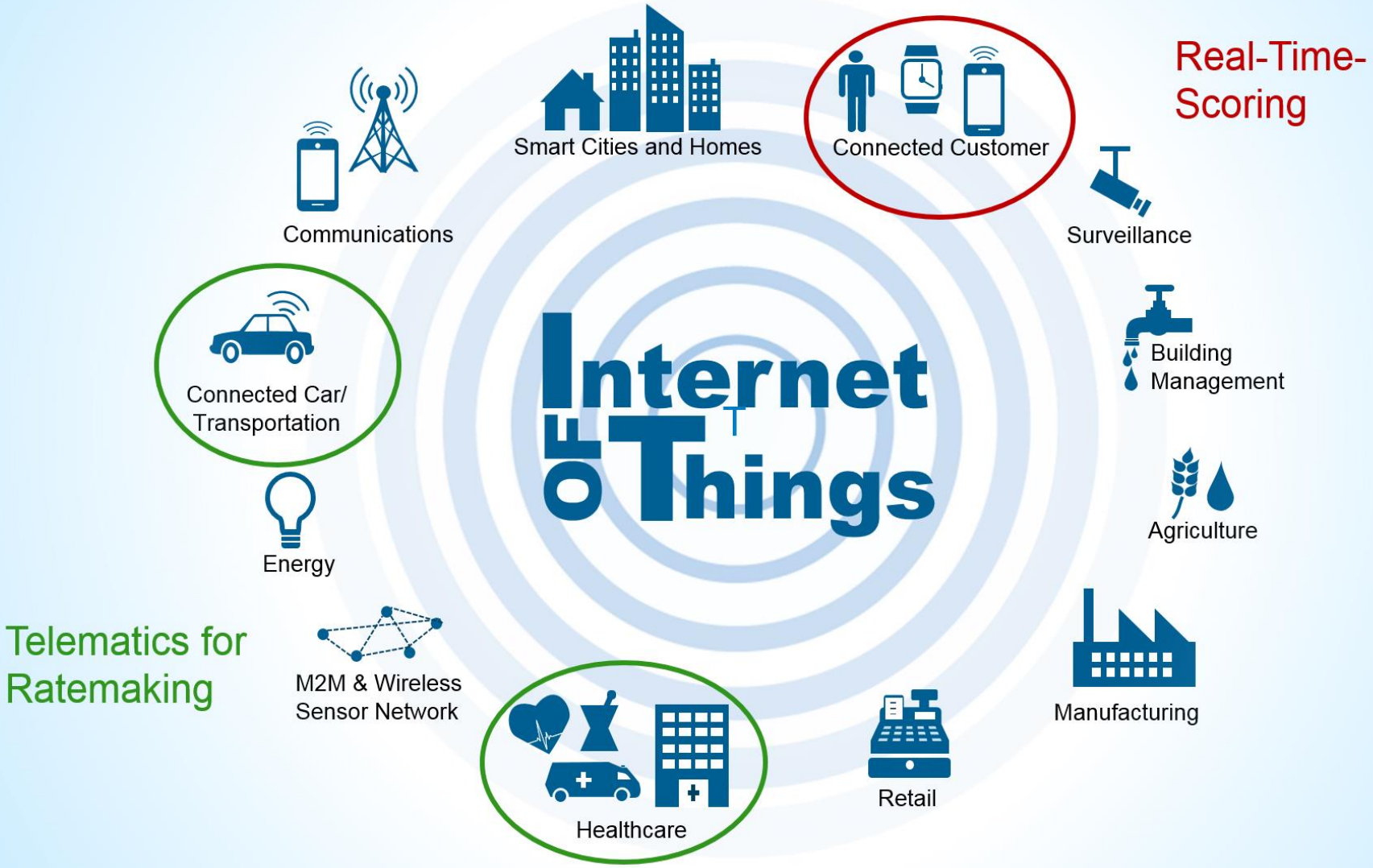
ENV/CC BENEFITS

- improved **road safety**
- **decreased air pollution** and **noise** through electrification
- **vehicle sharing** and **on-demand** mobility
- **optimization of transport flows** through vehicle-infrastructure communication
- **increased energy efficiency per km** through route predictions

ENV/CC RISKS

- **induced transport through** alteration of travel behaviour (route choice and vehicle hours travelled)
- potentially negative impact on **public transport**
- urban **sprawl**
- new **infrastructure requirements**
- unknown implications for **micromobility and slow mobility**
- **Energy & material demands** asscoiated with production and disposal of bateries (for EBVs)

Internet of Things



Picture **courtesy**: SAS.com

ENV/CC BENEFITS

- Improved **monitoring and management of energy use**, resource use and environmental issues of concern

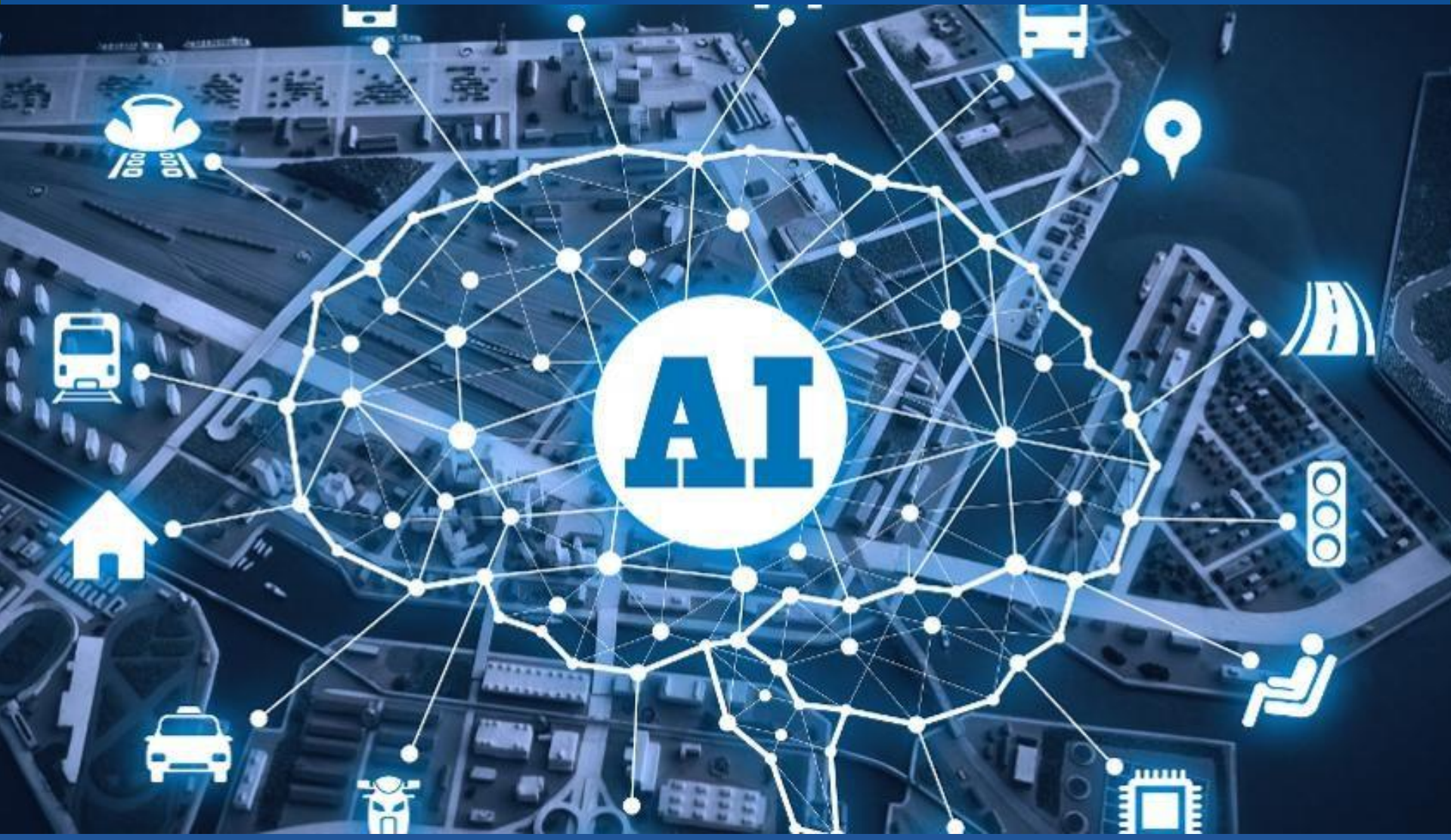
- Transparency in trading and supply chains and **improved product tracking**

ENV/CC RISKS

- **Increased total energy demands** of IoT devices, machine-machine interactions and transactions
- **Changes in consumer choices** (due to automated purchases or over-reliance on instructions given by IoT devices)

- **Material and energy demands** for production and maintenance of IoT components
- **Increased electronic waste** due to proliferation of electronic appliances and equipment

AI



Picture courtesy: houseofbots.com

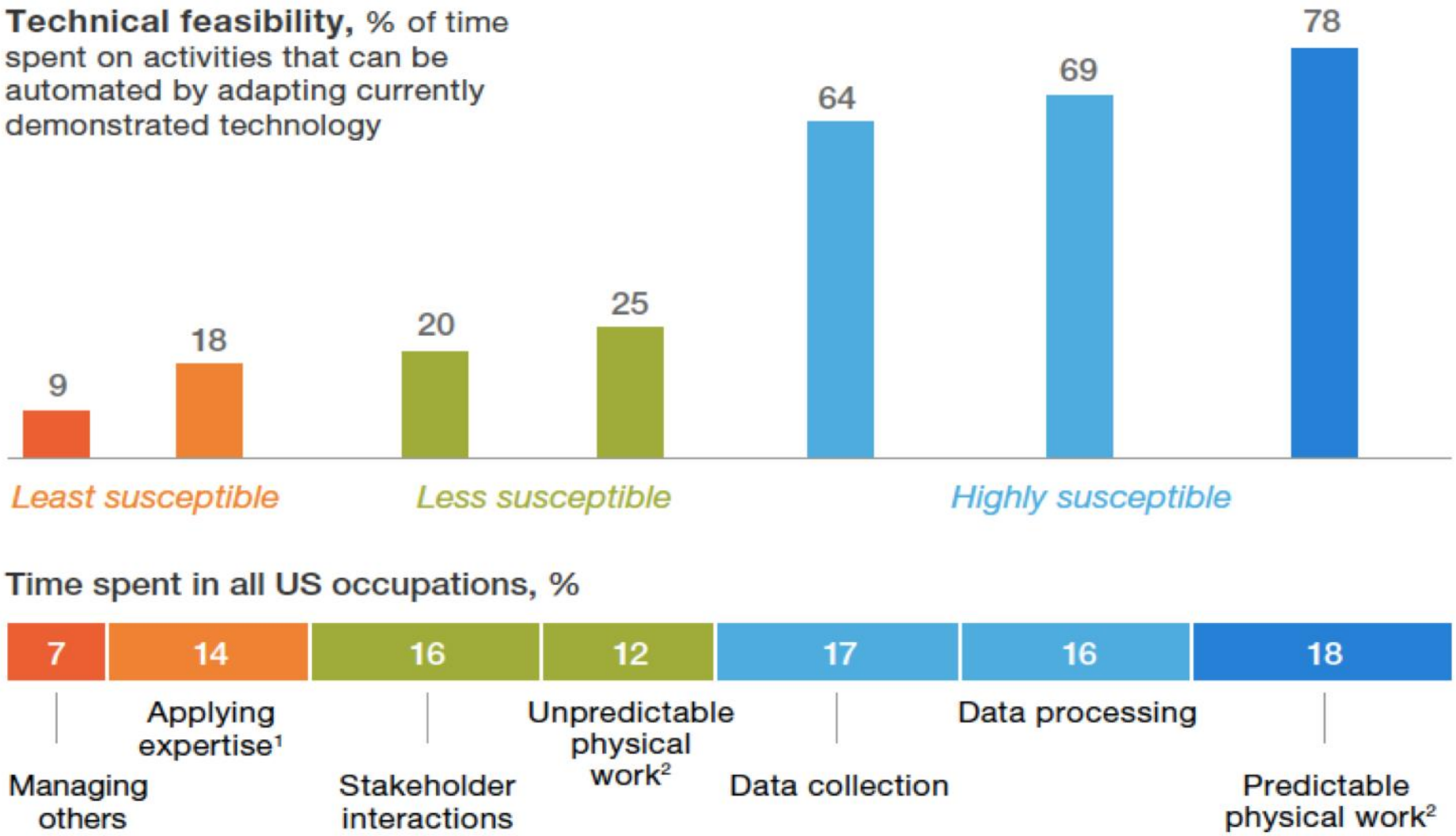
ENV/CC BENEFITS

- Multi-source **monitoring and verification of energy use**, natural resource use and environmental trends at different scales
- Data-driven choices and **system optimization (e.g. in energy and resource use)**
- **early detection** of emerging patterns and risks, **better forecasting and modelling** of response measures

ENV/CC RISKS

- **Total demand for electricity**
- Improved insights into resources availability can facilitate **stretch their utilisation to the limits**. (overfishing by AI powered drones)
- Combined **effects of competing or collaborating algorithms** and their control

Shifts in jobs and livelihoods



Source: McKinsey 2016

ENV/CC BENEFITS

Potential new green jobs in:

- **climate change adaptation and mitigation**,
- sustainable lifestyles, sustainable production and consumption,
- sustainable use of natural resources, and ecosystem restoration

ENV/CC RISKS

- Nature of new jobs unknown,
- Pressures on utilization of available natural resources (low-middle income settings)
- environmental pressures associated with expansion of the experience economy (generally)

- ??? green jobs and sustainable business models that actually reduce consumption depend on incentives

POTENTIAL OVERALL OUTCOMES

Best case scenario	GHG emissions	Non-GHG emissions	Resource use	Ecosystem use
3D printing & custom manufacturing				
Advanced industrial robotics				
Autonomous transport				
Internet of Things				
Artificial Intelligence				
Shifts in occupations and livelihoods				

Worst case scenario	GHG emissions	Non-GHG emissions	Resource use	Ecosystem use
3D printing & custom manufacturing				
Advanced industrial robotics				
Autonomous transport				
Internet of Things				
Artificial Intelligence				
Shifts in occupations and livelihoods				

Key:

Source: Dusik et al (2018)

Significant positive impact	Moderate positive impact	Limited or no impact	Moderate adverse impact	Significant adverse impact

OVERALL CONCLUSIONS

- There are **no upfront guarantees** that digitisation and automation will support env. sustainability

- Corporate studies assume **best business practices and environmentally friendly consumer preferences**
- **No consideration of rebound effects** caused efficiency and productivity
- **Lower environmental footprint per production unit** can be offset by increased consumption
- Limited boundaries of assessment **disregard upstream and downstream impacts** on environment and resource use

INTERIM RECOMMENDATIONS (2018)

- Link both agendas (climate change and new industries) - consider not only benefits but also adverse side effects
- Invitation to join full-fledged SEAs – but no clear policy process for this
- Use economic instruments (env/carbon taxes) to address externalities and support energy- and resource efficient innovations (Korinek & Stiglitz, 2017))
- Link digitisation with environmental management accounting (Burritt & Christ, 2016)

INTERIM RECOMMENDATIONS (2018)

- 4IR in pre-NEPA phase

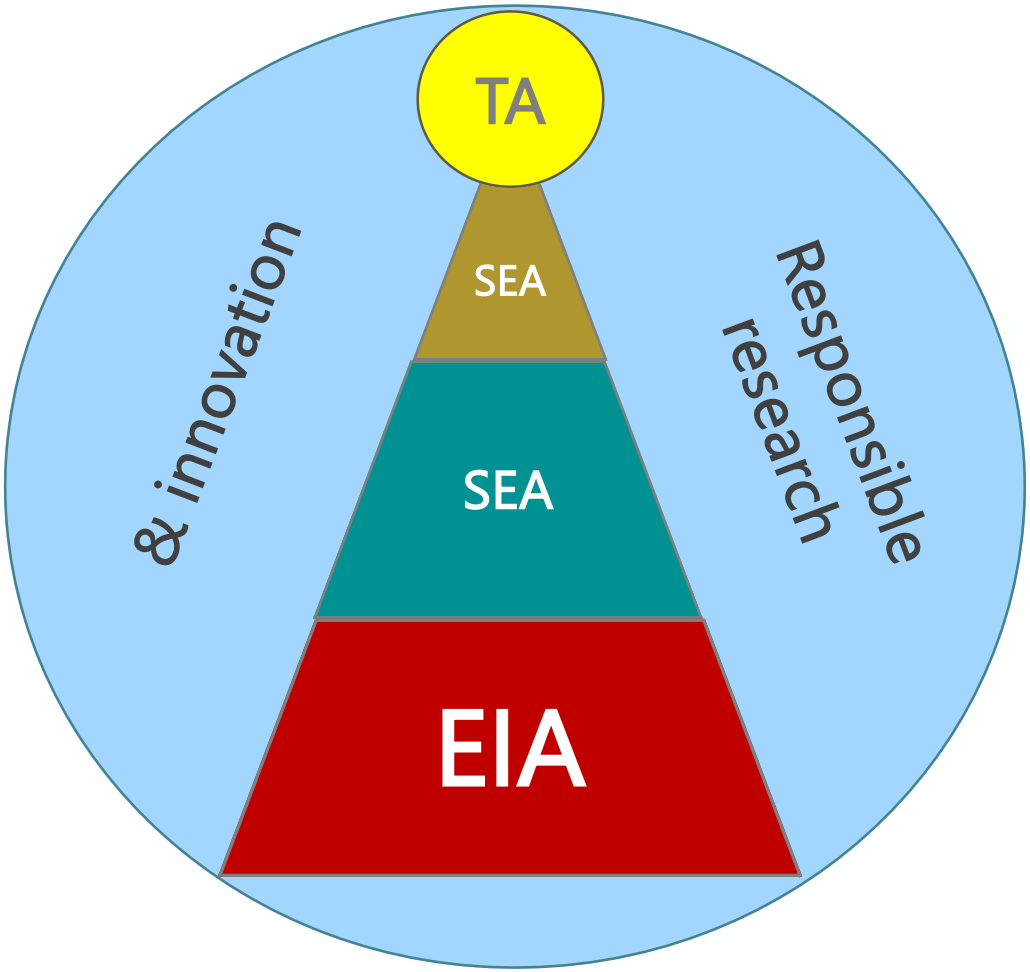
- Expand IA to cover decision-making related to emerging technologies

  and/or

- Formalize TA processes and endow them with strong sustainability-oriented impact assessment elements

(Bond & Dusik, 2019)

POTENTIAL FUTURE IMPACT ASSESSMENT HIERARCHY?



THANK YOU FOR YOUR ATTENTION

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International Association for Impact Assessment

https://www.iaia.org/

https://conferences.iaia.org/2020/program.php