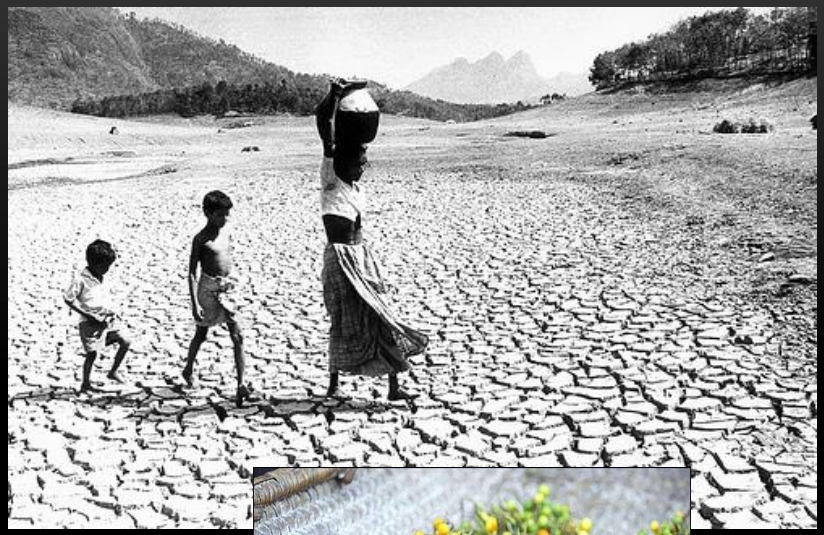
# ENGINEERING ETHICS: RESPONSIBLE INNOVATION & VALUE SENSITIVE DESIGN

Jeroen van den Hoven

Professor of Ethics and Technology

Delft University of Technology

# GRAND CHALLENGES 21ST CENTURY



# ENGINEERING ETHICS

- Engineering, Applied Science, Technology, Innovation involved in the origin and/or in solution of the world's problems
- Engineers need to understand where they fit in

# FIRST QUESTION: THIS IS SMART AND INNOVATIVE, BUT IS IS IT GOOD?

# CHALLENGES

- Clean drinking water
- Food production
- Climate Change
- Overfishing
- Deforestation
- Sustainable Energy
- Waste Management
- Affordable Health Care
- Cyber-security
- Mobility and Transport
- Urbanization
- Internet Governance
- Poverty
- Hunger
- Failing states
- Child mortality
- Orphan diseases

# UN MILENNIUM GOALS

- Poverty reduction
- Primary education
- Gender Equality
- Infant mortality
- Maternal Health
- Combat disease
- Global sustainability
- Global development

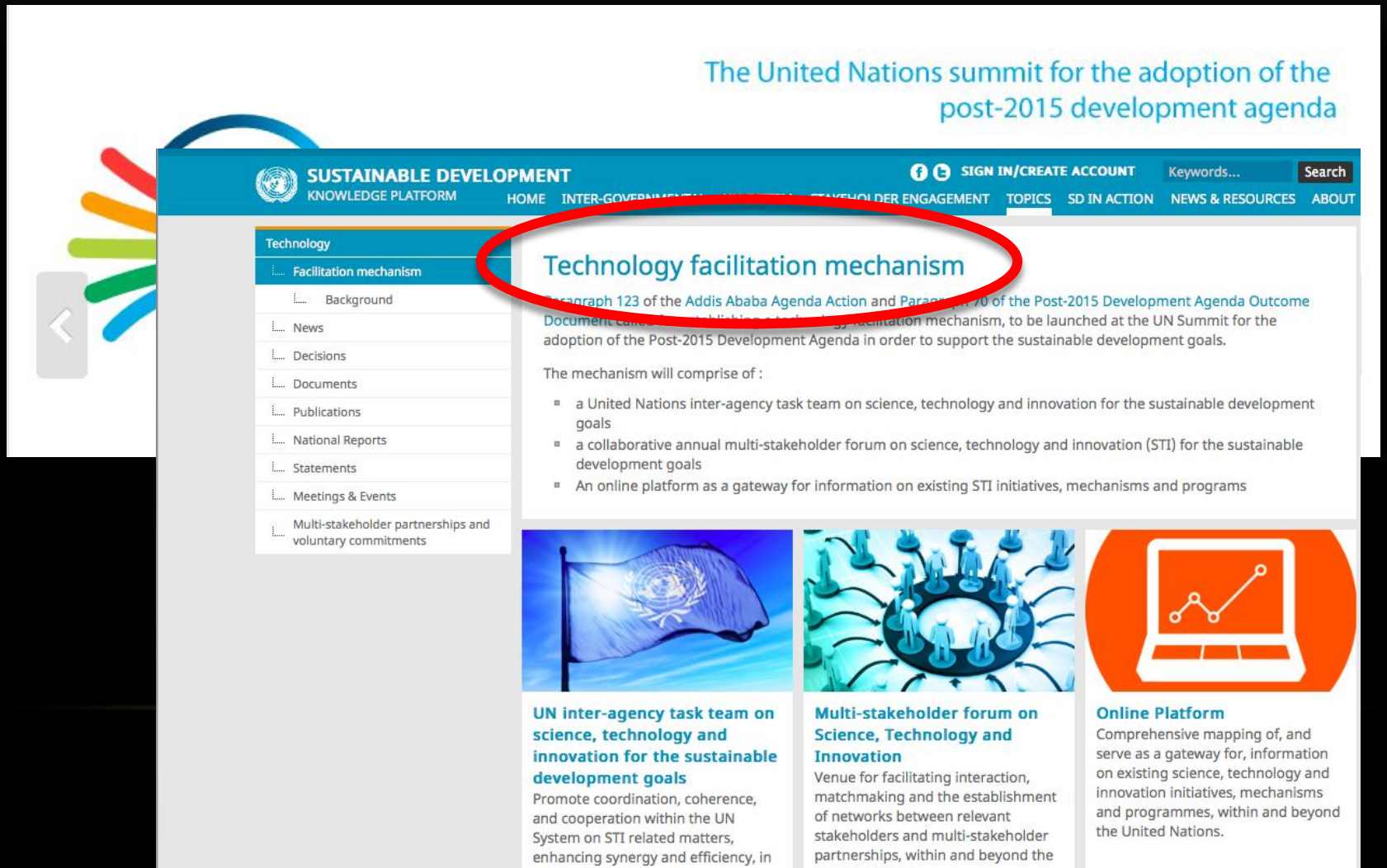
# UN SUSTAINABLE DEVELOPMENT GOALS


# UN SUSTAINABLE DEVELOPMENT GOALS

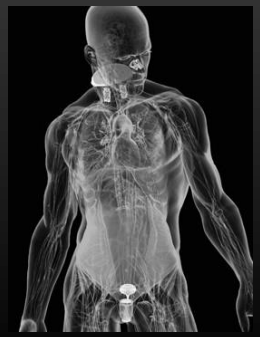
## GLOBAL COMPACT: UN & BUSINESS ALLIANCE

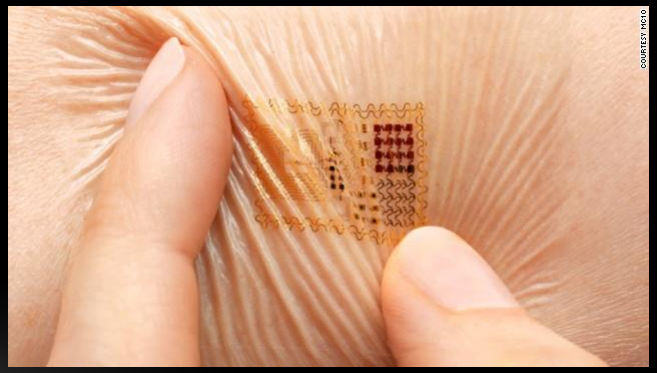
- People
- Planet
- Prosperity: “flourishing lives”
- Peace
- Partnership

# UN SUSTAINABLE DEVELOPMENT GOALS

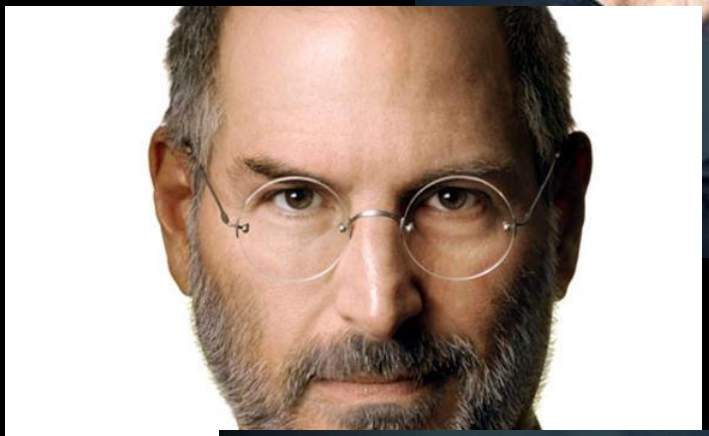


# **LIFE** ALTERING **INNOVATIONS**




534 million shares
$20.3 billion



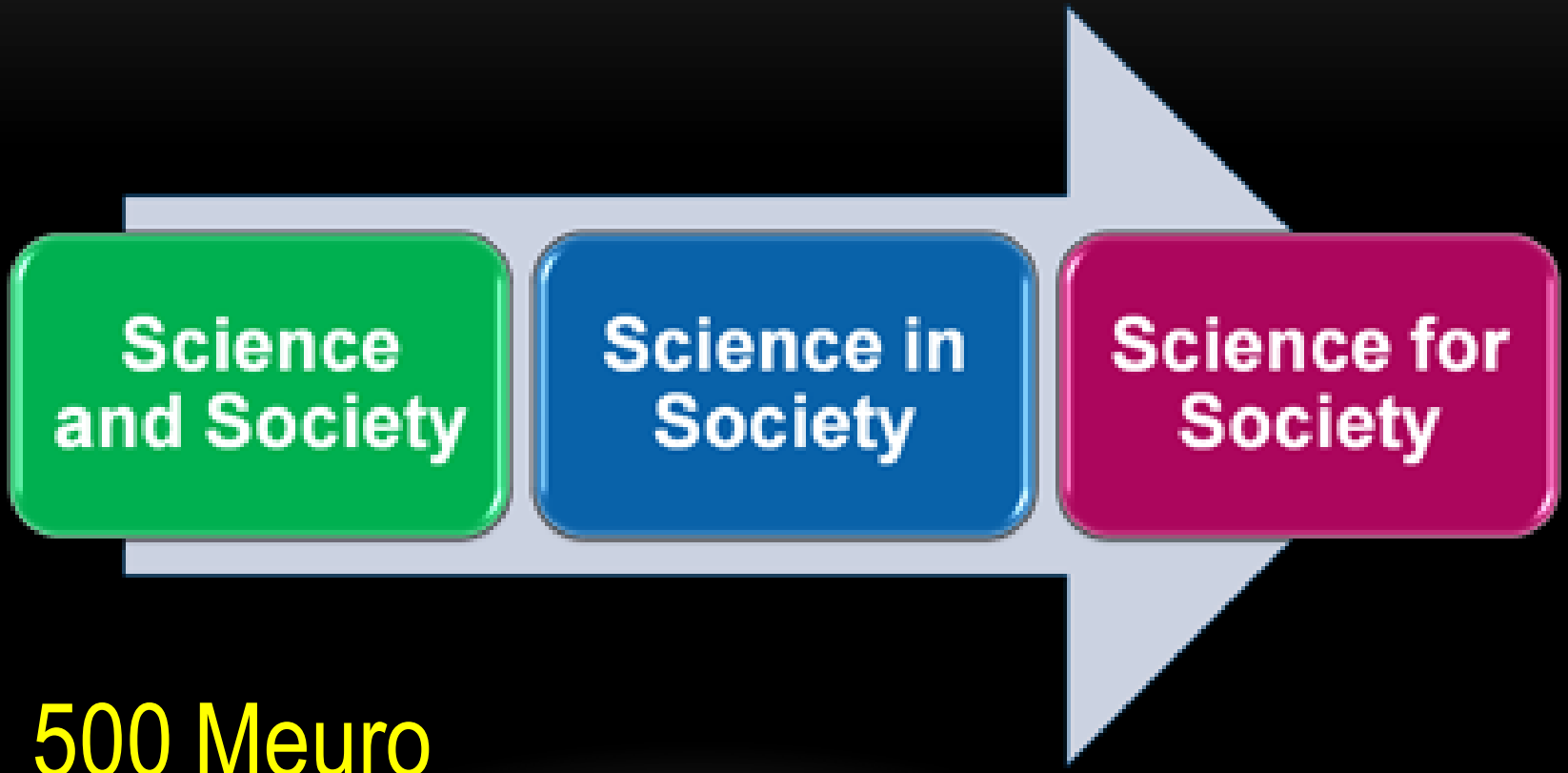

ELON MUSK
SPACEX
TESLA MOTORS

# RESPONSIBLE INNOVATION

# RESEARCH AND DEVELOPMENT/INNOVATION

# EUROPE

# RRI: RESPONSIBLE RESEARCH AND INNOVATION




500 Meuro

# EXPERT GROUP REPORT TO EUROPEAN COMMISSION


"Options for Strengthening Responsible Research and Innovation"
Van den Hoven, e.a.

# LUND DECLARATION: GRAND CHALLENGES

# ROME DECALATION ON RESPONSIBLE INNOVATION


“ RRI a Central Objective across
All relevant policies and activities…”

# RESPONSIBLE INNOVATION

## Dutch Research Council Program


# FOLDABLE CONTAINER

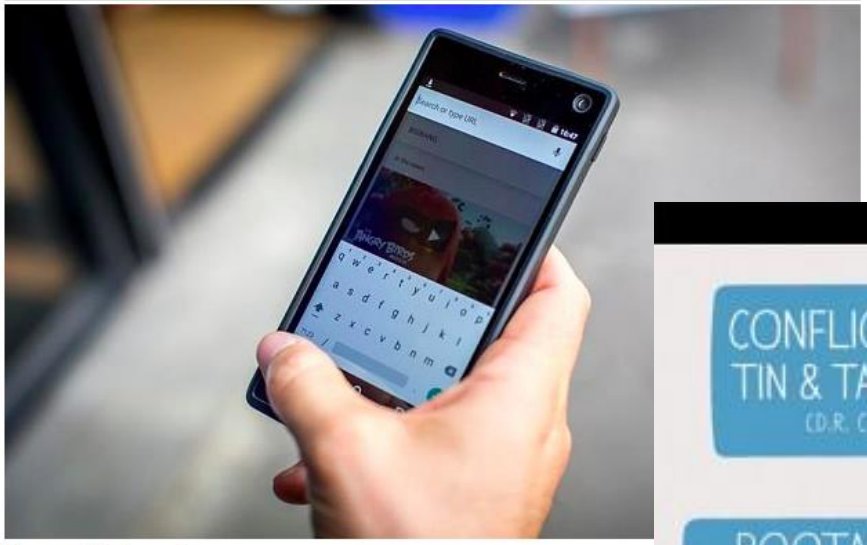
**SUSTAINABILITY**


HOME » TECHNOLOGY » MOBILE PHONES

# 'Ethical' Fairphone 2 smartphone launched to combat electronic waste

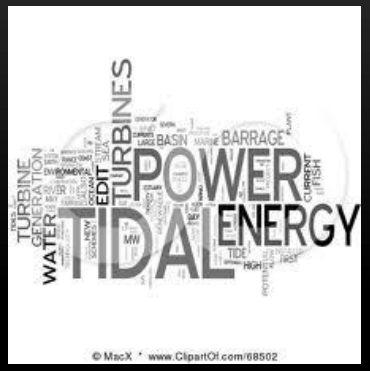
The Fairphone 2 aims to challenge the "throwaway" nature of consumer electronics and ever-shorter product cycles

196 0 59 255 Email



The new Fairphone 2

# TIDAL ENERGY




Grevelingen Tidal Energy Proposal (Van Lier -Lels, May 2012

# DATA CENTRE


- Mobile Datacentres and Glasshouses

# STREET LIGHTING ON DEMAND


Safety, Security, & Sustainability

# ELEMENTAL WATER MAKERS

- Desalination
- Reverse Osmosis


Constant operation

Accomodates fluctuations odf solar and wind power

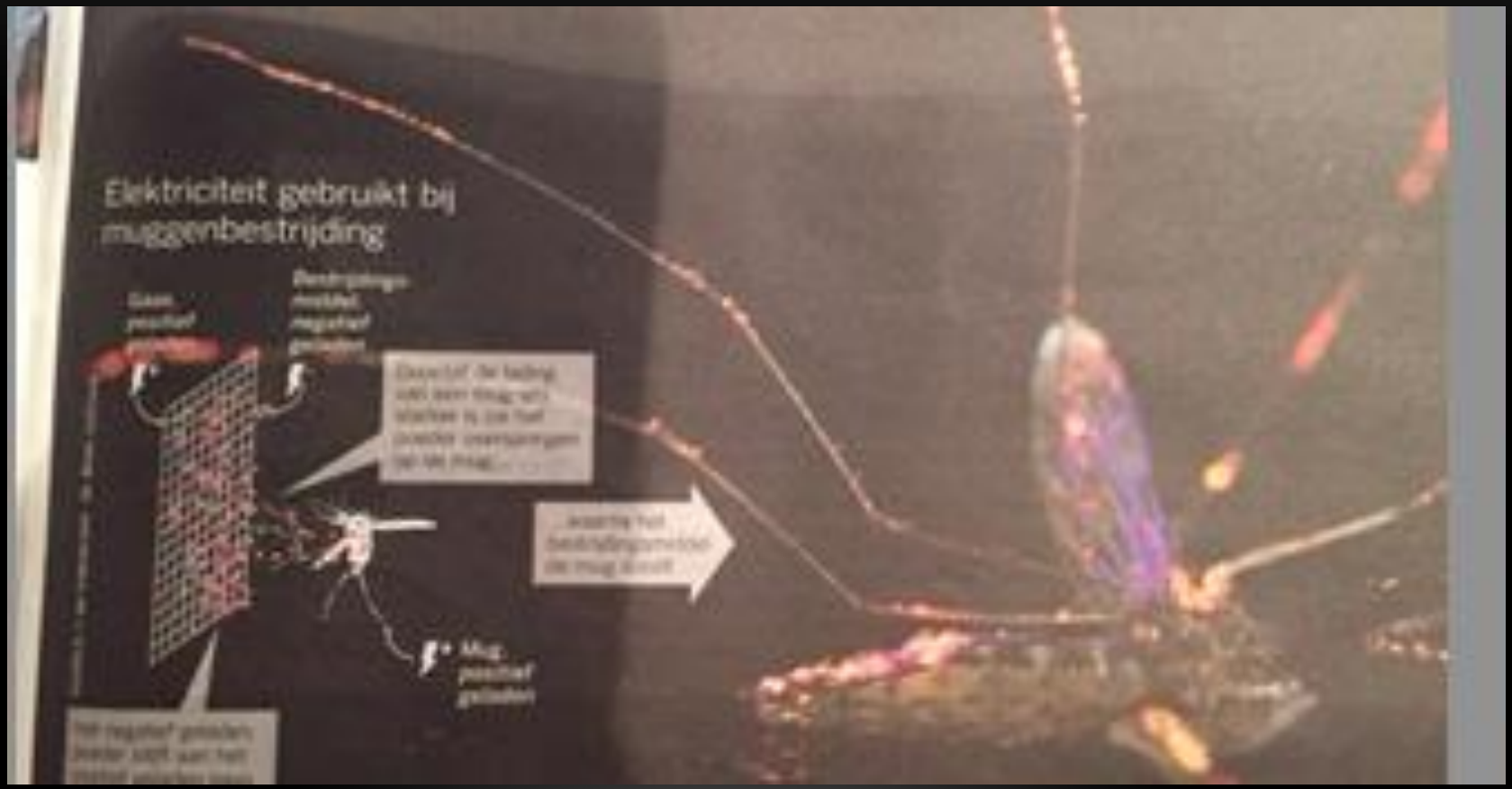
No CO2 emissions

3300 Gallons of fresh water a day

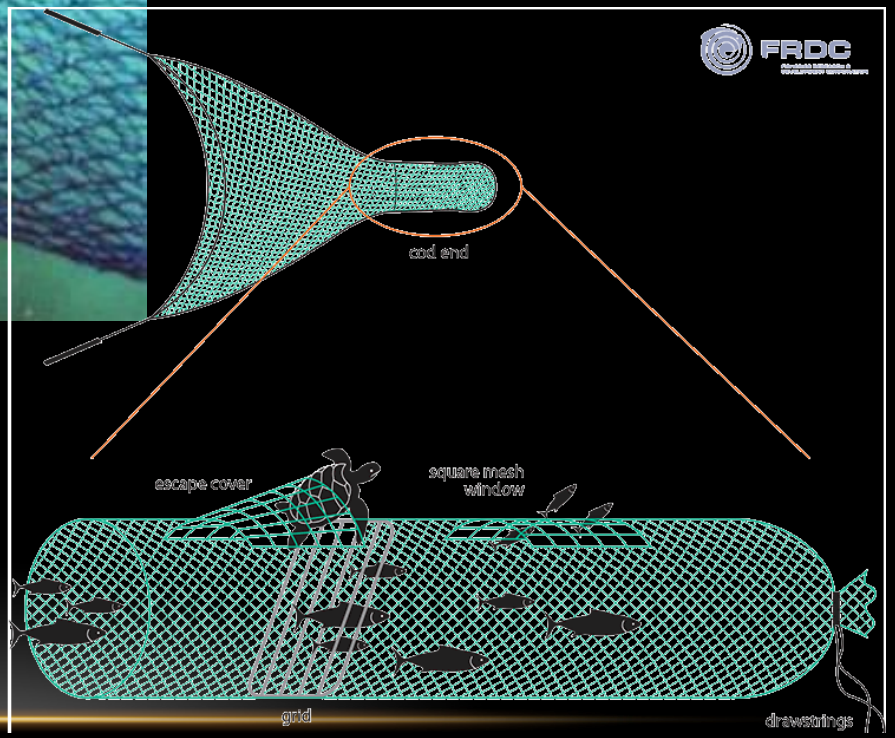
# ENERGIZE THE CHAIN

ENERGIZE THE CHAIN

# RESPONSIBLE INNOVATION: FIGHT MALARIA



# TURTLE EXCLUDER DEVICES (TED'S)



# COLA LIFE



## The Colalife Anti-Diarrhoea Kit (ADK)

**Lid/soap tray & soap**
- Re-usable lid
- Separates the soap from the other components of the kit

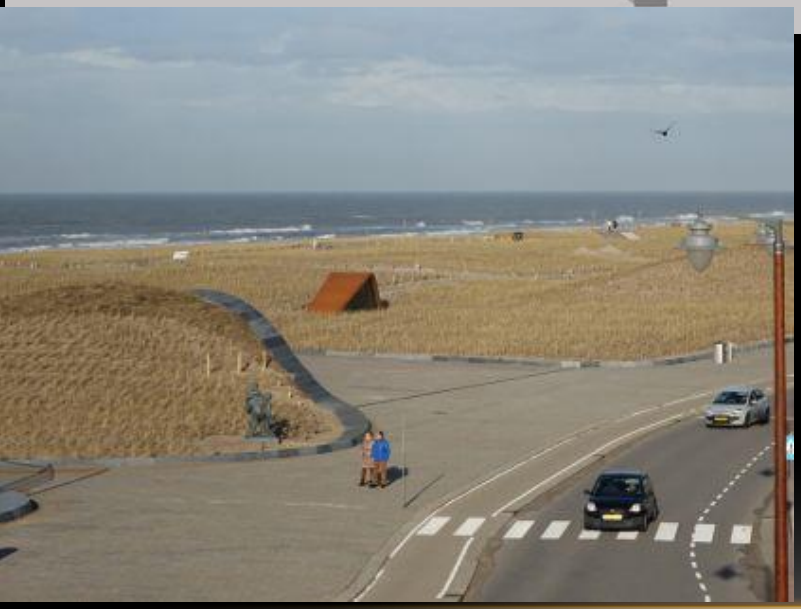
**Container/measure/mixer/cup**
- Holds and protects the ADK components in transit
- Acts as a measuring jug for the ORS - calibrated at 200ml
- Mixing device and storage vessel (with lid)
- Cup for administering the ORS solution
- Attractive and distinctive
- Fits in the unused space in a Coca-Cola crate
- Re-usable


**Heat-sealed film**
- Tamper evidencing
- Water proofing
- Micro-porous
- Transparent

**Low Osmolarity Oral Rehydration Salts**
- Eight 4.12g sachets to make up 200ml of solution

**Zinc supplements**
- 10 scored and sweetened Zinc Sulfate tablets

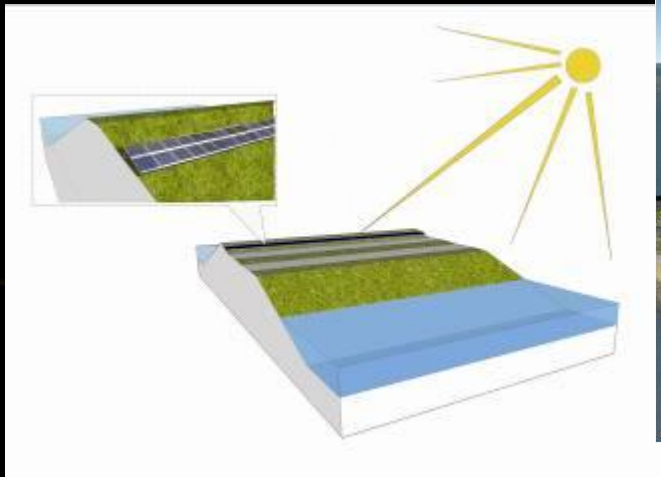
**IEC Materials**
- Concertina information leaflet which also carries:
  - the ADK branding
  - unique ADK ID for authentication
  - recommended retail price



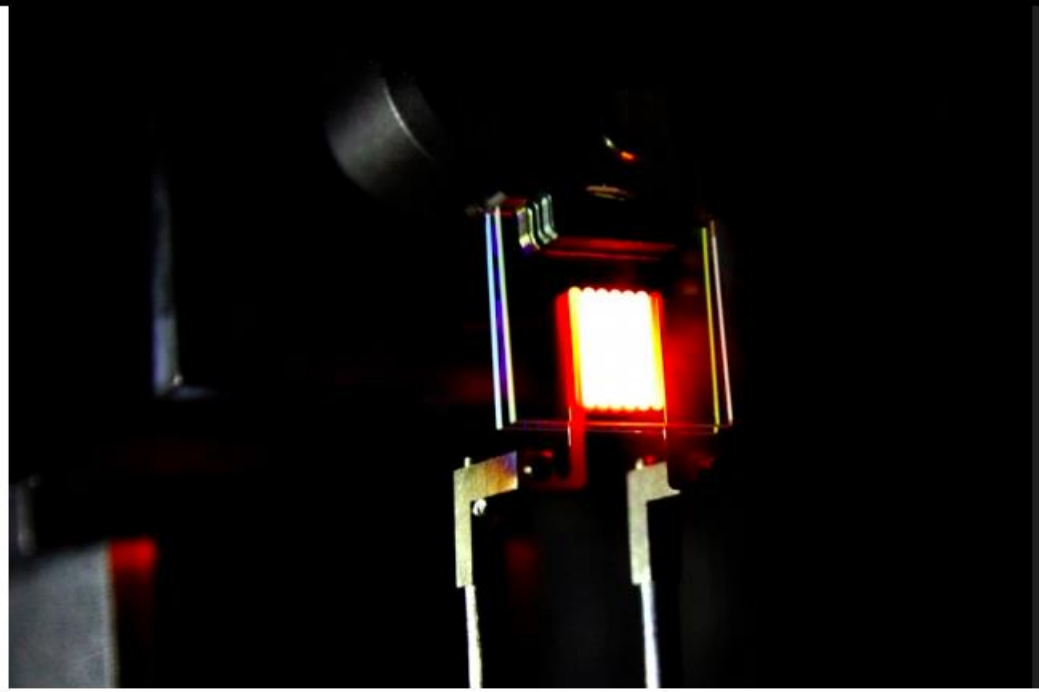
# AFSLUITDIJK

# BUILDING WITH AND FOR NATURE

# RENEWABLE ENERGY

# MOBILITY, RECREATION, WILD LIFE



FULL SCREEN

A proof-of-concept device built by MIT researchers demonstrates the principle of a two-stage process to make incandescent bulbs more efficient. This device already achieves efficiency comparable to some compact fluorescent and LED bulbs.

Courtesy of the researchers

# A nanophotonic comeback for incandescent bulbs?

Researchers combine the warm look of traditional light bulbs with 21st-century energy efficiency.

# RRI

- (A) obtain – as much as possible – the relevant knowledge on (i) the consequences of the outcomes of your actions and on (ii) the range of options open
- (B) evaluate both outcomes and options (under A) effectively in terms of relevant moral values (including, but not limited to wellbeing, justice, equality, privacy, autonomy, safety, security, sustainability, accountability, democracy and efficiency).
- (C) use these considerations (under B) as requirements for design and development of new technology, products and services leading to moral improvement, i.e.

# SECOND QUESTION: CAN WE BUILD OUR VALUES INTO OUR TECHNOLOGY?

# L. WINNER: DO ARTEFACTS HAVE POLITICS?


# VALUES BUILT INTO SYSTEMS

- Interfaces
- Infrastructures
- Algorithms
- Ontologies
- Code
- Protocols
- Integrity constraints
- Architectures
- Governance arrangements
- Identity Management Systems
- Authorization Matrix
- Procedures
- Regulations
- Incentive structures
- Auction mechanisms
- Voting mechanism
- Monitoring and inspection

# HEALTH CARE

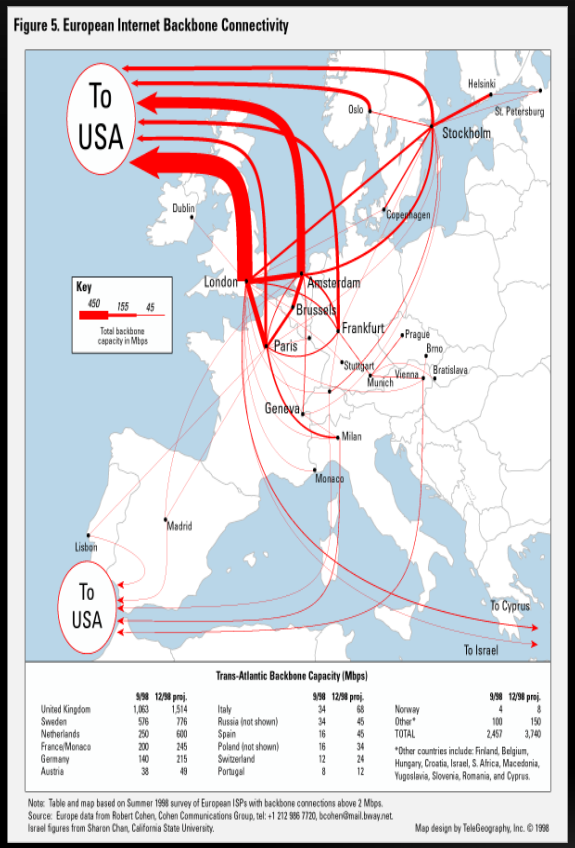




# FINANCE



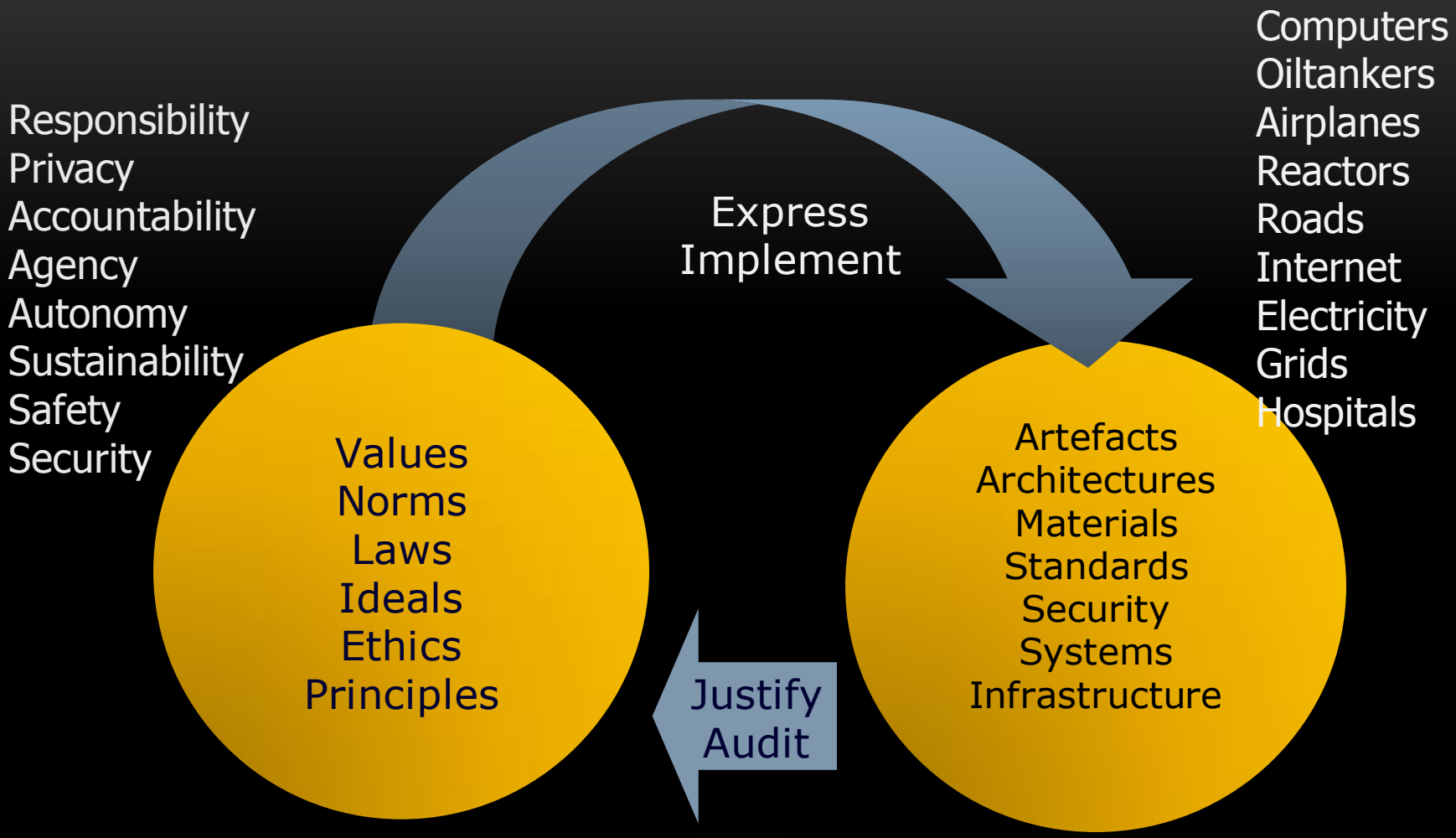
# INTERNET & GAS




# SMART CITIES

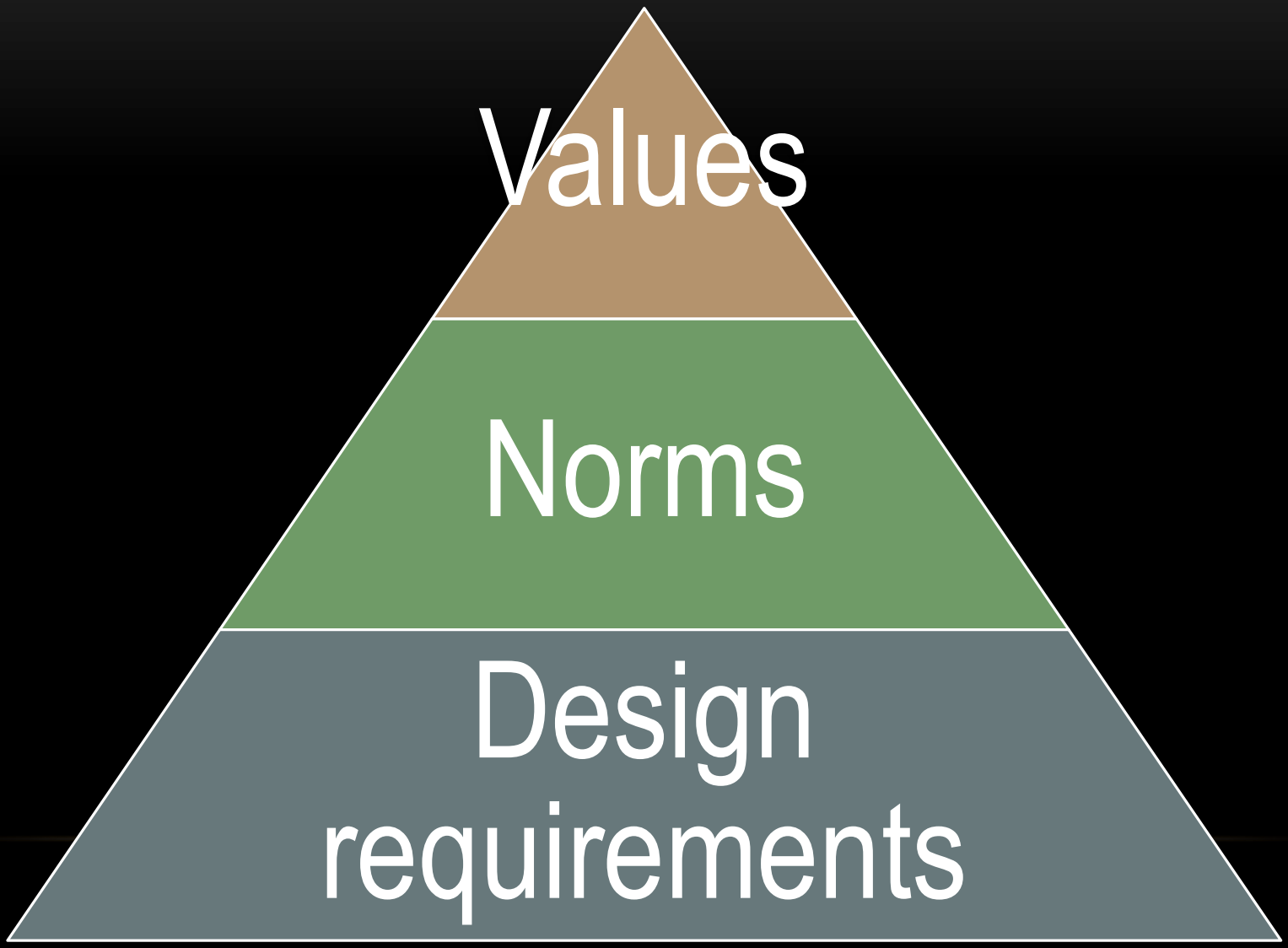

# CHURCHILL


"WE SHAPE OUR BUILDINGS; THEREAFTER THEY SHAPE US."
WINSTON CHURCHILL
© Lifehack Quotes

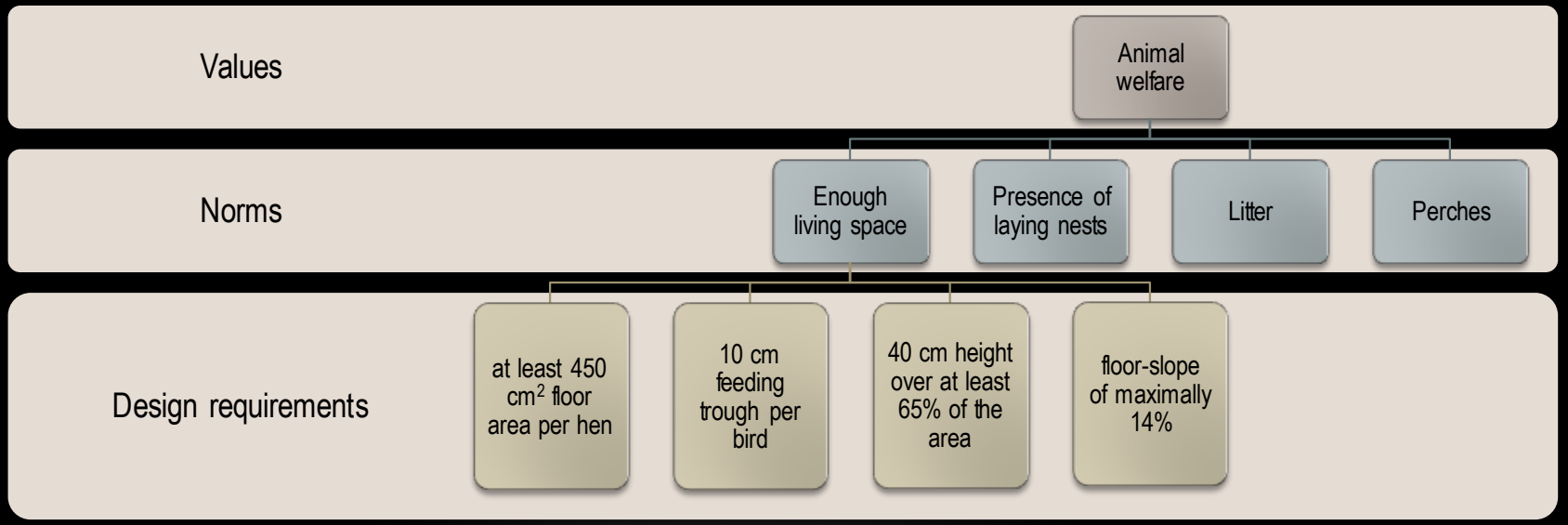


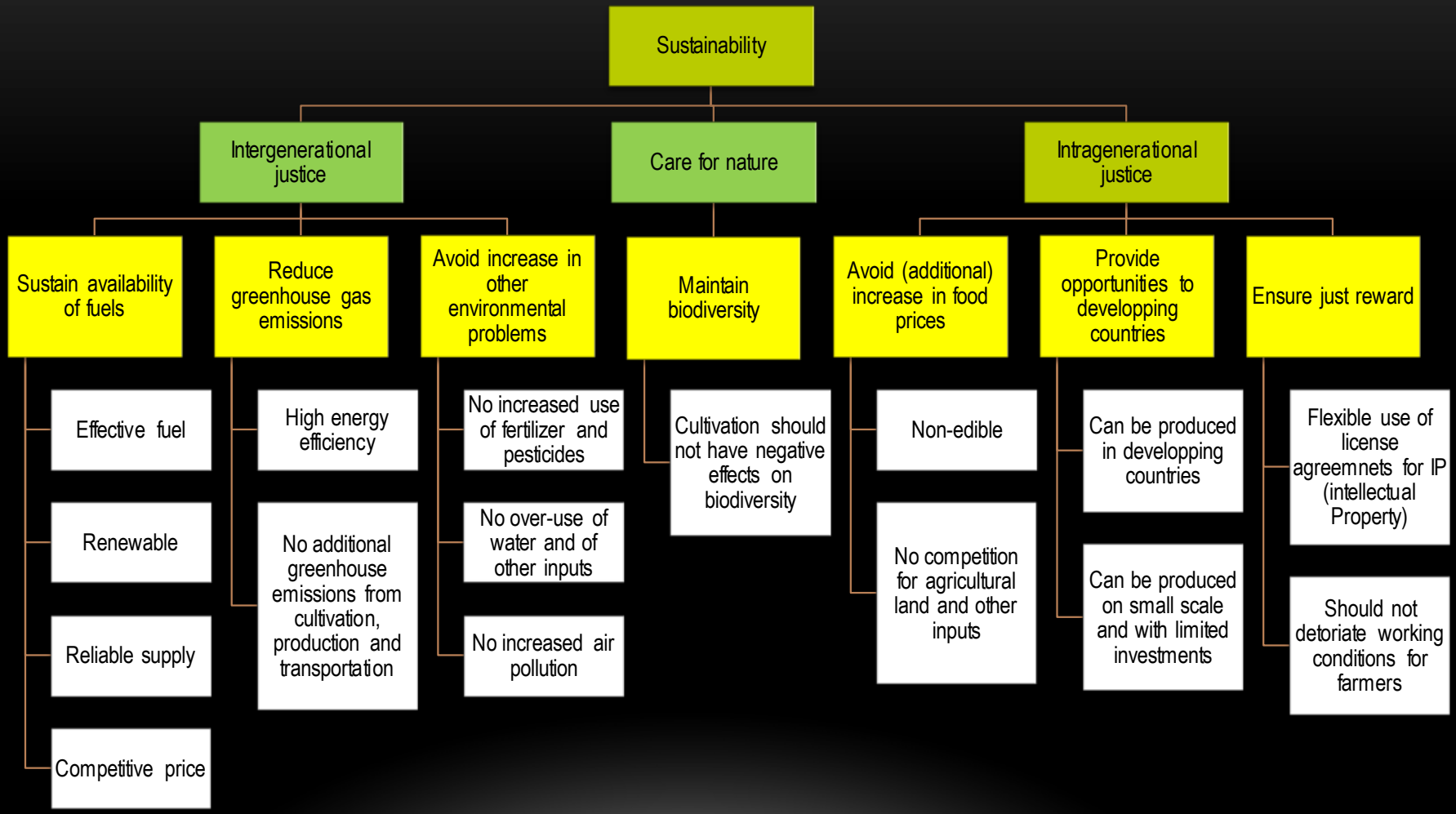

# KEY PROBLEM
# 21ST CENTURY: VALUE SENSITIVE DESIGN

# VALUES HIERARCHY



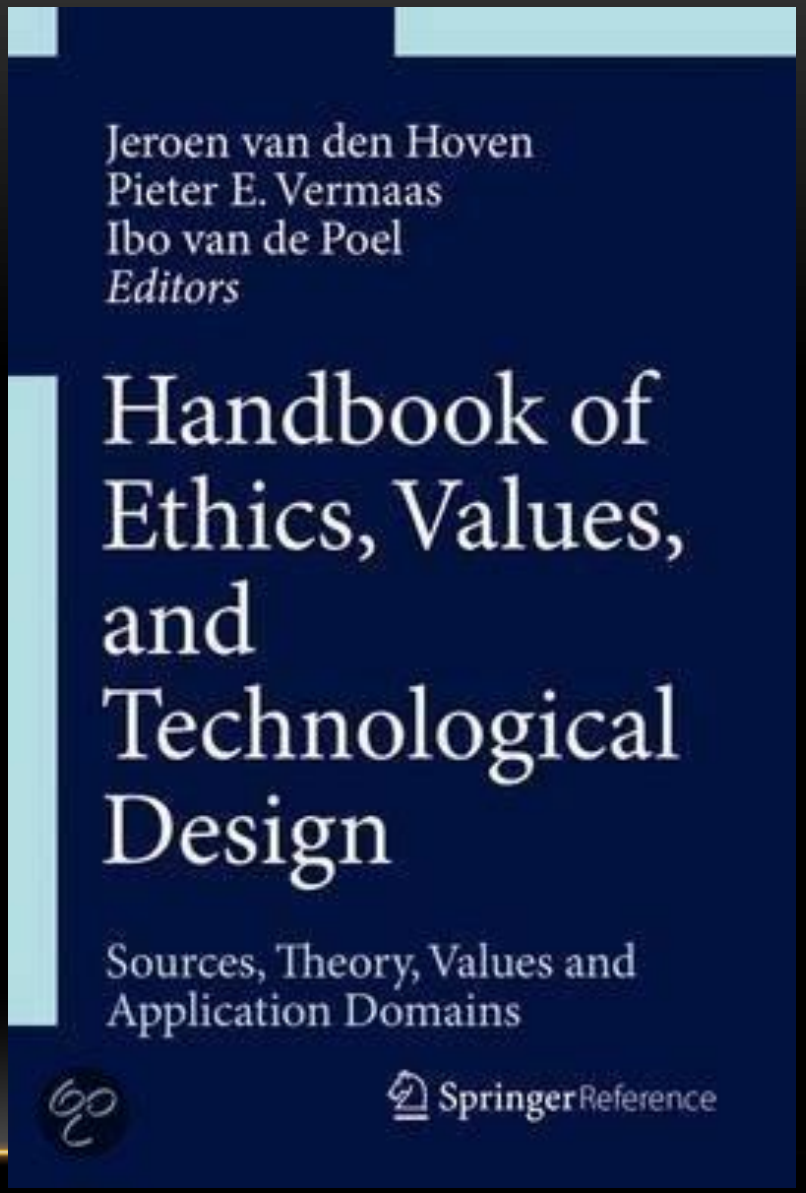
# EXAMPLE OF VALUES HIERARCHY




Sustainability
Intergenerational justice
Care for nature
Intragenerational justice
Sustain availability of fuels
Reduce greenhouse gas emissions
Avoid increase in other environmental problems
Maintain biodiversity
Avoid (additional) increase in food prices
Provide opportunities to developping countries
Ensure just reward
Effective fuel
Renewable
Reliable supply
Competitive price
High energy efficiency
No additional greenhouse emissions from cultivation, production and transportation
No increased use of fertilizer and pesticides
No over-use of water and of other inputs
No increased air pollution
Cultivation should not have negative effects on biodiversity
Non-edible
No competition for agricultural land and other inputs
Can be produced in developping countries
Can be produced on small scale and with limited investments
Flexible use of license agreemnets for IP (intellectual Property)
Should not detoriate working conditions for farmers

# DESIGN FOR X

- Design for privacy
- Design for security
- Design for inclusion
- Design for sustainability
- Design for democracy
- Design for safety
- Design for transparency
- Design for accountability
- Design for human capabilities



# VALUE PLURALISM

- Privacy
- Autonomy
- Equity
- Justice
- Dignity
- Wellbeing and Happiness
- Safety
- Security
- Sustainability
- Health
- Friendship
- Solidarity

**CONFLICT DILEMMA**

- Dependability
- Usability
- Resilience
- Reliability
- Efficiency
- Flexibility

# THIRD QUESTION: CAN TECHNOLOGY HELP TO OVERCOME VALUE CONFLICTS?

## THE PROBLEM OF MORAL OVERLOAD

# SUSTAINABLE UNSAFE BUS

# MORAL OVERLOAD

- Prosperity **AND** sustainability
- Security **AND** Privacy
- Efficiency **AND** Safety
- Accountability **AND** Confidentiality

# SMART ELECTRICITY GRIDS & SMART METERS





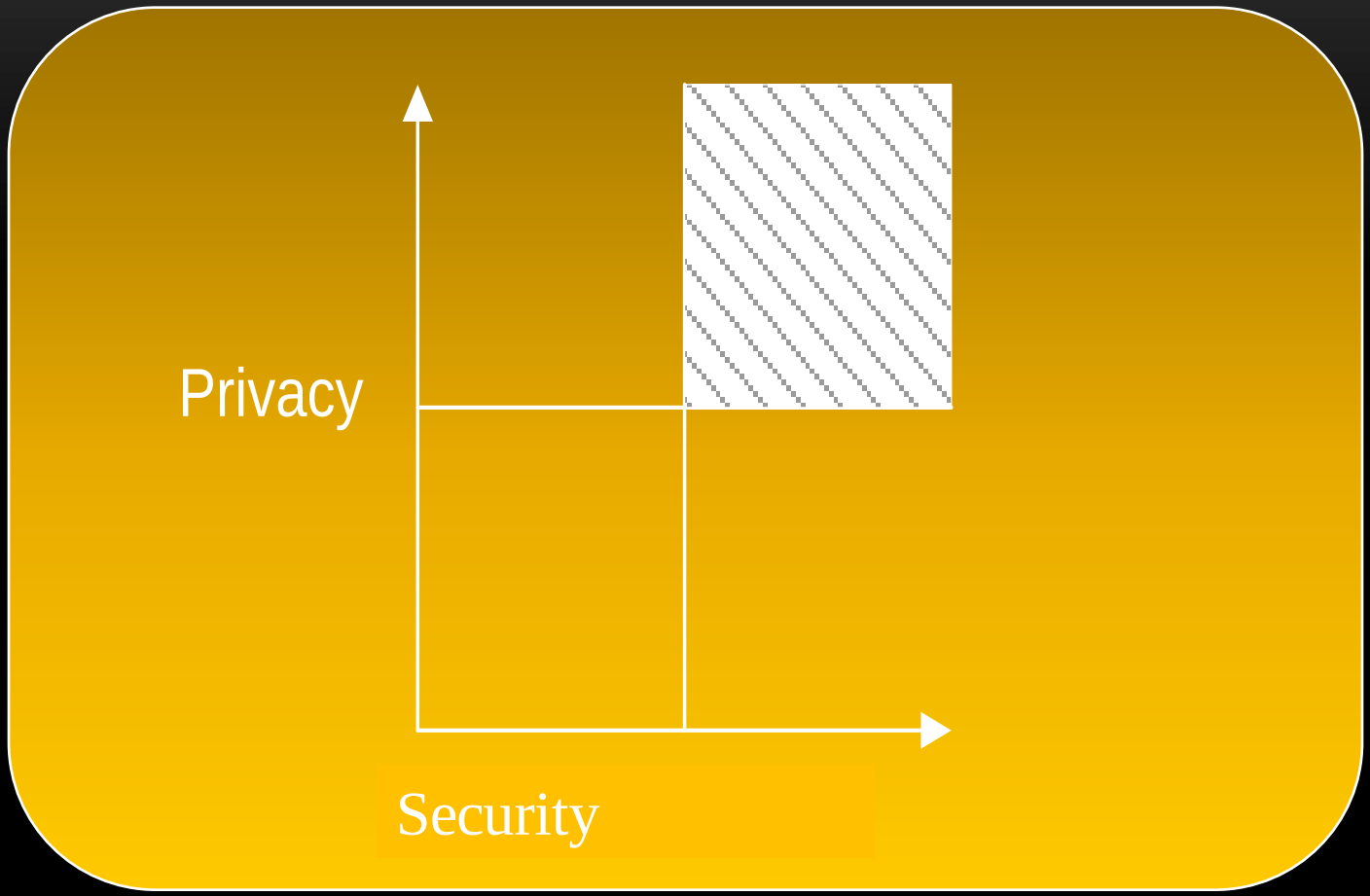
# ELECTRONIC PATIENT RECORDS


300 Million: failed Innovation

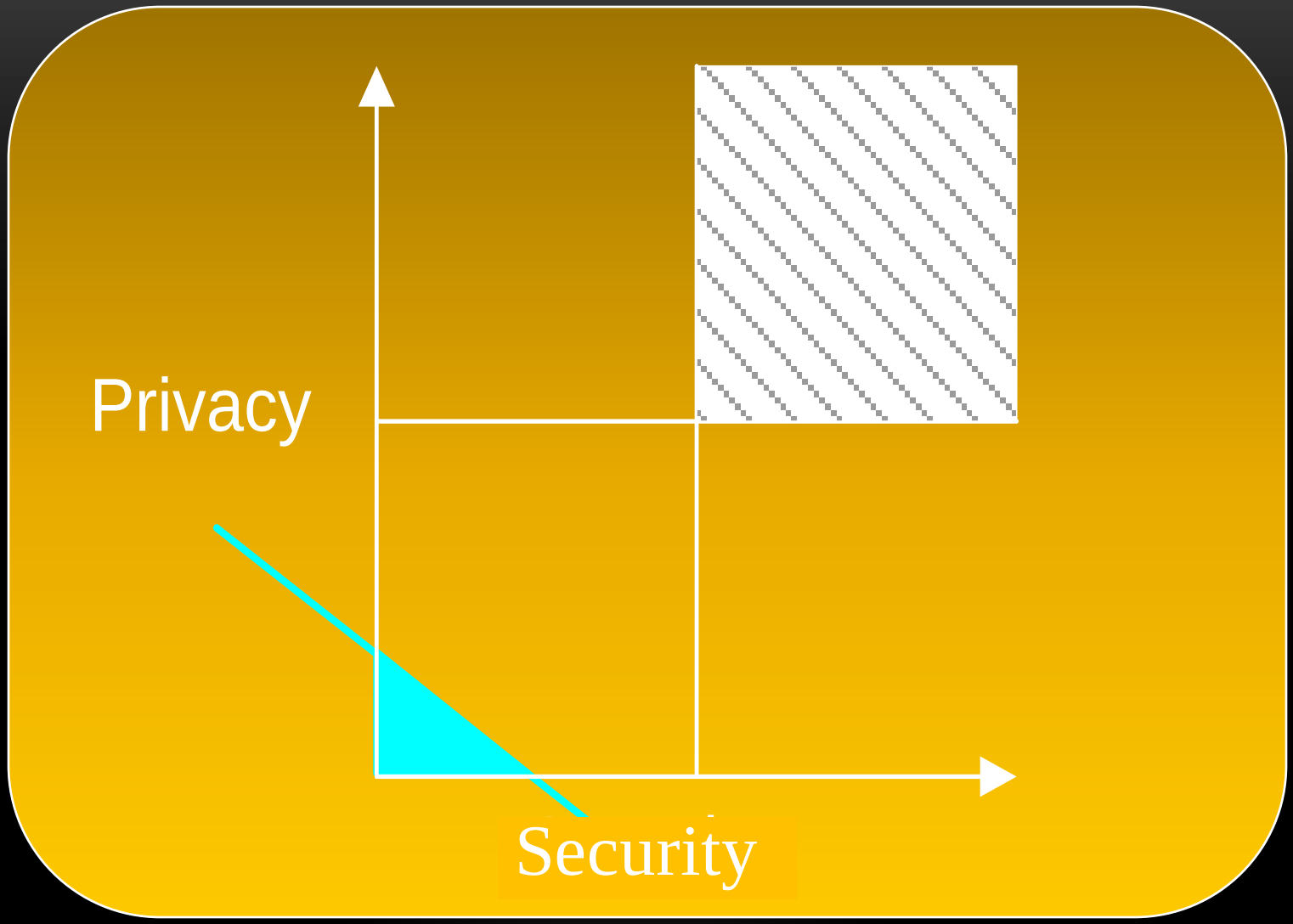
# WE WANT SUSTAINABILITY

# WE ALSO WANT PRIVACY

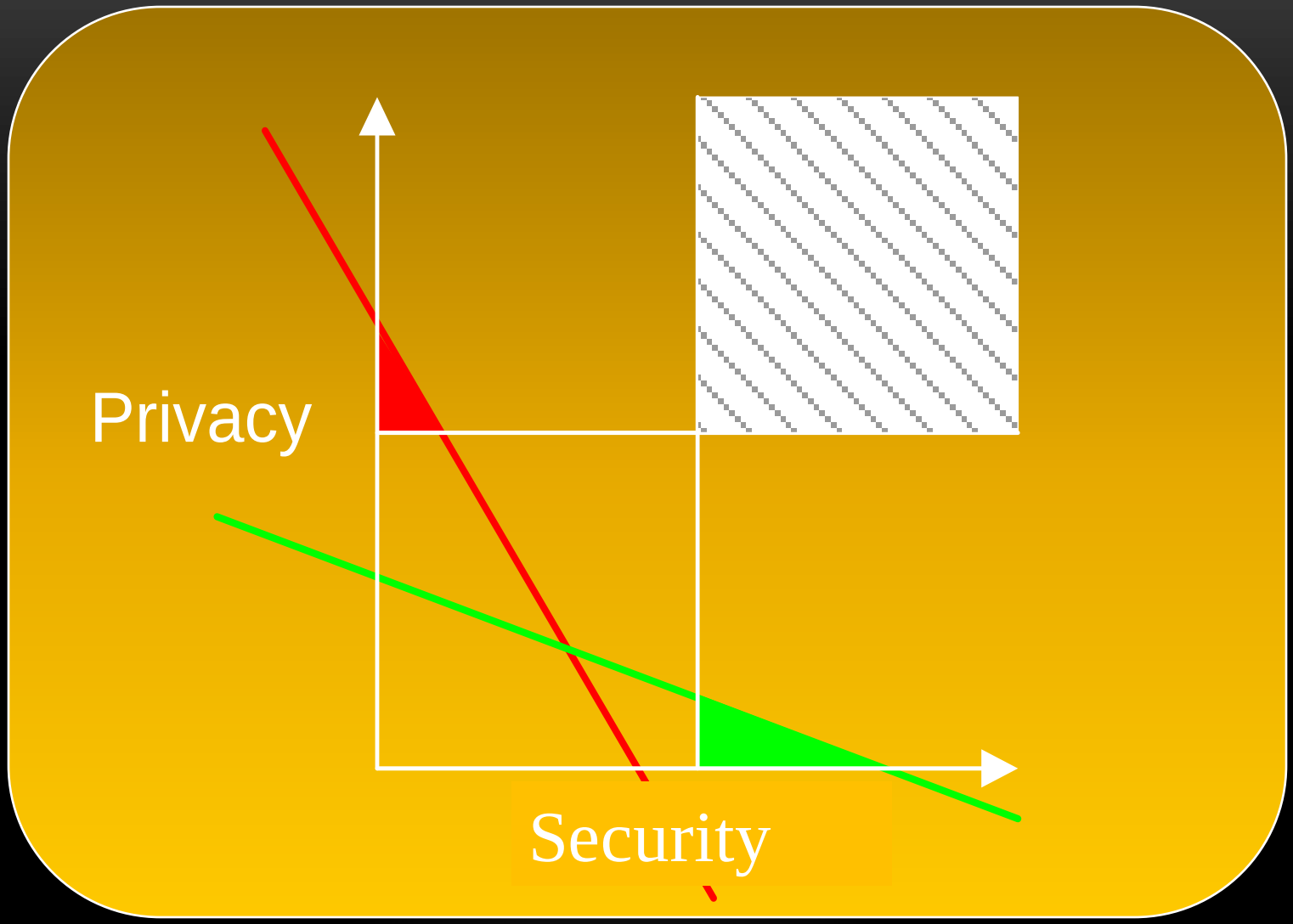
# SECURITY

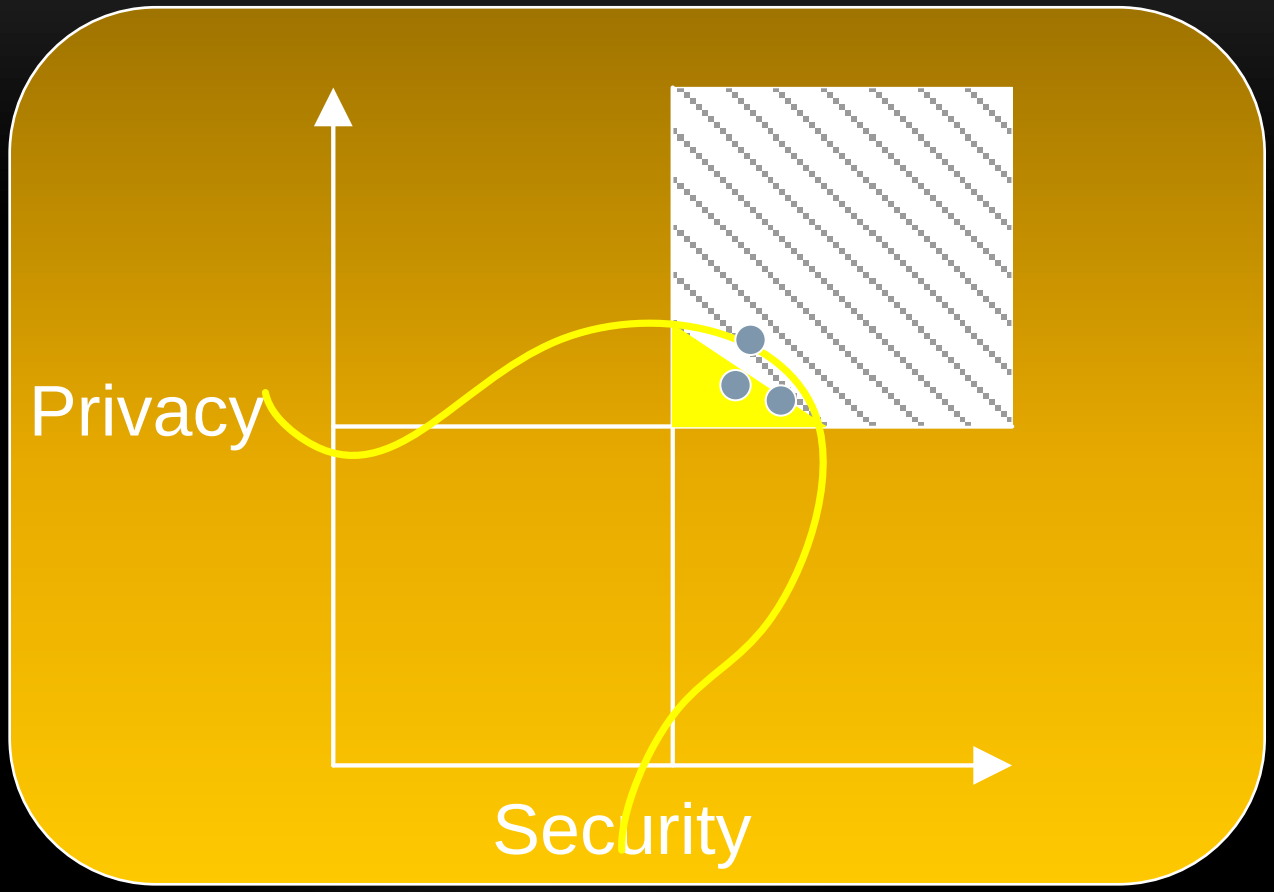

# MORAL OVERLOAD




# NO PRIVACY, NO SECURITY (1.0)




# PRIVACY OR SECURITY (2.0)




# PRIVACY & SECURITY (3.0)

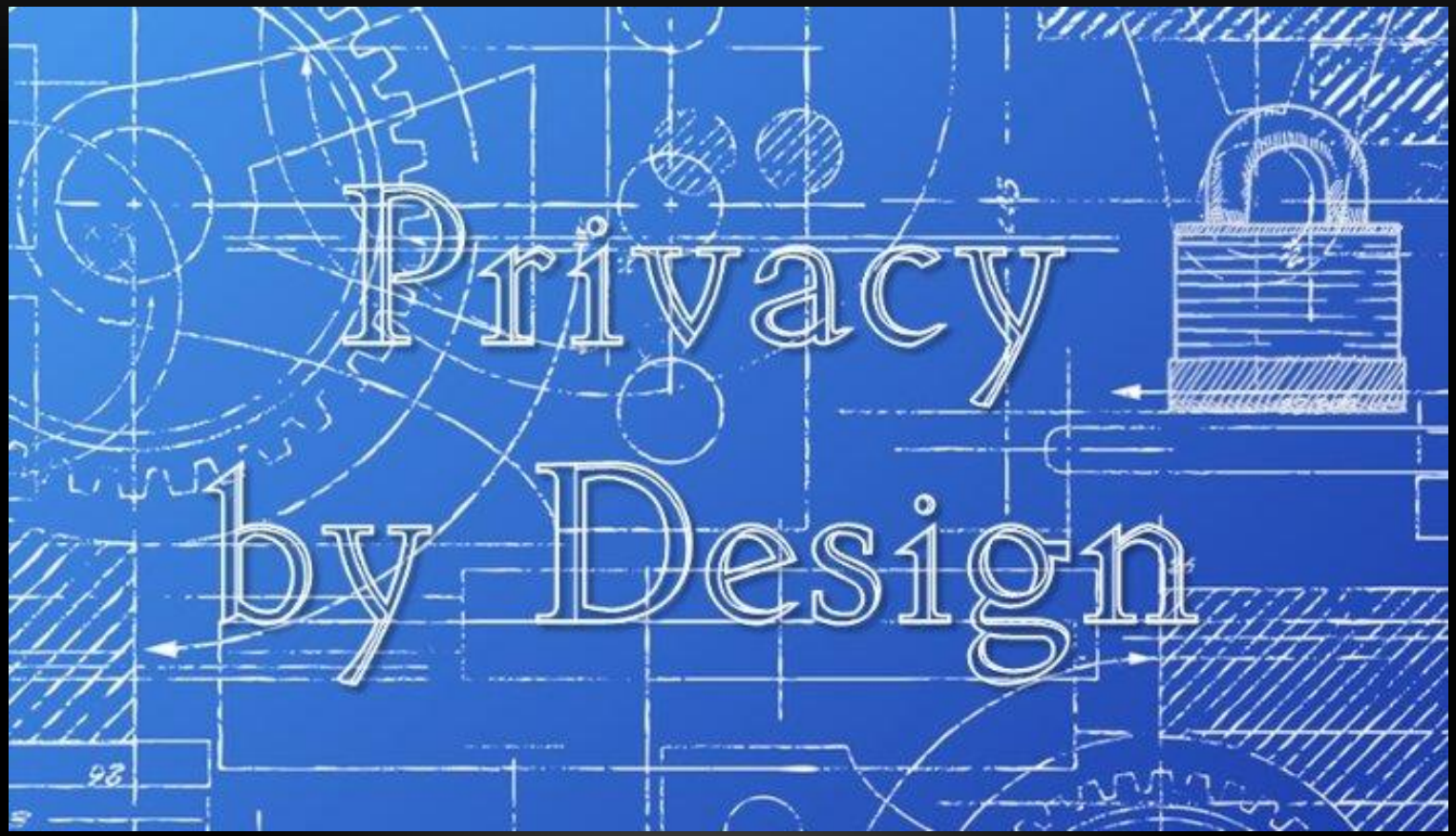
# HIGHER ORDER OBLIGATION

- Ruth Barcan Marcus
- If there is an obligation to do both A and B
- We have a second order obligation to see to it that we can do both A and B

If a contingent state of the world at time t1 does not allow us to satisfy two or more of our moral values or moral obligations at the same time, but we can bring about change by innovation in the world at t1 that allows us to satisfy them all together at a later time t2, then we have a moral obligation at t1 to innovate

# MORAL AXIOM

If you can change the world by innovation today so that you can satisfy more of your obligations tomorrow, you have a moral obligation to innovate today.


Privacy
by Design

# PRIVACY RESPECTING TECHNOLOGY

# MORAL OVERLOAD

## Green Party: Sustainability


# MORAL OVERLOAD

Government: Economic growth

# VALUE SYNERGY

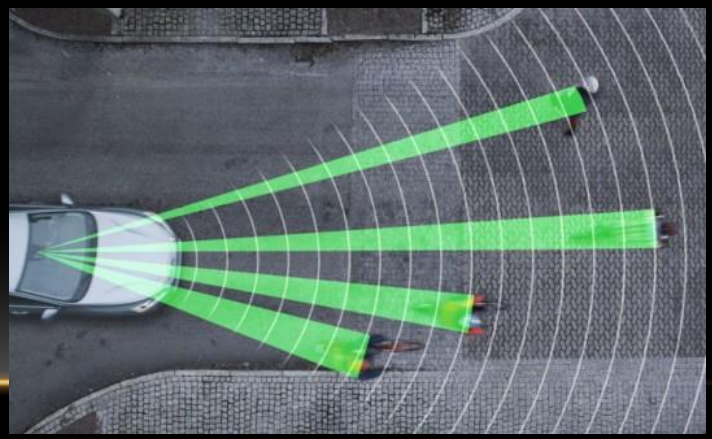
Sustainability
and Growth


# ZERO VISIONS

- ZERO Road Traffic Accidents Sweden
- ZER Emissions
- ZERO Prevenatble Children death



# VOLVO AIMS FOR ZERO ACCIDENTS



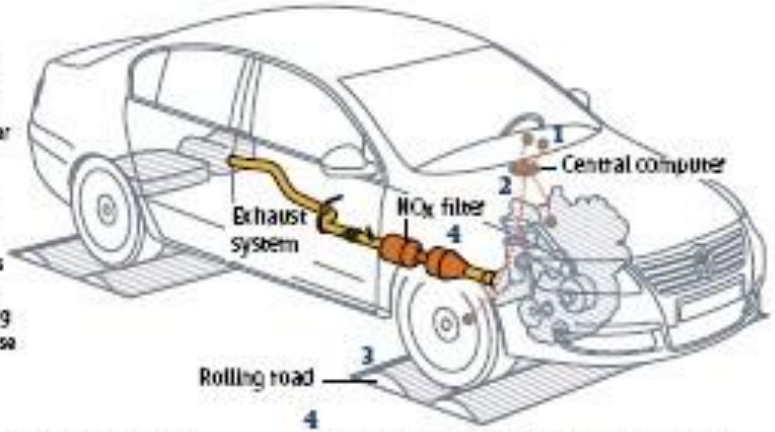

© Rex Features

# SOLVING MORAL OVERLOAD BY DECEPTION


## How VW cheated the system

**1**
Speedometer, steering wheel sensors and air pressure sensors send data to central computer

**2**
Computer recognises that it is under test conditions and switches on a 'dyno calibration', which alters the working of the engine to minimise emissions

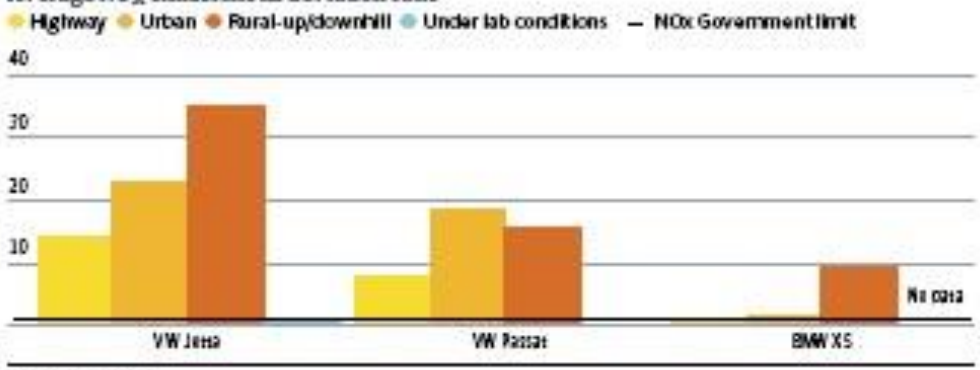



**3**
If road, rather than rolling road, conditions are detected the computer uses a 'road calibration', which bypasses the emissions reduction mechanisms to favour engine performance and efficiency

**4**
The EPA says it was the $NO_x$ filter whose behaviour was changing in the different calibrations

## Emission tests

Average $NO_x$ emissions as deviation ratio




SOURCE: THEICCT.ORG

Winterkorn personally visited the lab's then Palo Alto location in January 2010, touting his company's expansion efforts. "We want to take Volkswagen to the top of the industry by 2018," Winterkorn told reporters. "We aim to be the most eco-friendly automaker in the world ... "For Volkswagen, 'green mobility' means setting new ecological standards in automobile manufacturing in order to put the cleanest, most economical and at the same time most fascinating cars on the road."

# VALUES AS DRIVERS OF INNOVATION

- Moral Progress by Innovation
- Transforming the world by design so that we can respect more obligations and responsibilities than before

# ENGINEERING ETHICS

- Engineers can , we ought and we do increasingly try to solve grand challenges by innovation

- Engineers can, ought and do increasingly use moral values as 'non functional of supra functional requirements' in engineering design

- Innovation is thereby becoming an important moral concept in the sense that it is concerned with amplification of the set of obligations we can satisfy (definition of Moral Progress)

- Not by tweaking our value systems, but by tweaking the world