HUMAN–COMPUTER INTERACTION AND CLIMATE CHANGE: TOWARD NEW DIRECTIONS

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PRESENTATION

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- Since 2011, at ESTIA Institute of Technology (France)
- Human–Computer Interaction
- Interaction with Tangible Interfaces

Energy

- **GeoTUI (2008)**: An interactive tangible tabletop for subsoil exploration in geosciences
- **StationENR (2012)**: A tangible kiosk to raise renewable energy awareness
- **CairnFORM (2019)**: A shape-changing tangible interface to notify on public spaces the forecasts on local renewable energy availability

FOREWORD

Several approaches from ICT

- GreenIT
- Eco-feedback
- Social practices

➲ **Framing those approaches in a broader contect**

THREE APPROACHES

Efficiency

- *Decrease the quantity of energy required for a same need*
- *Better isolate buildings, improve effeciency of electrical appliances, cars, etc.*

Sobriety

- *Priority is given to required needs only*
- *Turn off light in offices at night, reduce packagings, etc.*

Substitution

- *Priority is given to renewable energies*
- *Flow energies instead of stock energies (coal, oil, gas, uranium)*
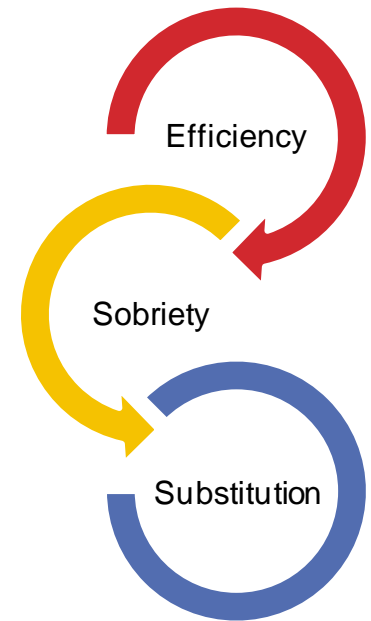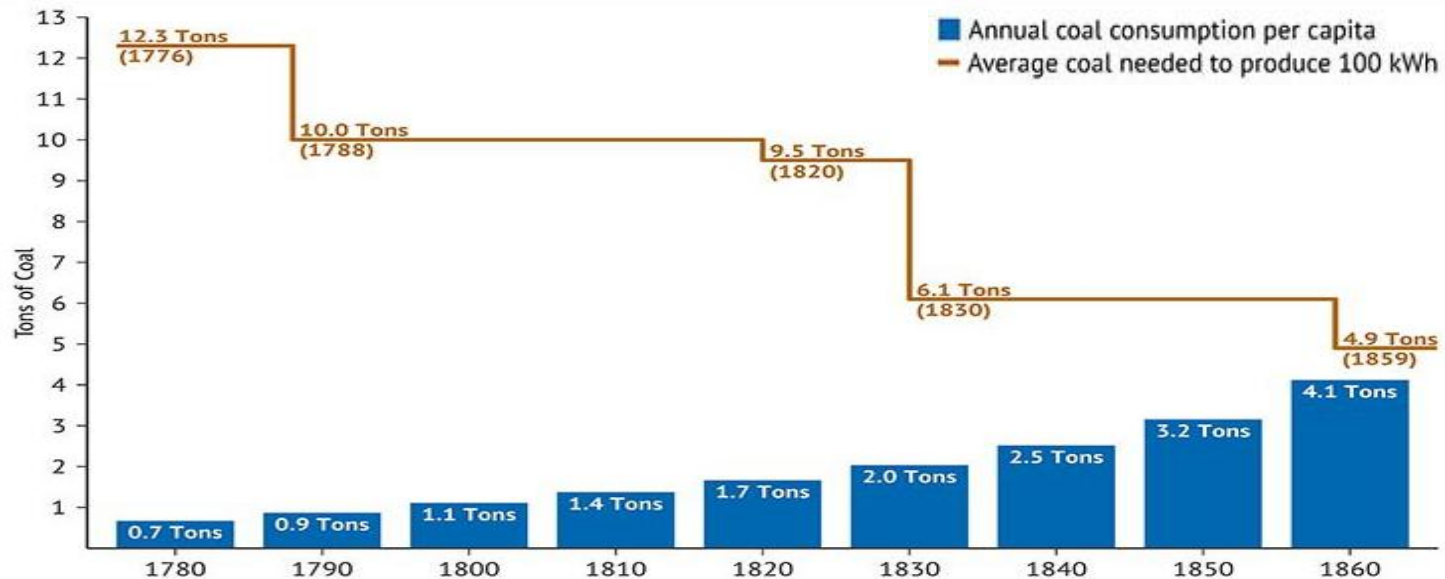
(negaWatt Scenario for 2017-2050)

Efficiency

Sobriety

Substitution

EFFICIENCY

EXAMPLE IN ICT

Computers or software that consume less electricity

- « Compressing or sending video stream consumes less electricity on the server »

-20%

JEVONS' PARADOX – REBOUND EFFECT (1865)

- **Improving the efficiency** of steam engines by the end of the 18th century resulted in **huge increasing** coal consumption during the 19th century

- **Increased profitability** and **reduced costs** boost utilization (less consumption per unit, but **massification** effect), hence the paradox

Legend:
- ■ Annual coal consumption per capita
- — Average coal needed to produce 100 kWh

Average coal needed to produce 100 kWh (Tons of Coal):
- 12.3 Tons (1776)
- 10.0 Tons (1788)
- 9.5 Tons (1820)
- 6.1 Tons (1830)
- 4.9 Tons (1859)

Annual coal consumption per capita:
- 1780: 0.7 Tons
- 1790: 0.9 Tons
- 1800: 1.1 Tons
- 1810: 1.4 Tons
- 1820: 1.7 Tons
- 1830: 2.0 Tons
- 1840: 2.5 Tons
- 1850: 3.2 Tons
- 1860: 4.1 Tons

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CONSEQUENCES FOR SUSTAINABILITY

Rebound effect **in sustainability**

- *From economical and historical perspectives, relying only on improving applicances efficiency (for energy production or consumption) will remain unsuccessfull unless they are combined with sufficiency strategies*

(Hilty, Lohmann, and Huang, 2011)

Do not separate technical concerns from usage

➲ Sobriety

SOBRIETY

EXAMPLE IN ICT

Reducing stream quality

- « A lower image resolution when listening to music on TV »
- « No image when doing something else in the room than watching the TV »

-50%

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« Handy Feedback »
([Weiss et al., 2009](#))
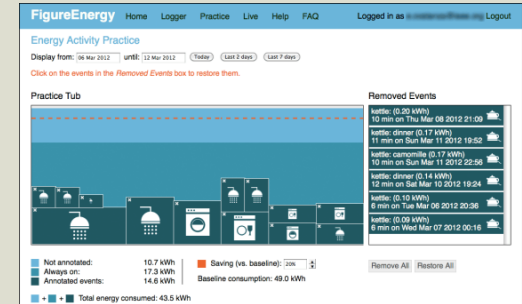
Power Advisor
([Kjeldskov et al., 2012](#))

Figure Energy
([Costanza et al., 2012](#))

Flower LAMP
([Backlund et al., 2007](#))

Share AWARE Light
([Broms, 2011](#))

Nuage Vert
([Evans et al., 2009](#))

SOME ECO-FEEDBACK SPECIMENS

➲ **From 5% to 20% decrease**

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SEVERAL LIMITATIONS

Everyday users are not resource managers

- Managing everyday life is necessary and time consuming

Boomerang effect

- People with low consumption start consuming more
- Money saved can be used for poluting activities
- Culpabilisation freeze people

Focusing on individual gestures

- Puts the responsability on individuals

Small gestures hide the reality of the problem

- Small invidual gestures remain small collective gain
- Small gestures avoid making great choices

GOING BACK TO THE CONTEXT

Today we consume ~1.7 planet resources a year (EOD)

- 1% growth $\Rightarrow$ doubling needs every 70 years
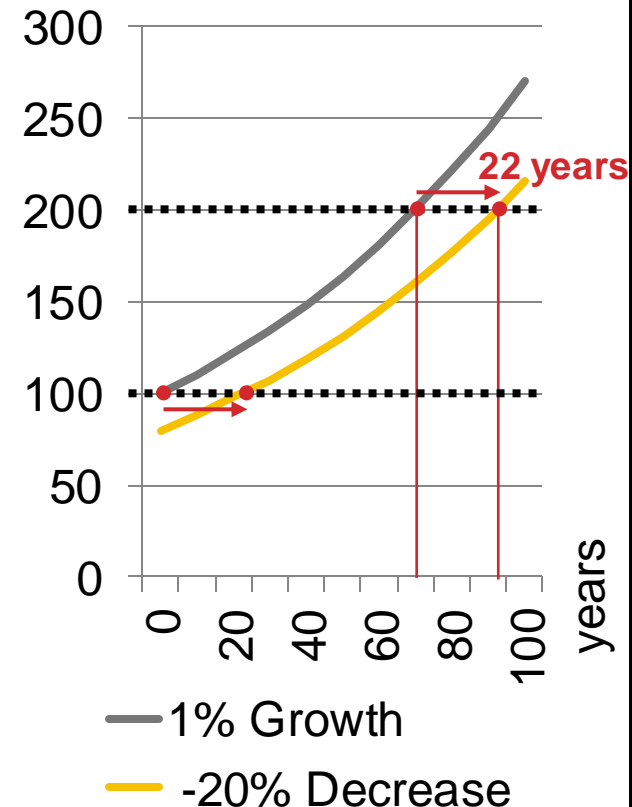
20% consumption decrease

- 92 years instead of 70 years to reach the same level
- Gain of 22 years
- Will not solve Earth overshooting problem but give a little bit more time ($\Leftrightarrow$ °C)

5% decrease…

- Gain of only 3 years… not worth it

What to do with a gain of 22 years?

- ➲ Introduce new social practices

22 years

years

— 1% Growth
— -20% Decrease

ILLUSTRATION

Optimizing diet

- Eat 200 g per day of soda and cakes

-20%

200 g/day   160 g/day

- Health is still in danger (e.g.: diabetes)

Changing diet
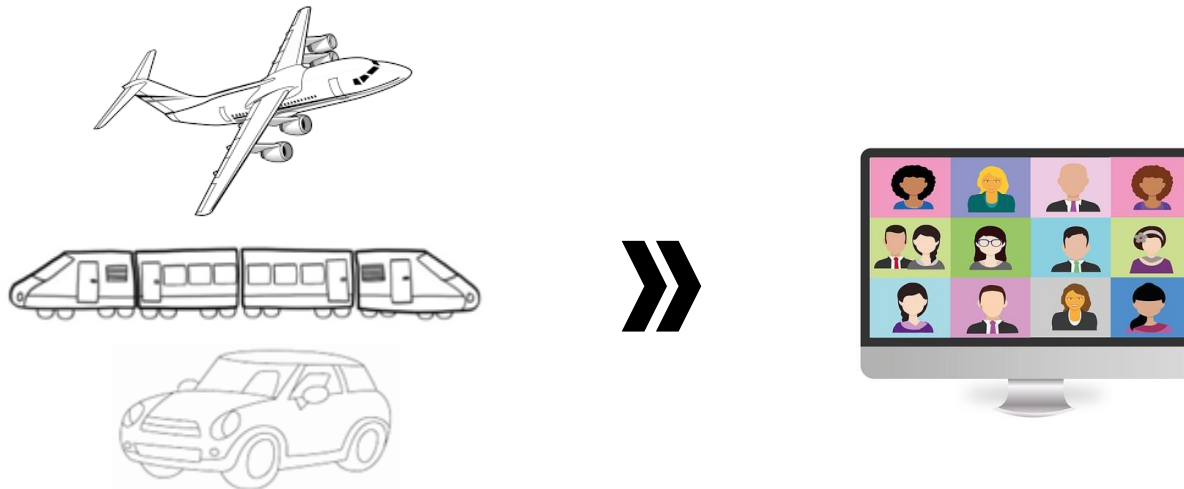
- Eat fruits and vegetables

➲ Substitution

SUBSTITUTION

EXAMPLE IN ICT

Online meetings rather than travelling across countries

- Habits changed because of pandemic crisis

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Watt-I-See
(Quintal et al., 2016)

Central coal power

Local solar power

Local wind power

Local human power

Local Energy Lamp
(Pierce et Paulos, 2010)

SHOWING ENERGY ORIGIN

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NEW ENERGY PRACTICES

Eco-feedback : nice attempt, not sufficient

- Guiding with data **to** introduce new social practices

Social practices evolution

- Not easy to understand and to create (not rational)

Positionning

- Find ways to create or assist new social practices
- Tangible interface <u>on public and collective spaces</u>
- Optimizing the rate of renewable energy that is consummed on workplaces

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CairnFORM

FIRST EXPLORATION

Taking advantage of Energy Storage

- Increase renewable energy rate
- Shift consumption (but not use) when renewable energy is available
- Eco-forecast display on public places
- User studies with a widespread storage on today workplaces: laptops' batteries
  - Unplug wire to wait for a higher renewable energy rate
  - Replug the wire to recharge the battery when rate is higher
  - Two-week user study in 2018 (Daniel and Rivière, 2021)
  - Six-month user study in 2023/2024
- First trends are encouraging
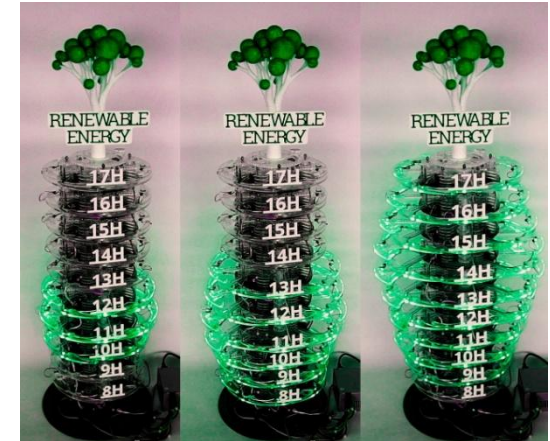
Renewable energy availability per hour
(Daniel, Rivière, and Couture, 2019)

0:47

CONCLUSION

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CONCLUSION

EFFICIENCY SOBRIETY

| GreenIT | Eco-Feedback |

- Rebound effect
- Boomerang effect
- Small individual gestures
- Necessary
- Postpone the problem for a few years
- Not sufficient solution to face climate change

TRANSITION

SUBSTITUTION

| Eco-Forecasts |

- Create new social practices
- Data driven assistance
- Zero-energy buildings

SOLUTION(S)

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