(Looking for)
Digital alternatives to physical activities
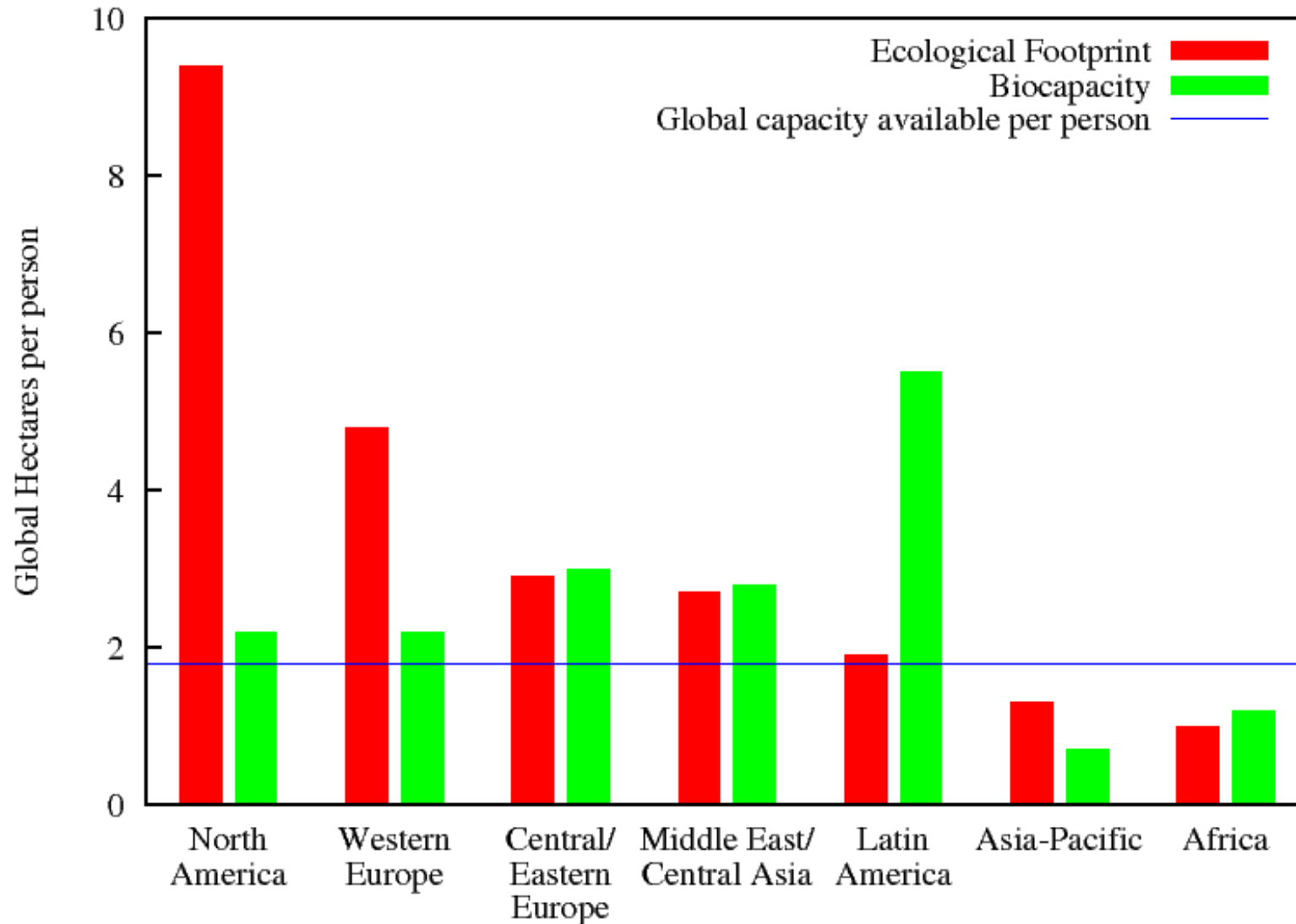
Andrew Rice
5th June 2008

We consume a lot of energy

Globally consumed: 5×10^{20}J in 2005
per person: 8MJ

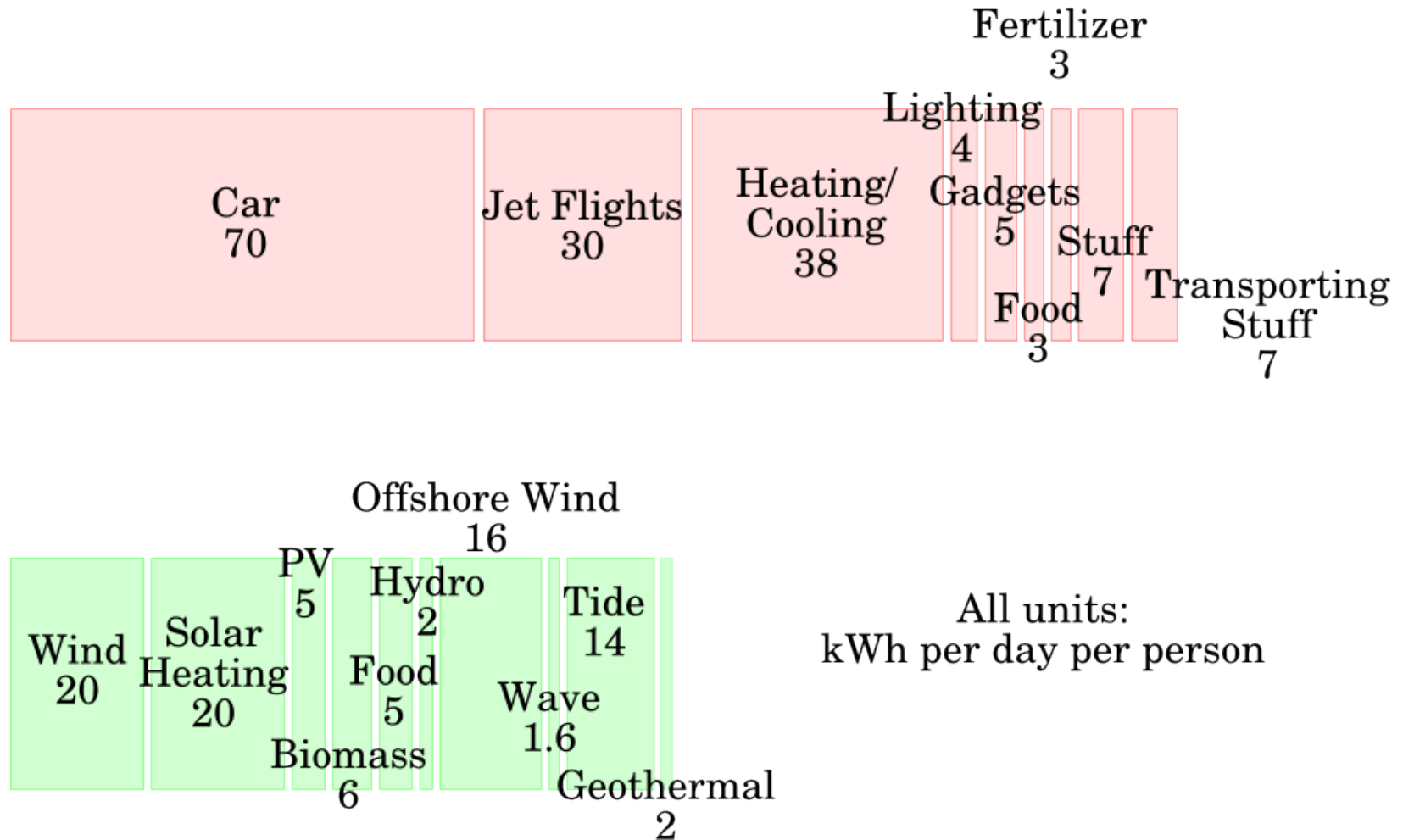This is approximately the same as boiling a kettle for a year

We consume too many resources
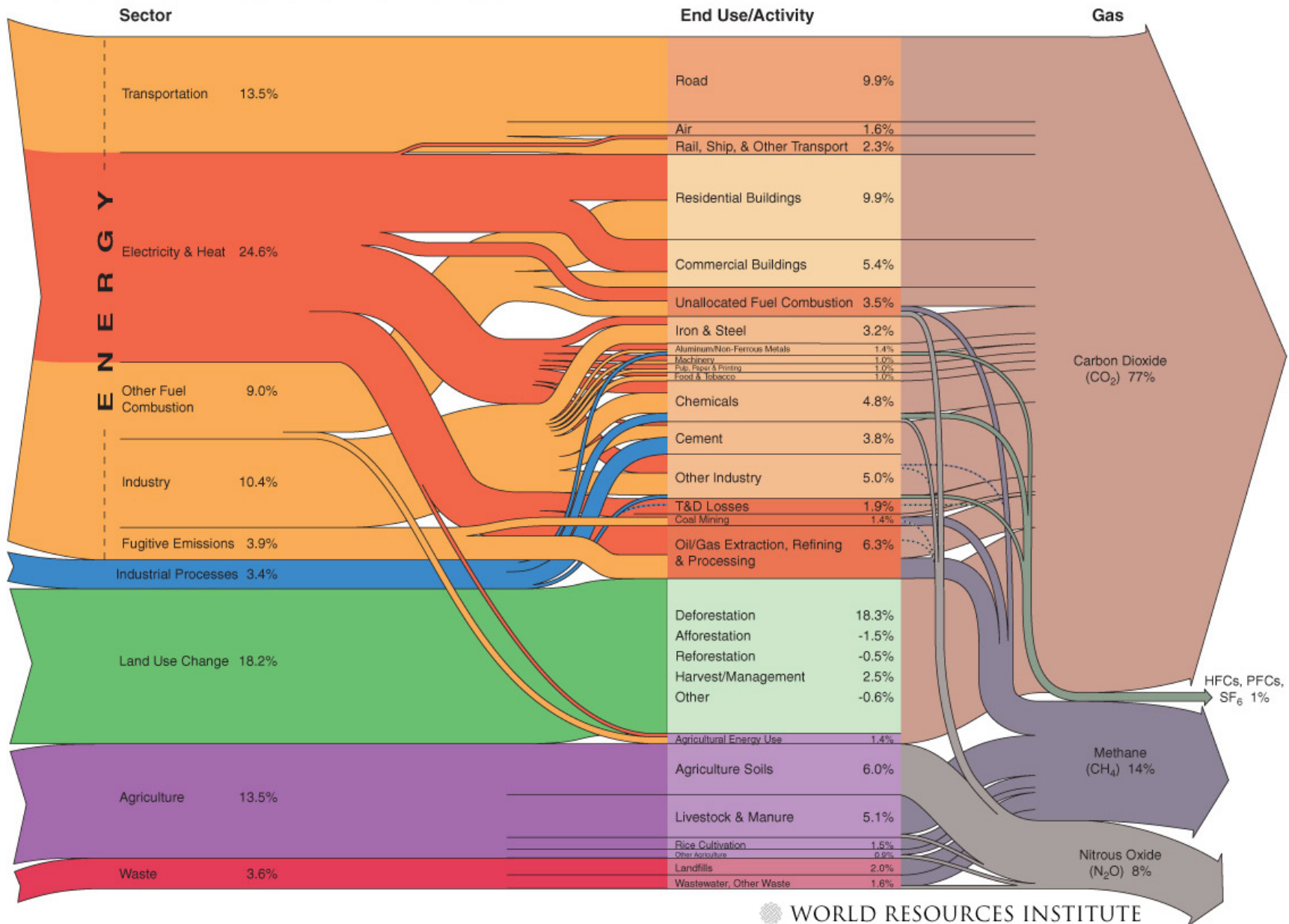
Most of UK consumption goes on transport

David Mackay
Renewable Energy without the hot air: http://www.withouthotair.com/

Car
70

Jet Flights
30

Heating/
Cooling
38

Fertilizer
3

Lighting
4

Gadgets
5

Stuff
7

Food
3

Transporting
Stuff
7

Offshore Wind
16

PV
5

Hydro
2

Tide
14

Wind
20

Solar
Heating
20

Food
5

Wave
1.6

Biomass
6

Geothermal
2

All units:
kWh per day per person

Many sources of GHG
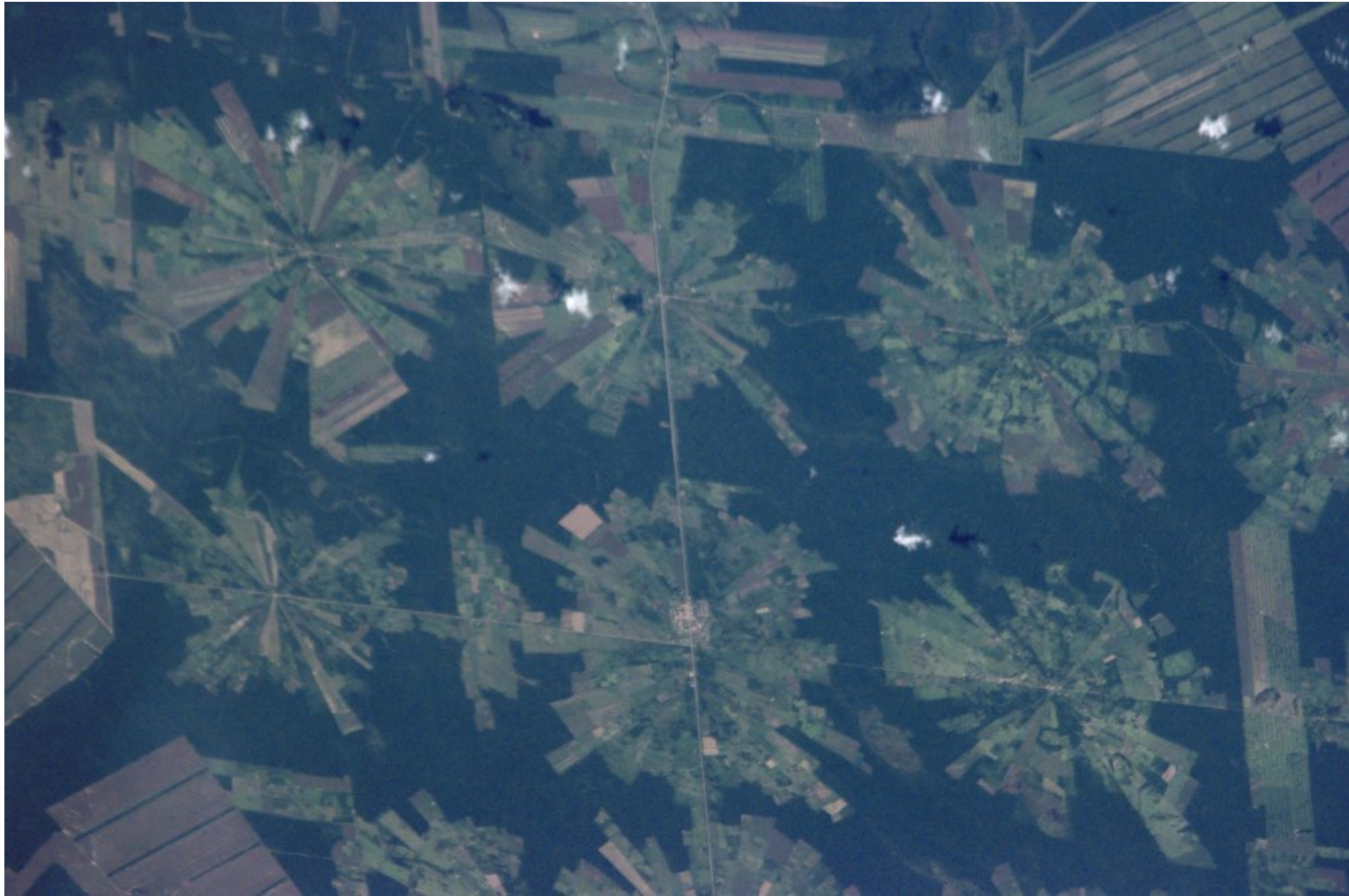

World GHG Emissions Flow Chart

There are lots of other problems

- Food production
- Water shortages
- Species extinction
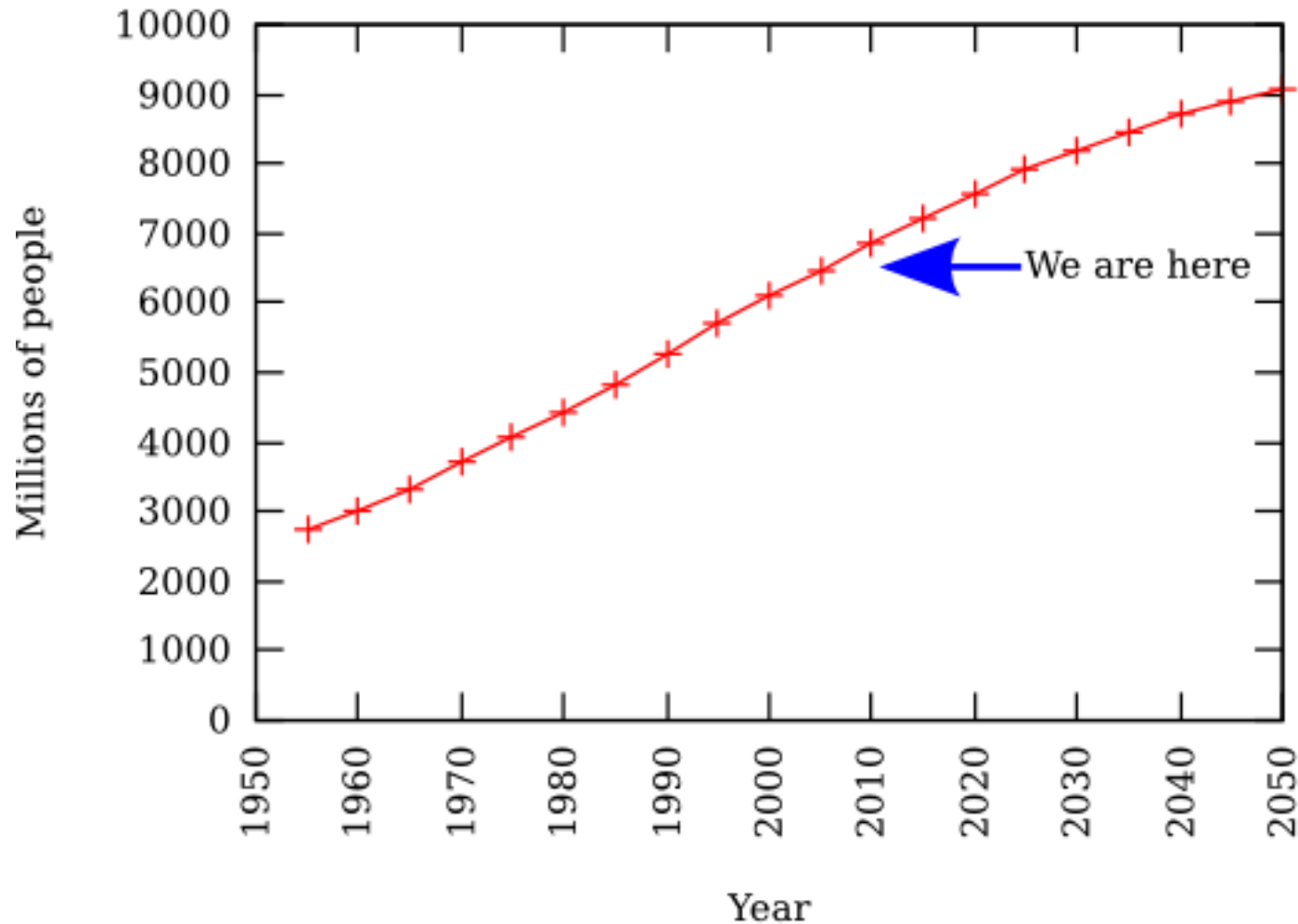- Chemical pollution + bioaccumulation

Deforestation

Tierras Bajas Deforestation, Bolivia

Source: NASA Earth Observatory

Population growth will negate all our efforts

Consider emissions from cars (using 2003 data),

141 cars per 1000 people globally (World Bank)
6302 million people globally in 2003 (CIA World factbook)
 => 889 million cars

442 cars per 1000 people in UK (World Bank)
 => 2785 million cars if everyone were like us
 => 3978 million cars in 2050

We need to cut emissions to 22% of the current total just to remain at present levels in 2050!

(assuming that individual car use does not increase
 from now on)

Computing can make a contribution

- 4 themes
- Outline each one
- How do they fit together?
- More detail: physical to digital

Optimal Digital Infrastructure

- Servers and cooling account for few percent of our total energy usage

- Its growing fast

We need more computing

% of the population with Internet access

63%	United Kingdom
70%	USA
9%	China
4%	India
17%	World

Satellite Links

Cellular networks

Low infrastructure networks

Delay tolerant networks
(Haggle project)
Trade physical
infrastructure for
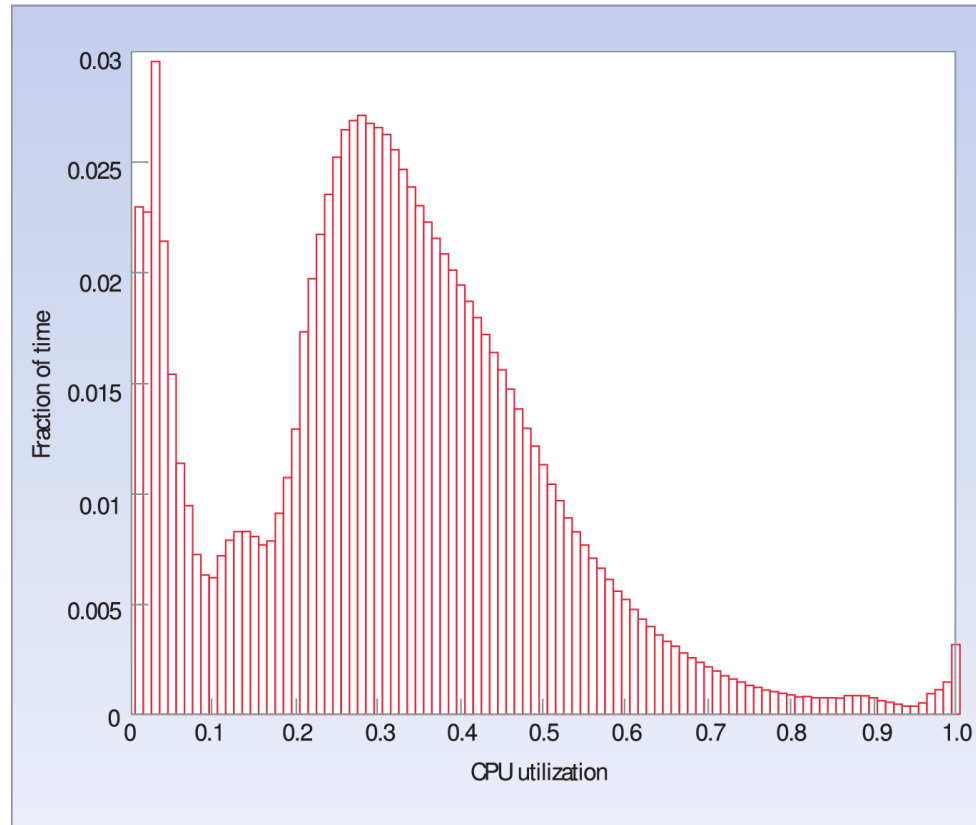digital infrastructure

Servers are often underutilised

Figure 1. Average CPU utilization of more than 5,000 servers during a six-month period. Servers are rarely completely idle and seldom operate near their maximum utilization, instead operating most of the time at between 10 and 50 percent of their maximum utilization levels.
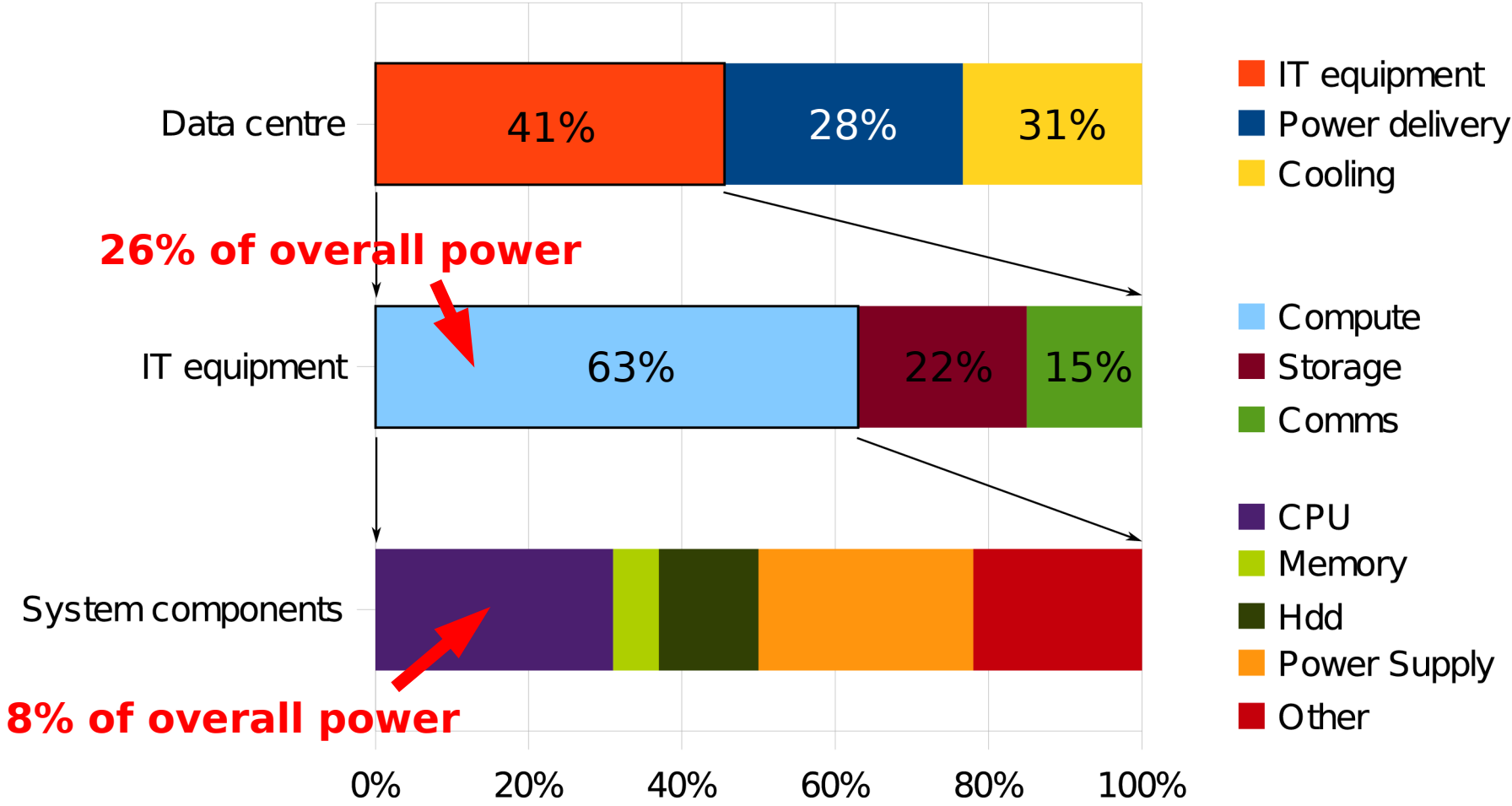
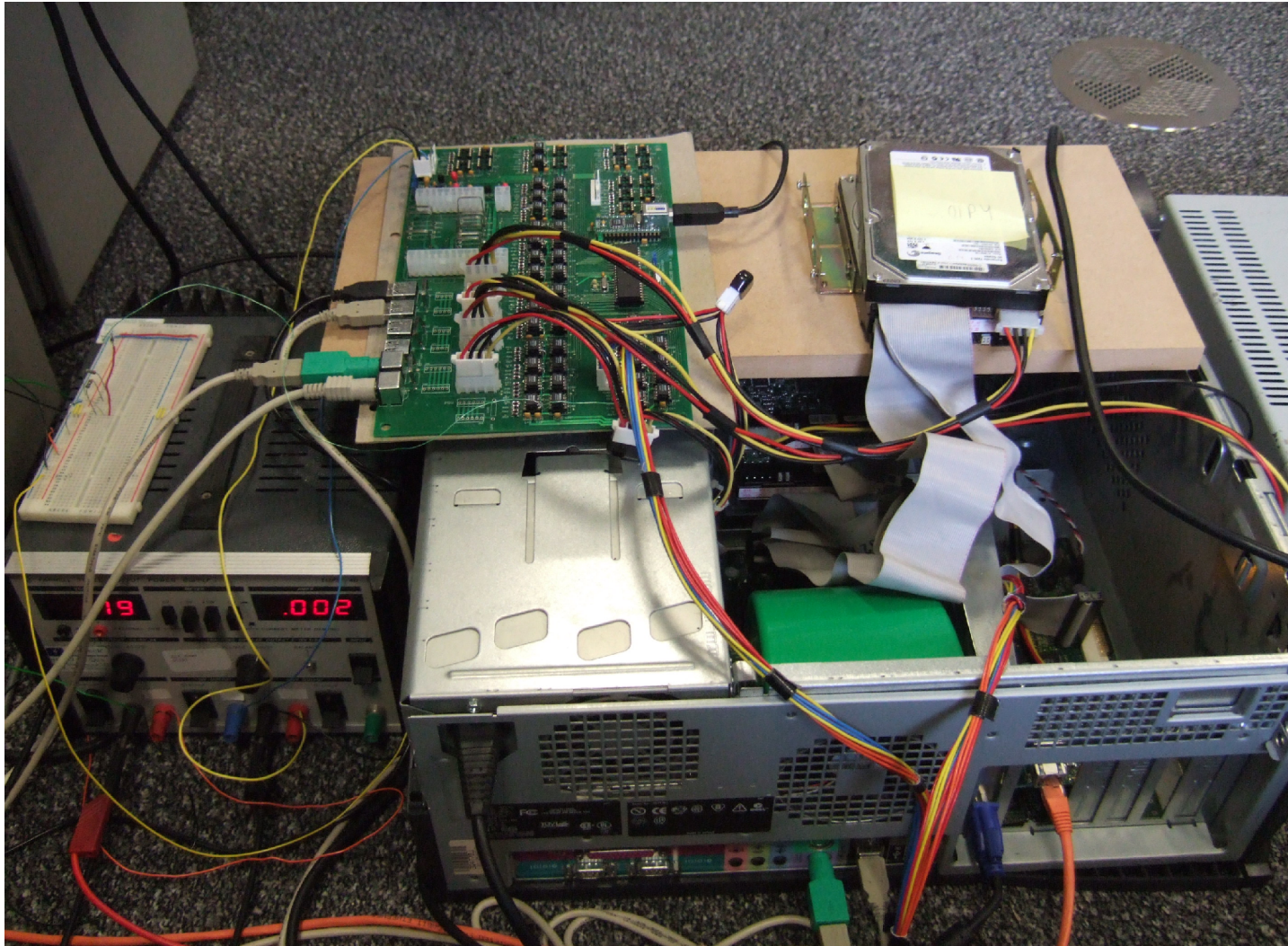Consolidation

Load concentration

Migration

Description languages
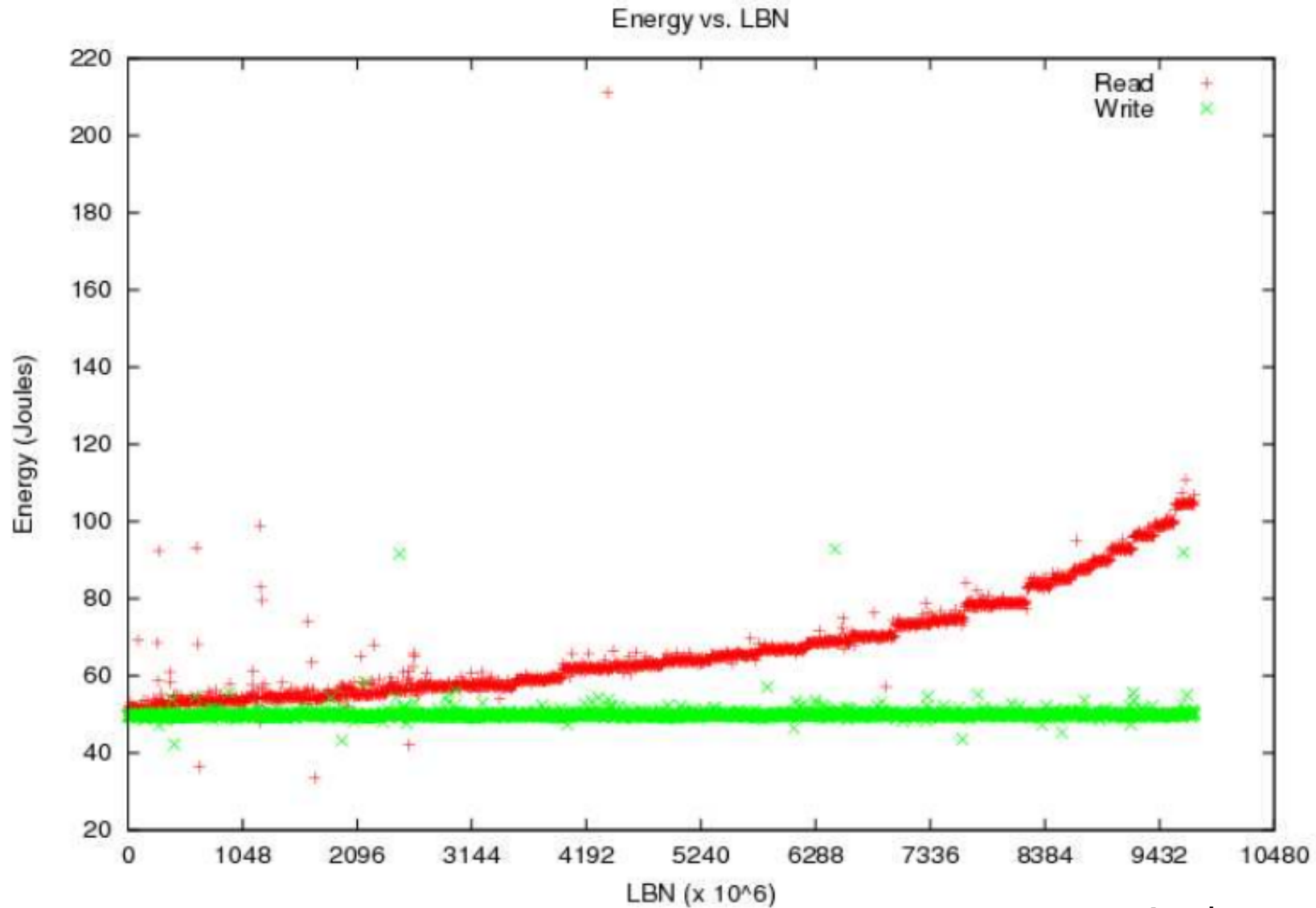
Very little energy actually gets to our servers

Source: Data Center Efficiency in the Scalable Enterprise, Dell Power Solutions, Feb 2007

Server power consumption

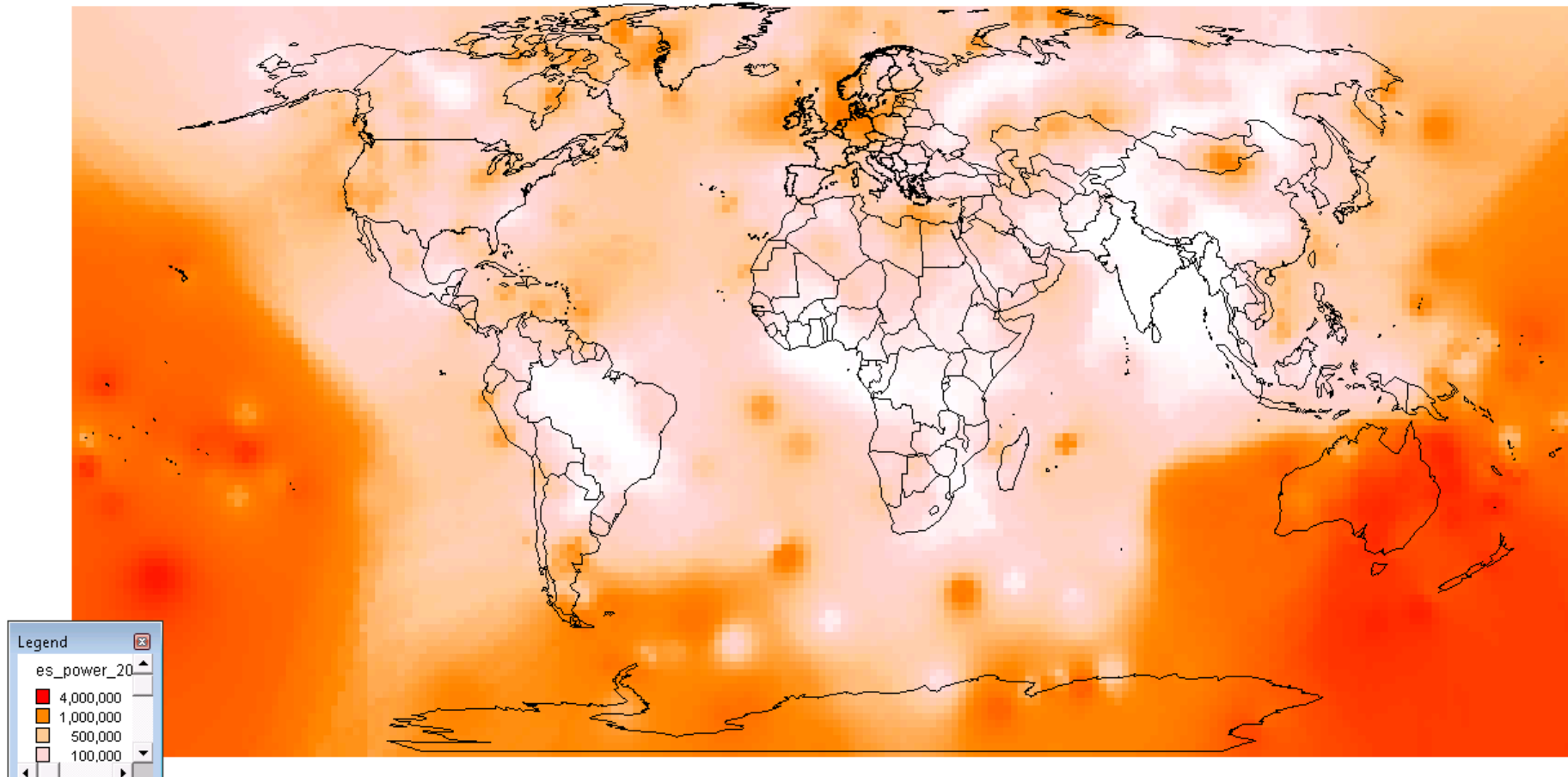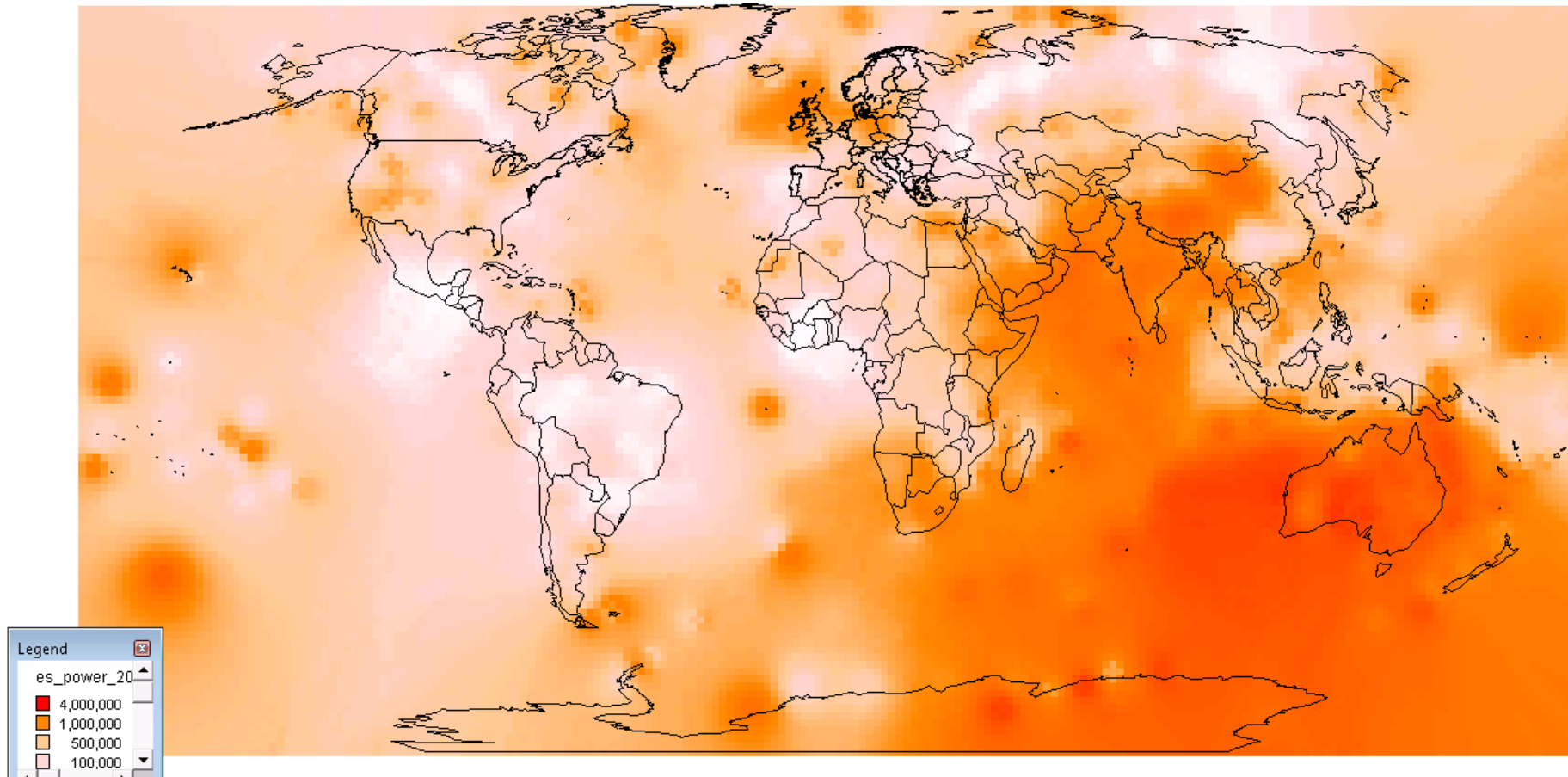Anthony Hylick

Writing data is cheaper than reading it

Energy vs. LBN

Anthony Hylick

Moving datacentres to renewable energy sources

Sherif Akoush

Energy available from Wind + Solar

Sherif Akoush

Energy available from Wind + Solar

Sherif Akoush

Energy available from Wind + Solar

Sherif Akoush

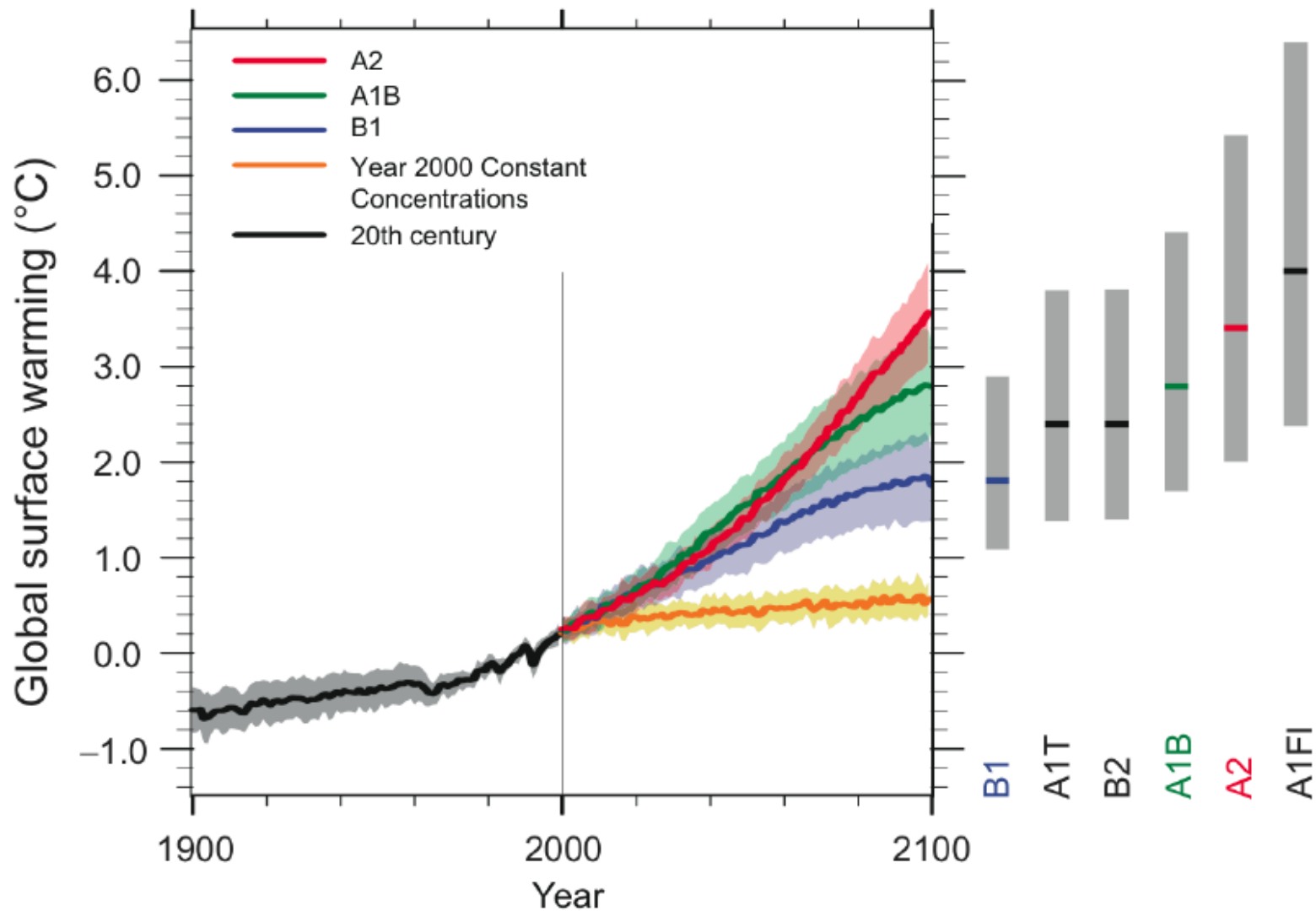# Energy available from Wind + Solar

Sherif Akoush

Energy available from Wind + Solar

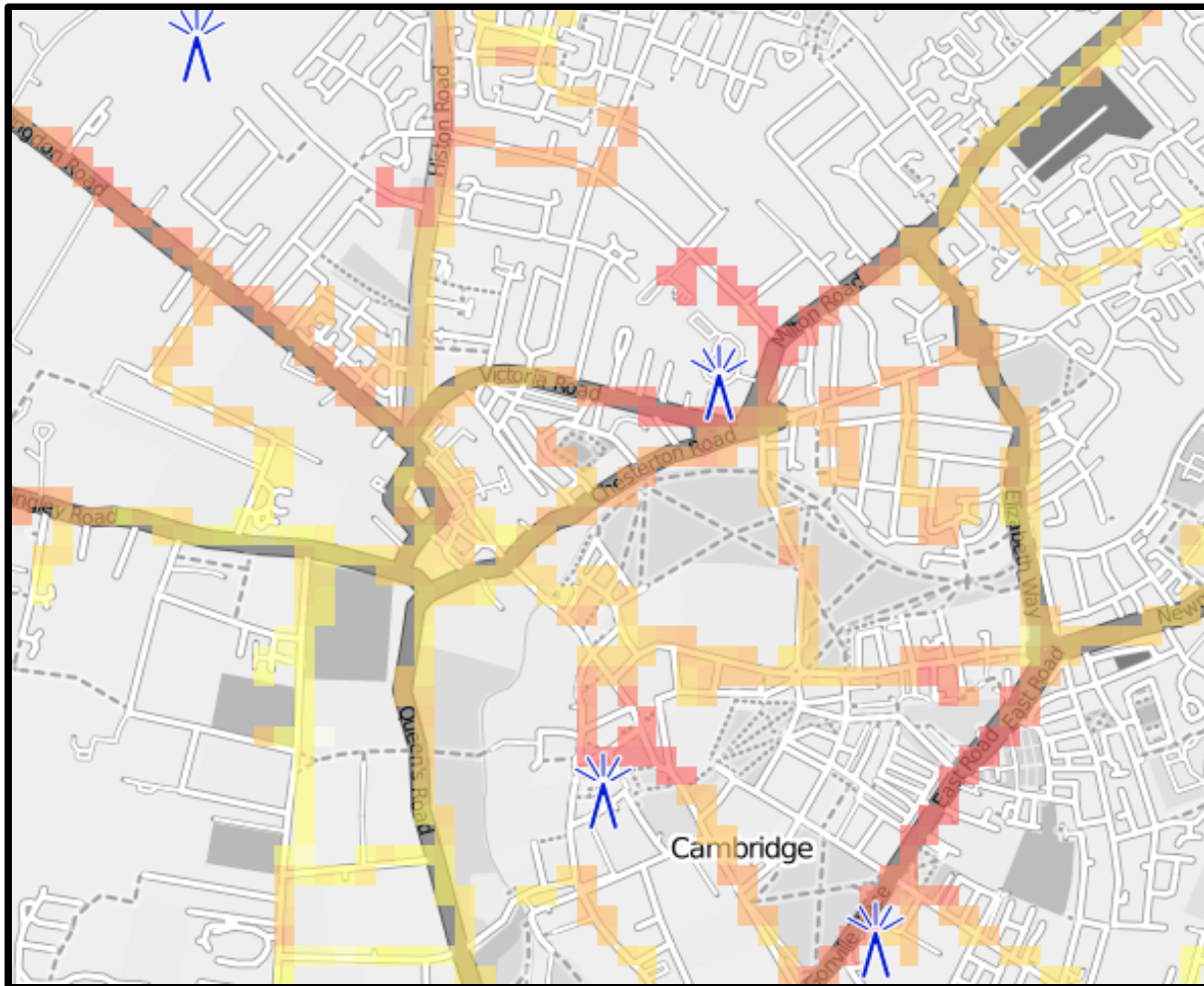Sherif Akoush
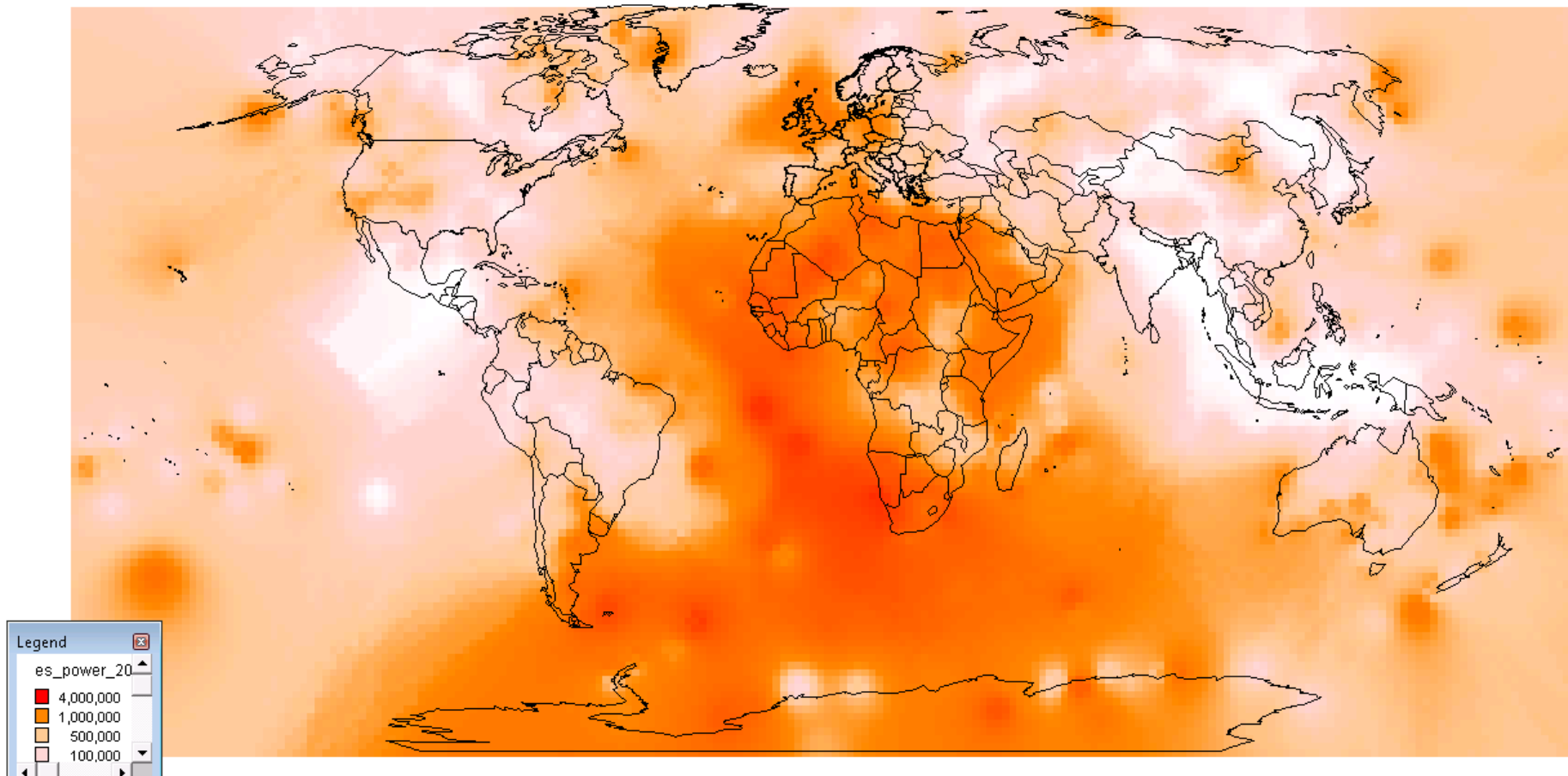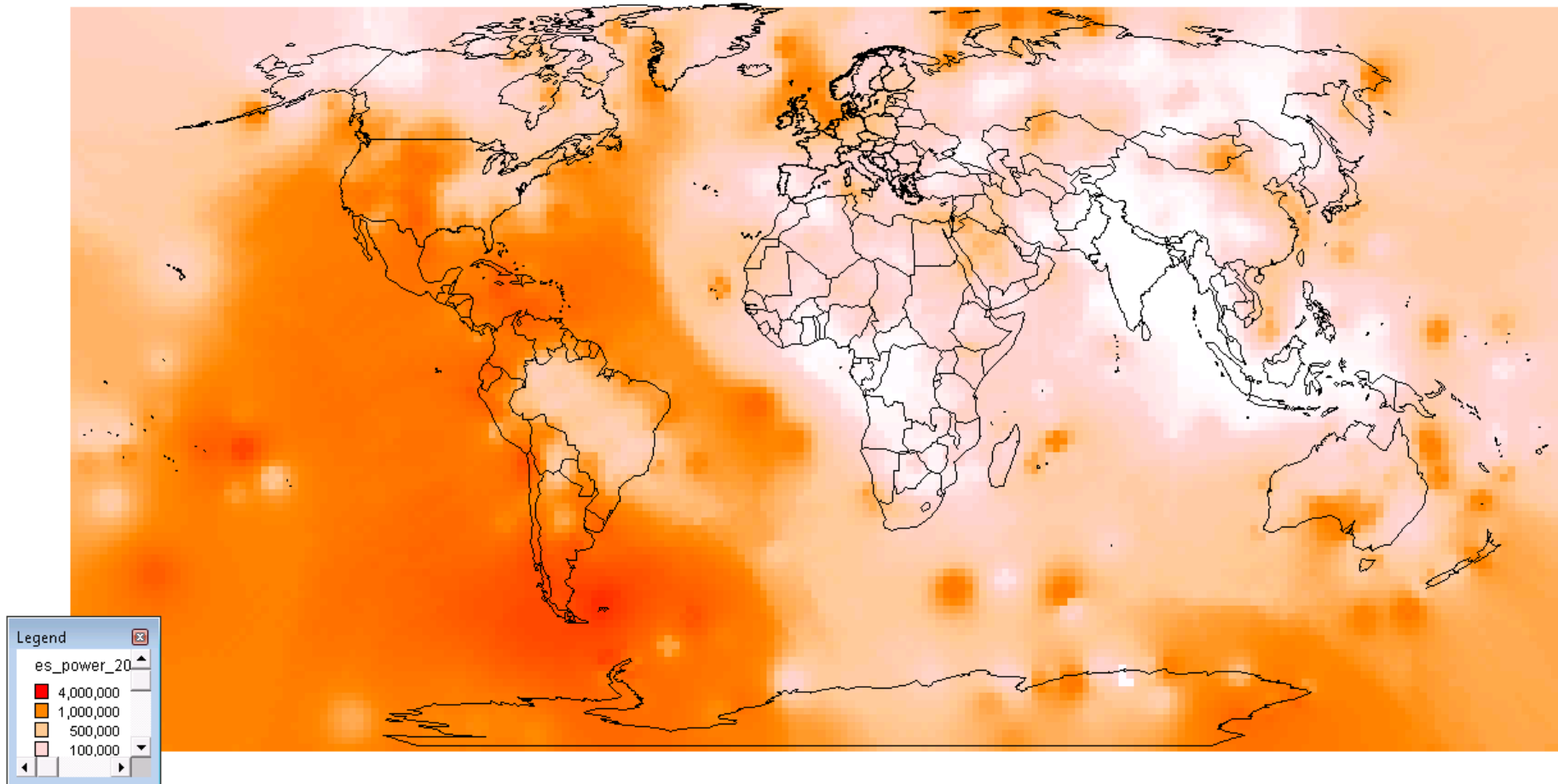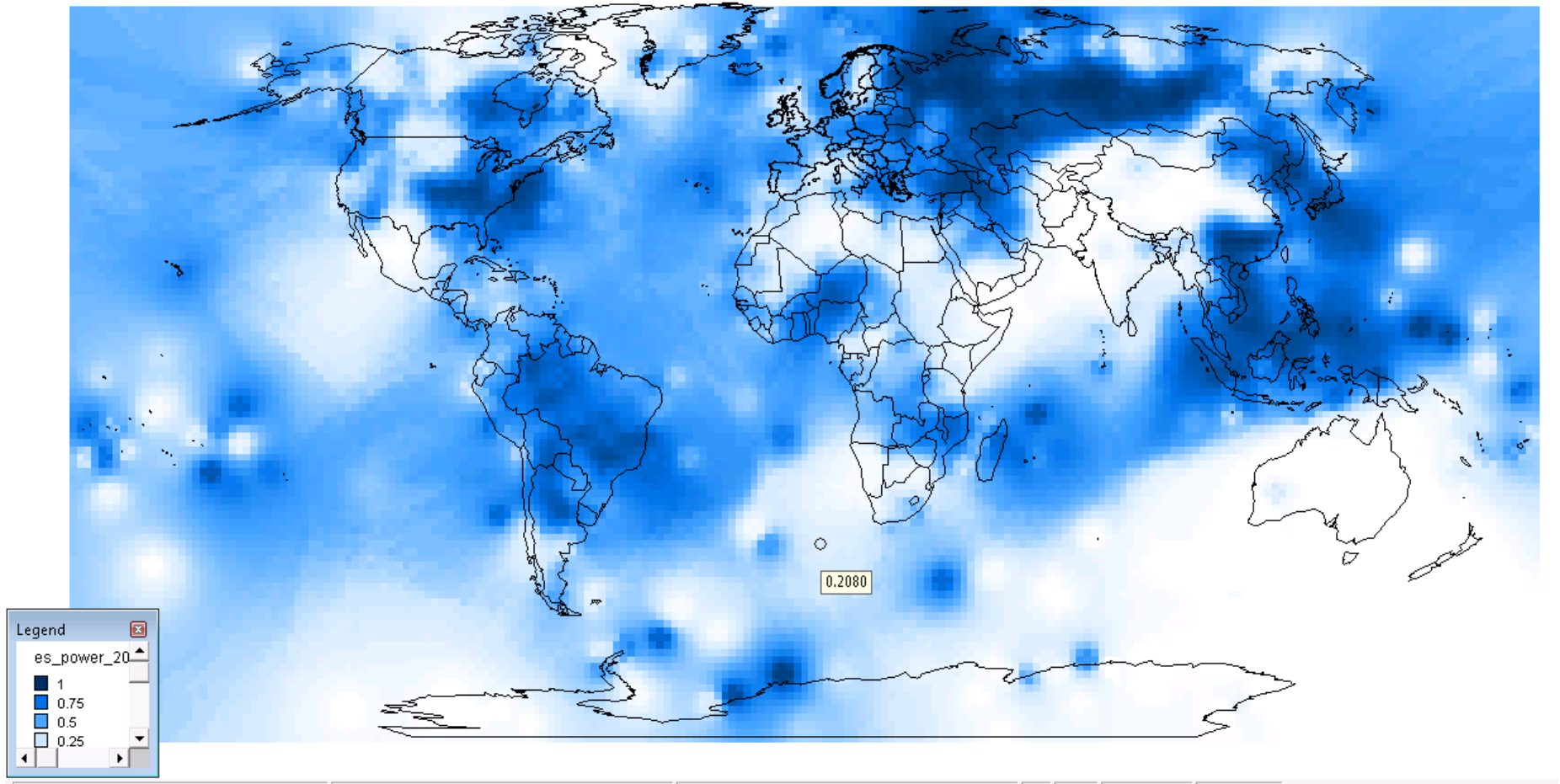
Predict and React

Multi-model Averages and Assessed Ranges for Surface Warming

Research points

- Models as part of a control loop
- Trustworthiness and dependability
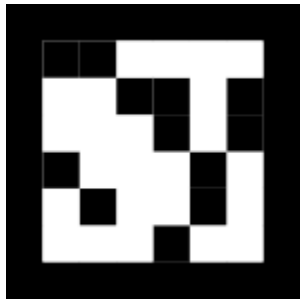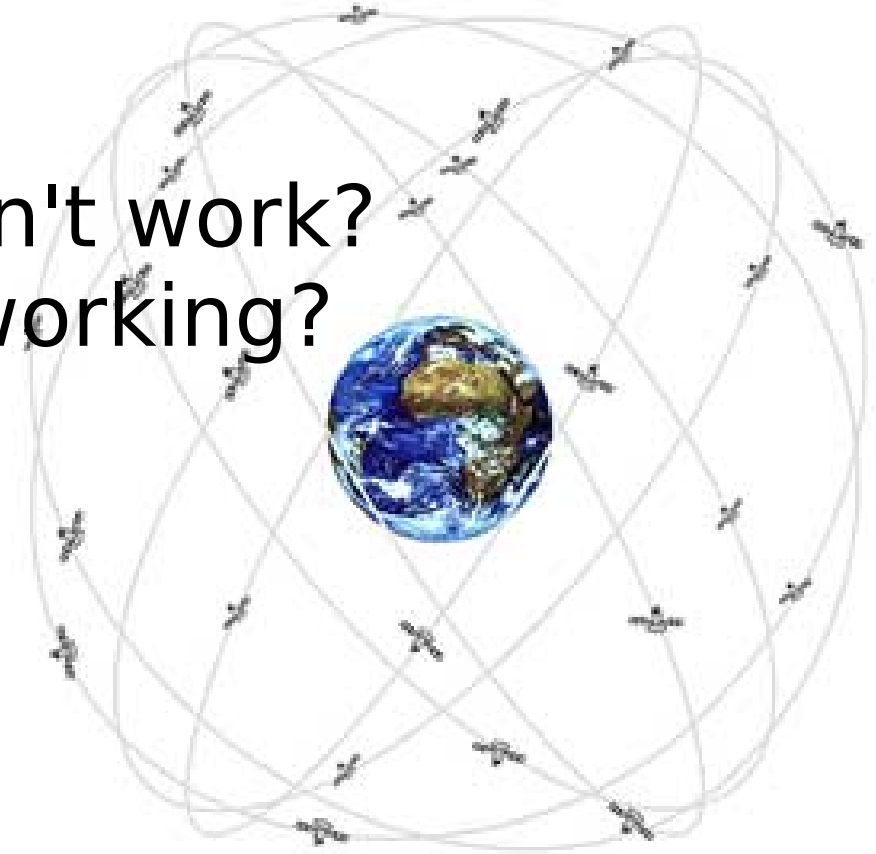- Separating algorithm from implementation

Sense and Optimize

Jon Davies and David Cottingham

Doomsday GPS

What's the cost of GPS?
What about where it doesn't work?
What happens if it stops working?
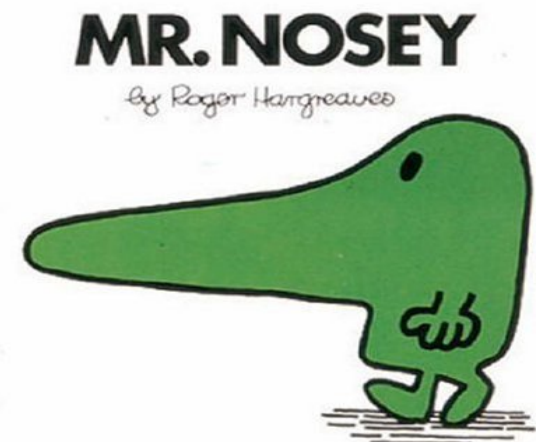(or it gets switched off)

low infrastructure
location systems

Tom Craig

Sensing the Planet

- Conventional Sensing
  - huge scale and diversity
  - maintenance, upgrade and management are significant problems

- Alternative: use people as sensors
  - self-repairing, self-recharging
  - autonomous, mobile
  - sophisticated sensors

MR. NOSEY
by Roger Hargreaves

Sensing the Planet

- Maps generated from hand-edited GPS traces

- Could maintain them automatically

Data from OpenStreetMap

Physical to Digital


vs

vs

Inge Reichart and Roland Hischier "The Environmental Impact of Getting the News: A Comparison of On-Line, Television, and Newspaper Information Delivery", in Journal of Industrial Ecology 2006

No clear wins yet for Physical to Digital

- Our computing infrastructure has a significant cost

- Teleconferencing has been shown to **increase** travel!

- Is there an asymptotic complexity argument?

  - can we find physical activities which grow faster in energy cost than digital ones?

Fitting the themes together
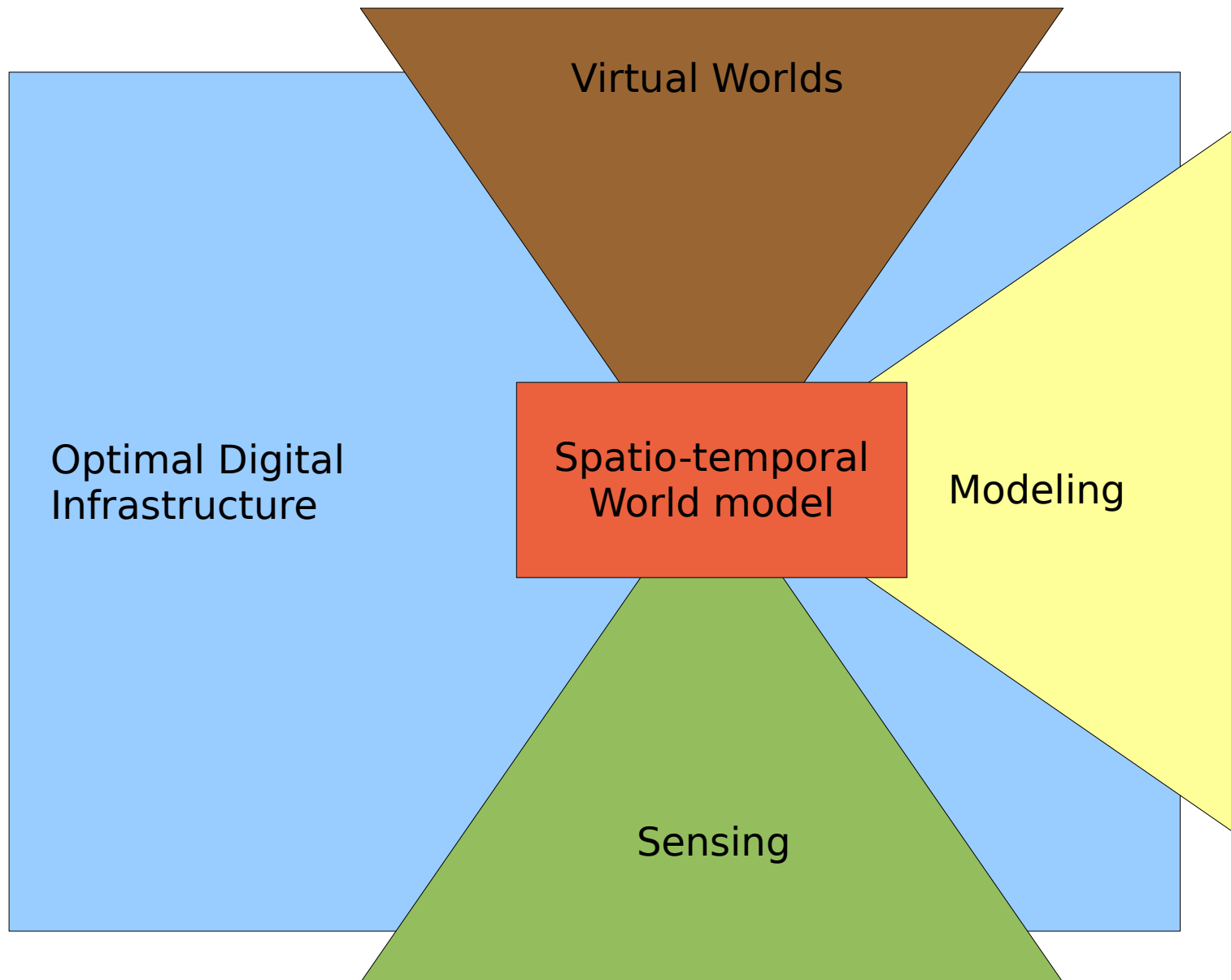
Summary

- We think technology can provide us with solutions to environmental and sustainability problems

- Physical to digital presents an unbounded upside

  – but only if we get it right!