



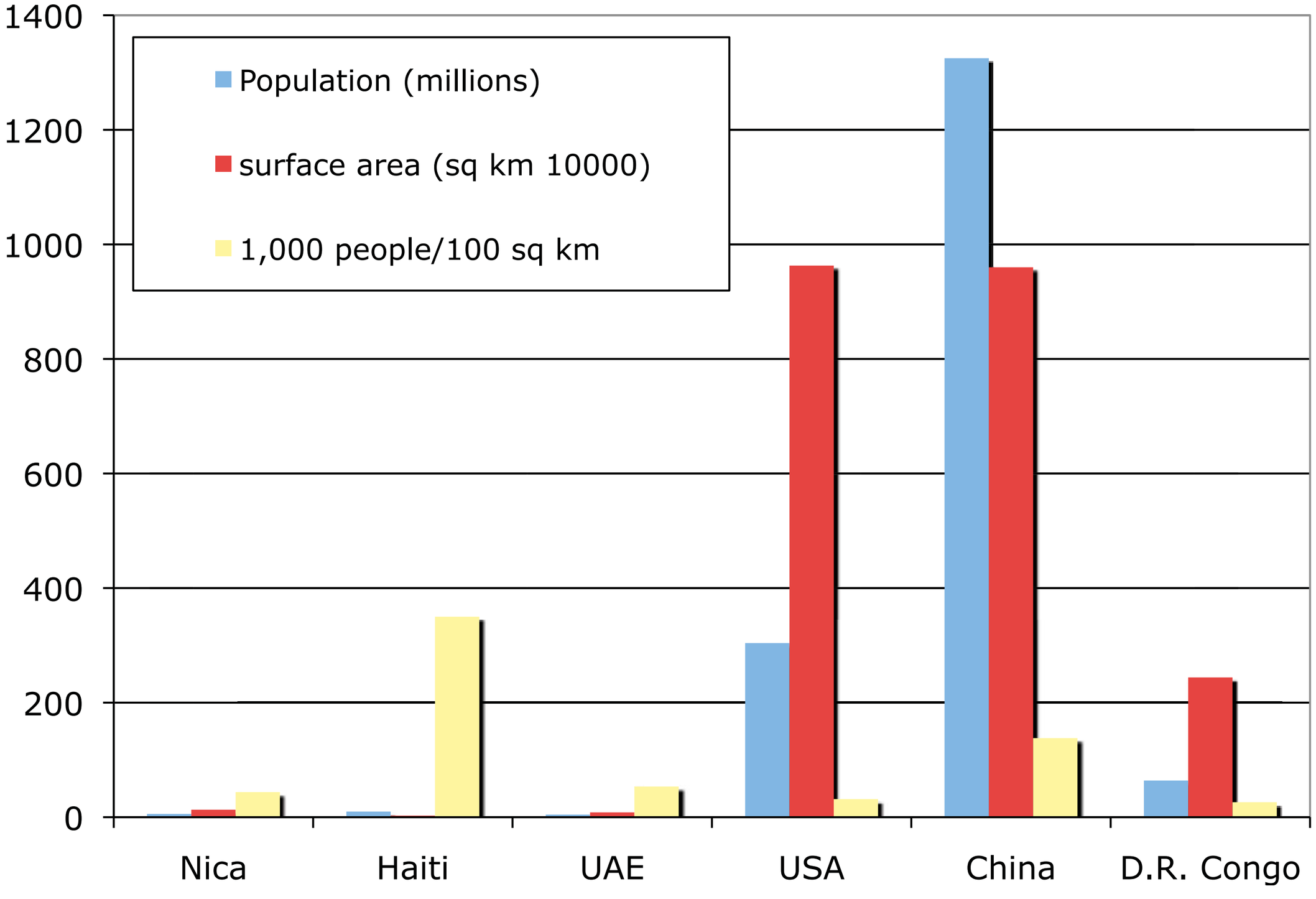
Welcome to

D-Lab: ENERGY

WORLD DEVELOPMENT INDICATORS:

ENERGY

[all numbers from the World Bank WDI website]

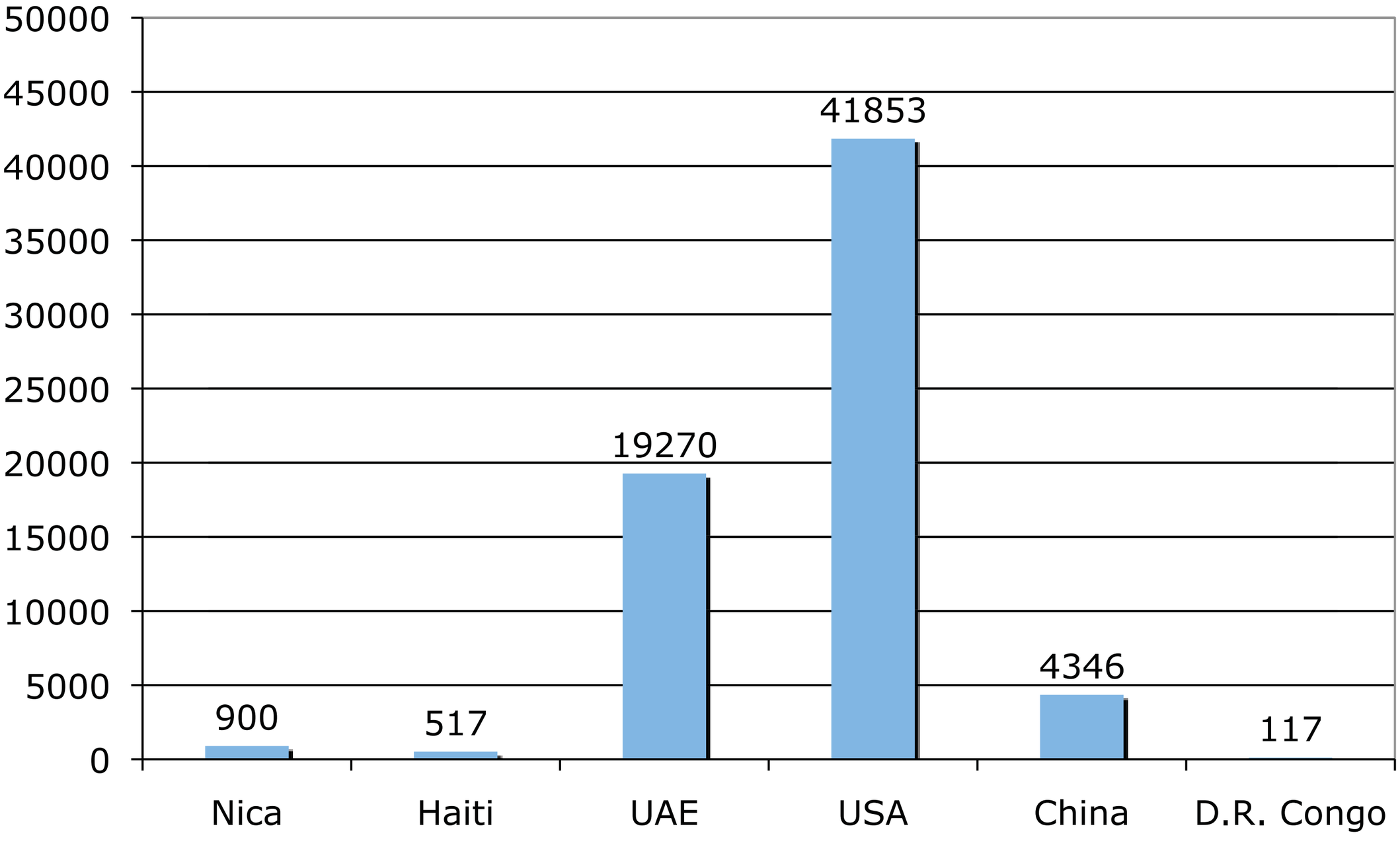

1400
1200
1000
800
600
400
200
0
Population (millions)
surface area (sq km 10000)
1,000 people/100 sq km
Nica
Haiti
UAE
USA
China
D.R. Congo

GNI per capita, Atlas method, US$

–

Nica Haiti UAE USA China D.R. Congo

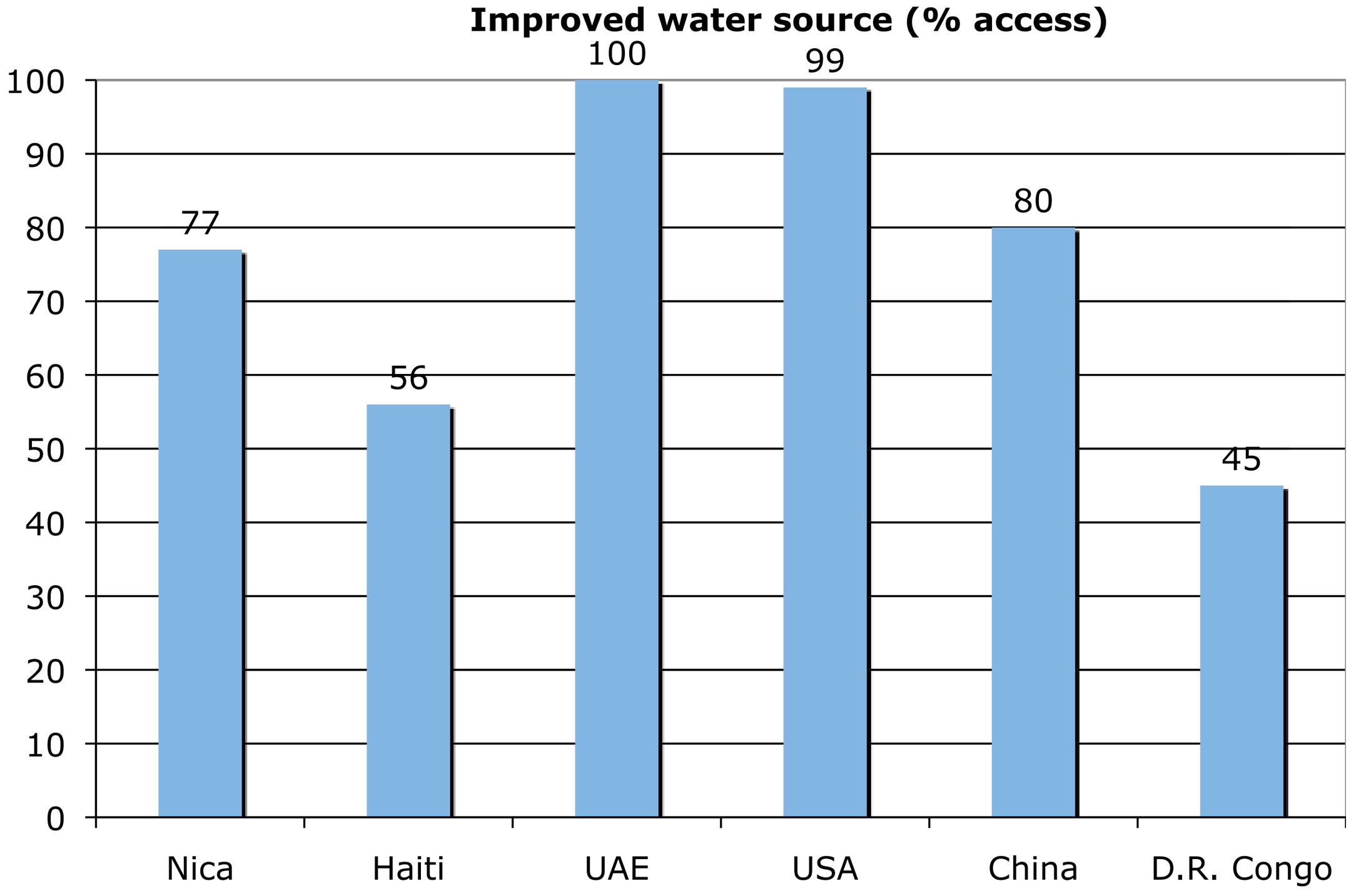
GNI per capita, Atlas method, US$



Improved water source (% access)

100
90
80
70
60
50
40
30
20
10
0

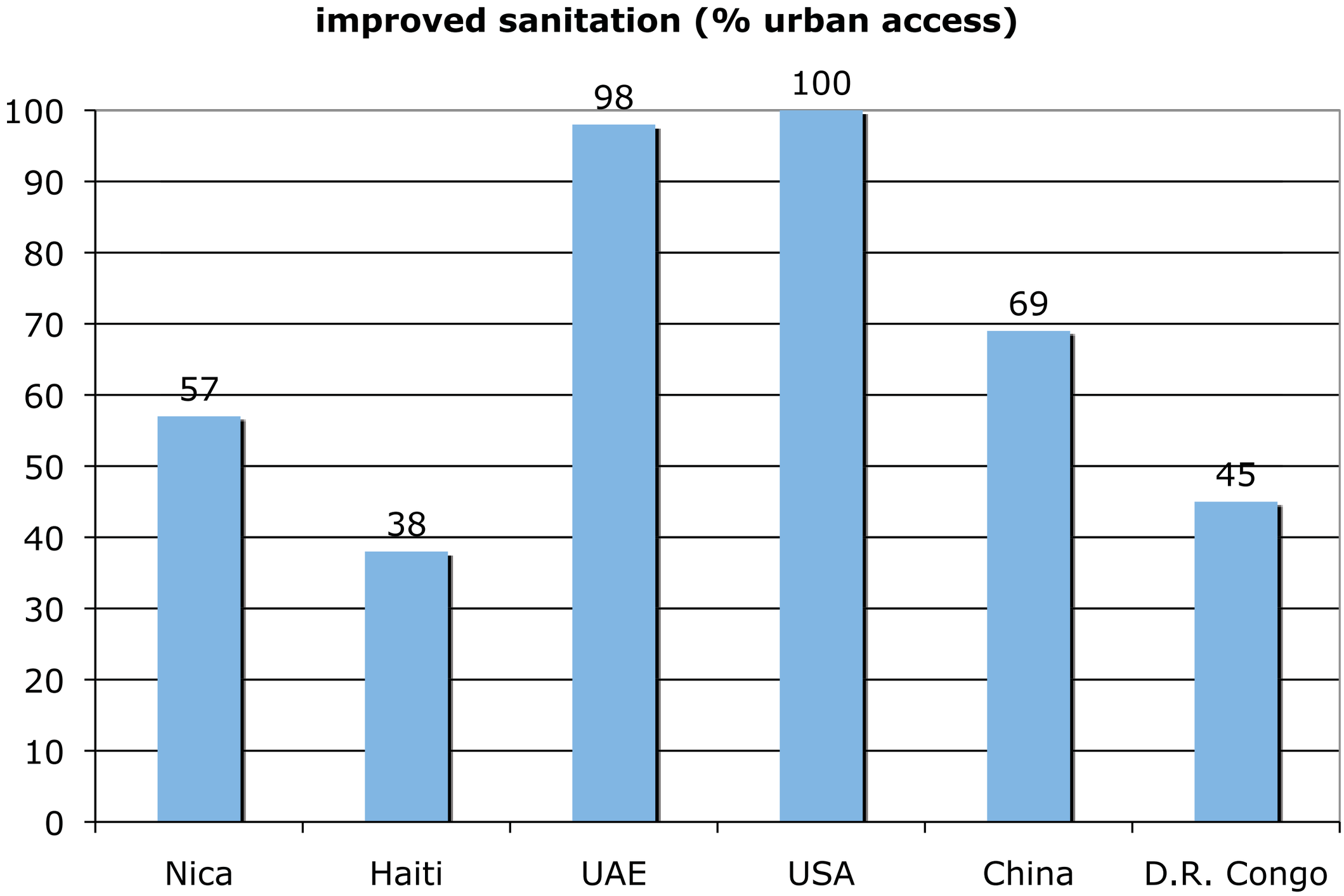
Nica
Haiti
UAE
USA
China
D.R. Congo


Improved water source (% access)
100
90
80
70
60
50
40
30
20
10
0
77
56
100
99
80
45
Nica
Haiti
UAE
USA
China
D.R. Congo

improved sanitation (% urban access)

100
90
80
70
60
50
40
30
20
10
0

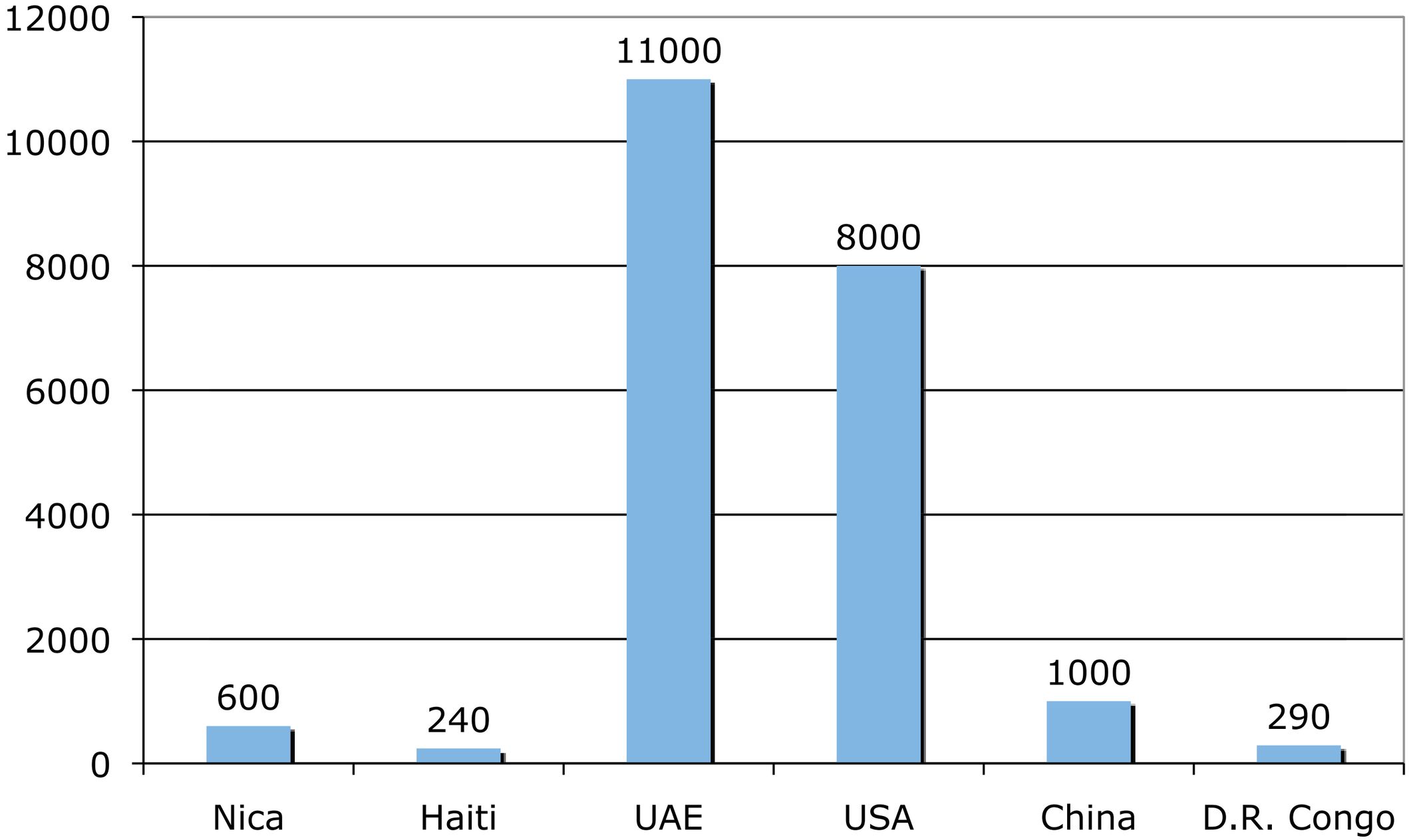
Nica
Haiti
UAE
USA
China
D.R. Congo


improved sanitation (% urban access)
100
90
80
70
60
50
40
30
20
10
0
57
38
98
100
69
45
Nica
Haiti
UAE
USA
China
D.R. Congo

Energy use (kg of oil equivalent per capita)

Nica Haiti UAE USA China D.R. Congo

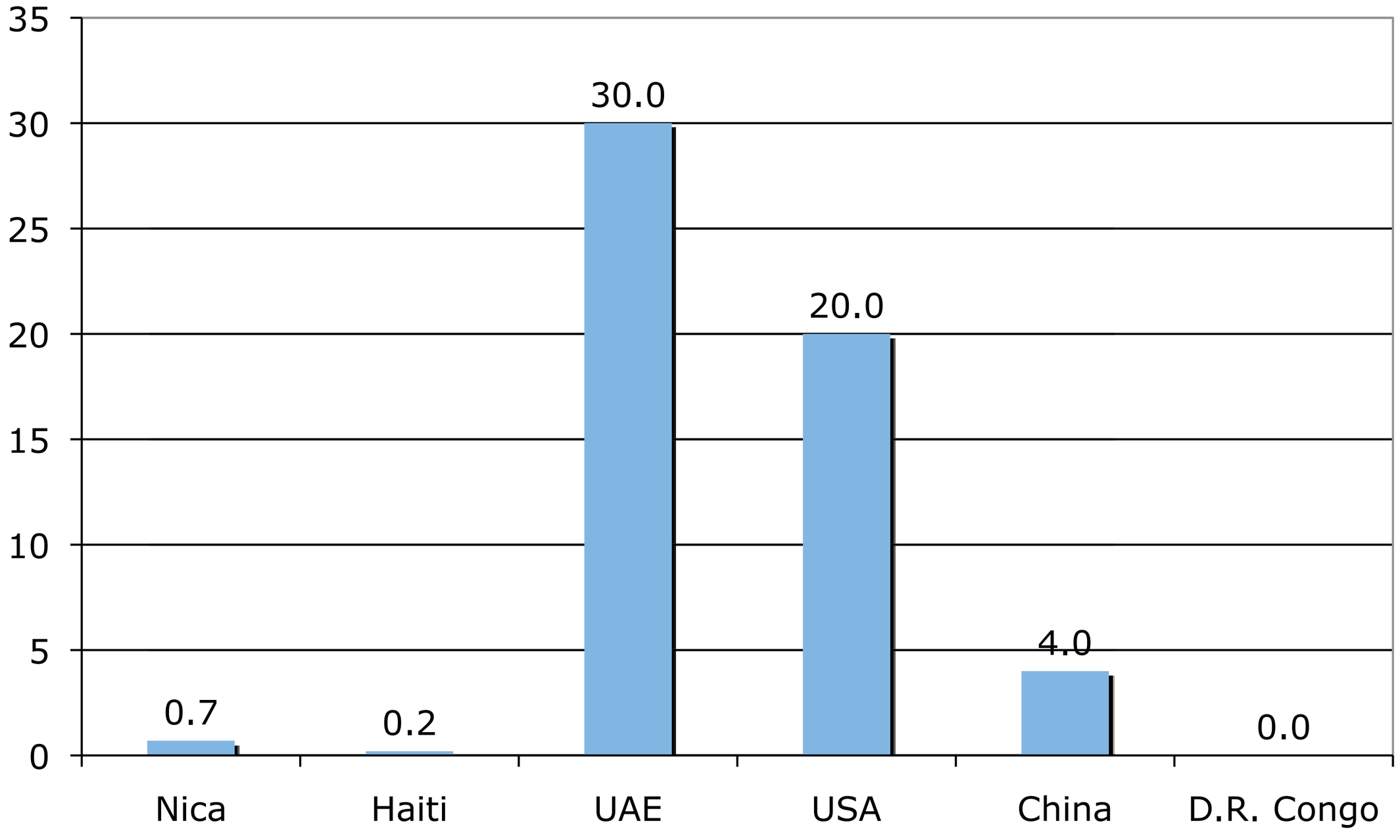
Energy use (kg of oil equivalent per capita)



CO2 emissions (metric tons per capita)

Nica Haiti UAE USA China D.R. Congo

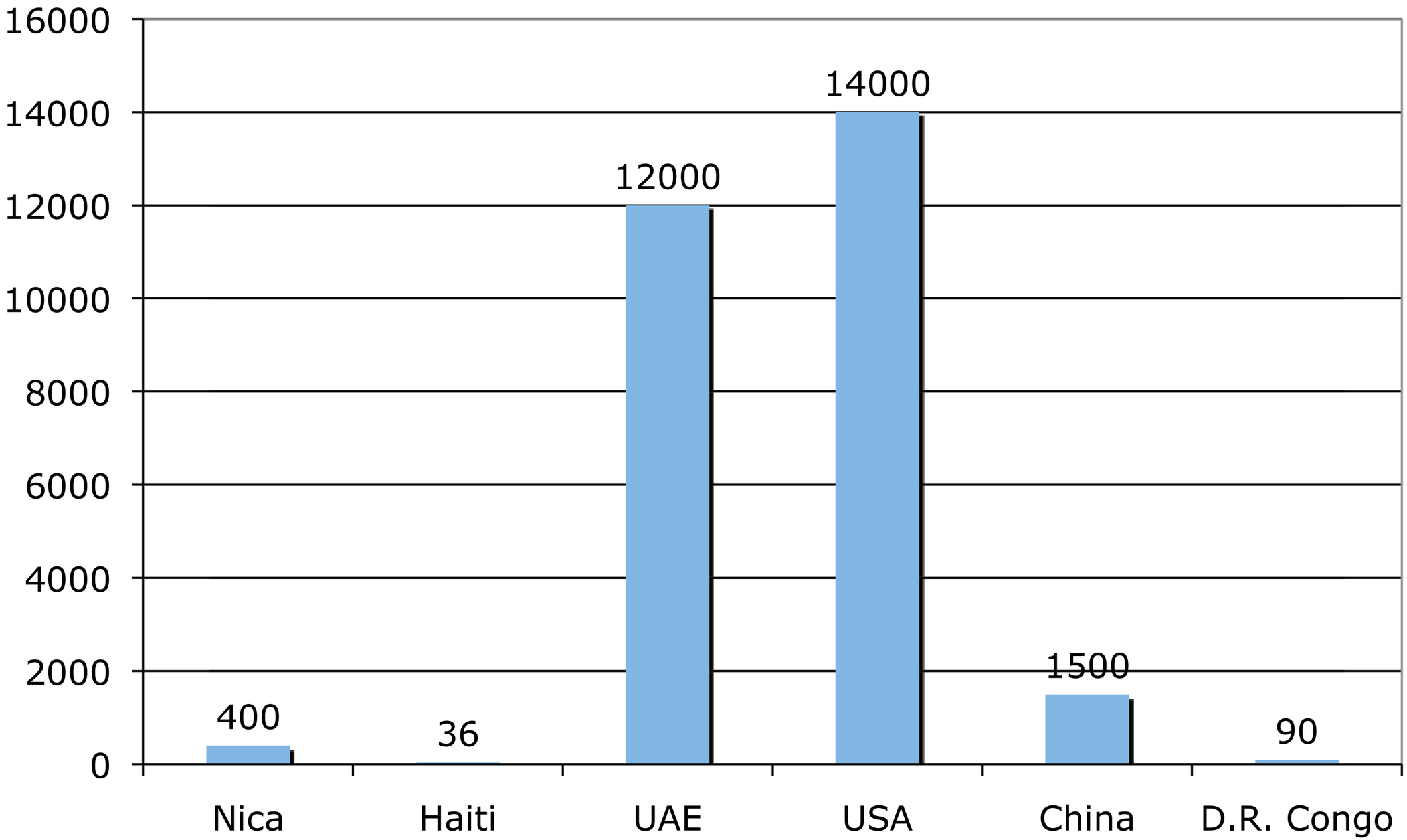
CO2 emissions (metric tons per capita)



Electric power consumption (kWh per capita)

Nica Haiti UAE USA China D.R. Congo

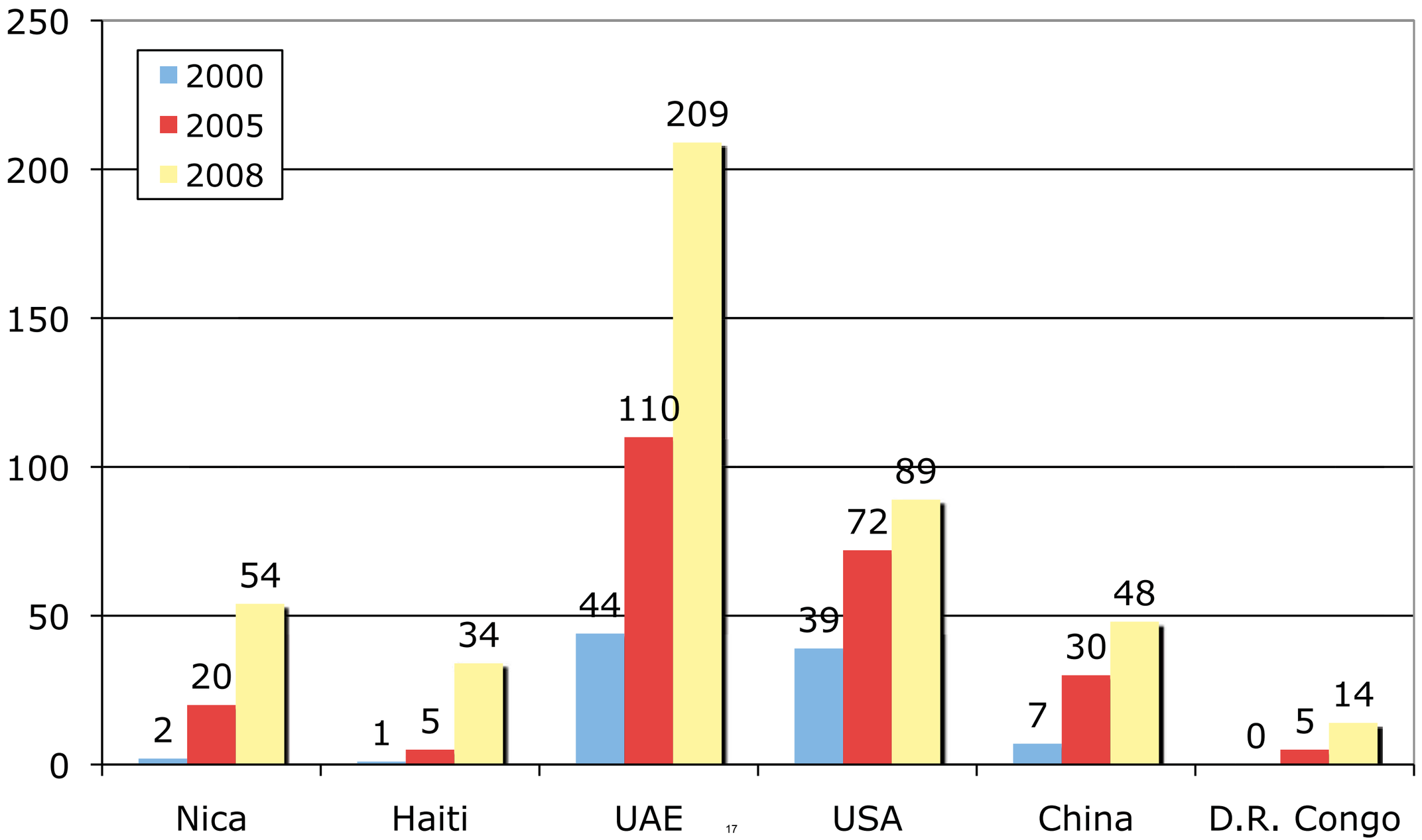
Electric power consumption (kWh per capita)



mobile cellular subscriptions (per 100 ppl)

Nica Haiti UAE USA China D.R. Congo

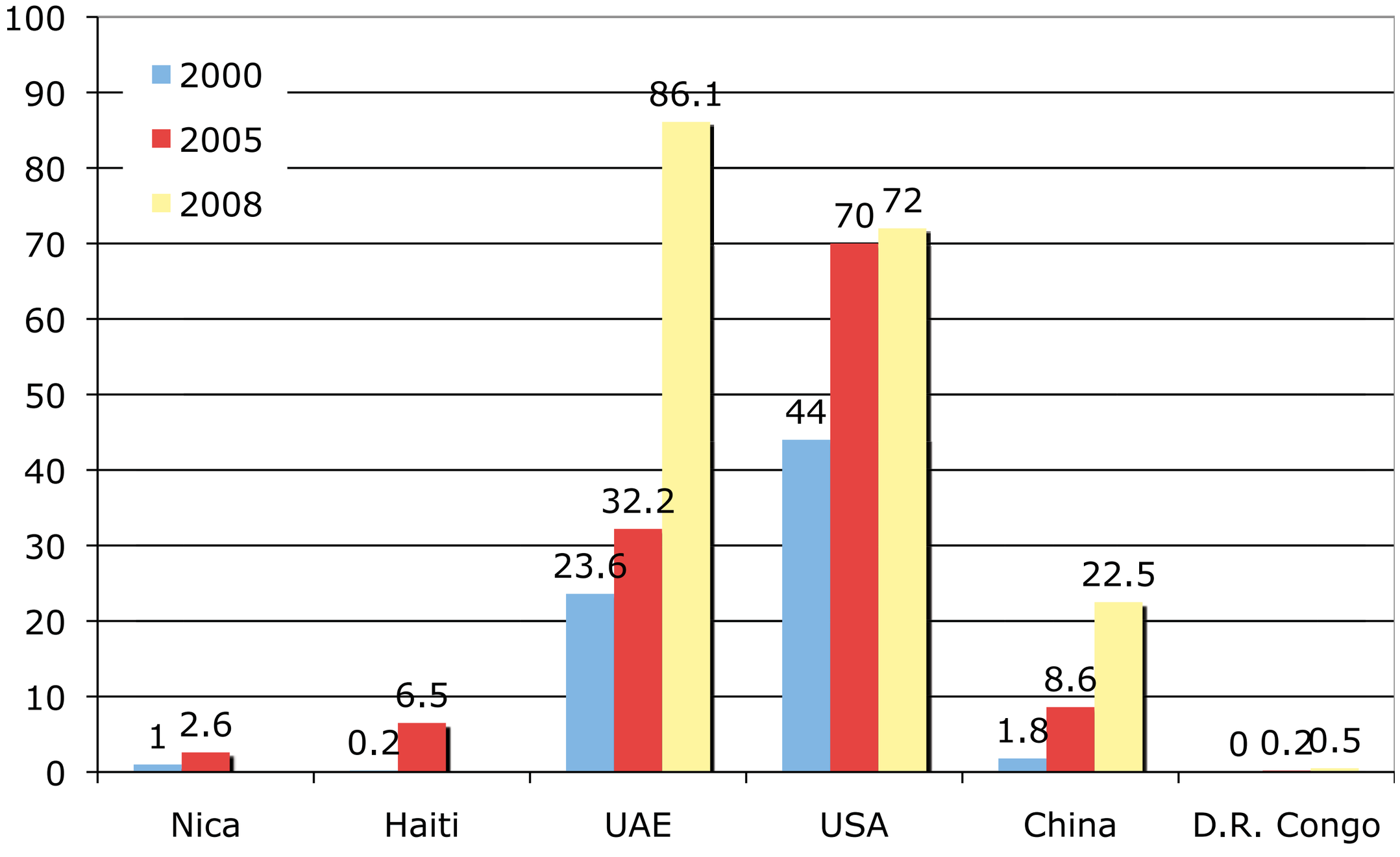
mobile cellular subscriptions (per 100 ppl)



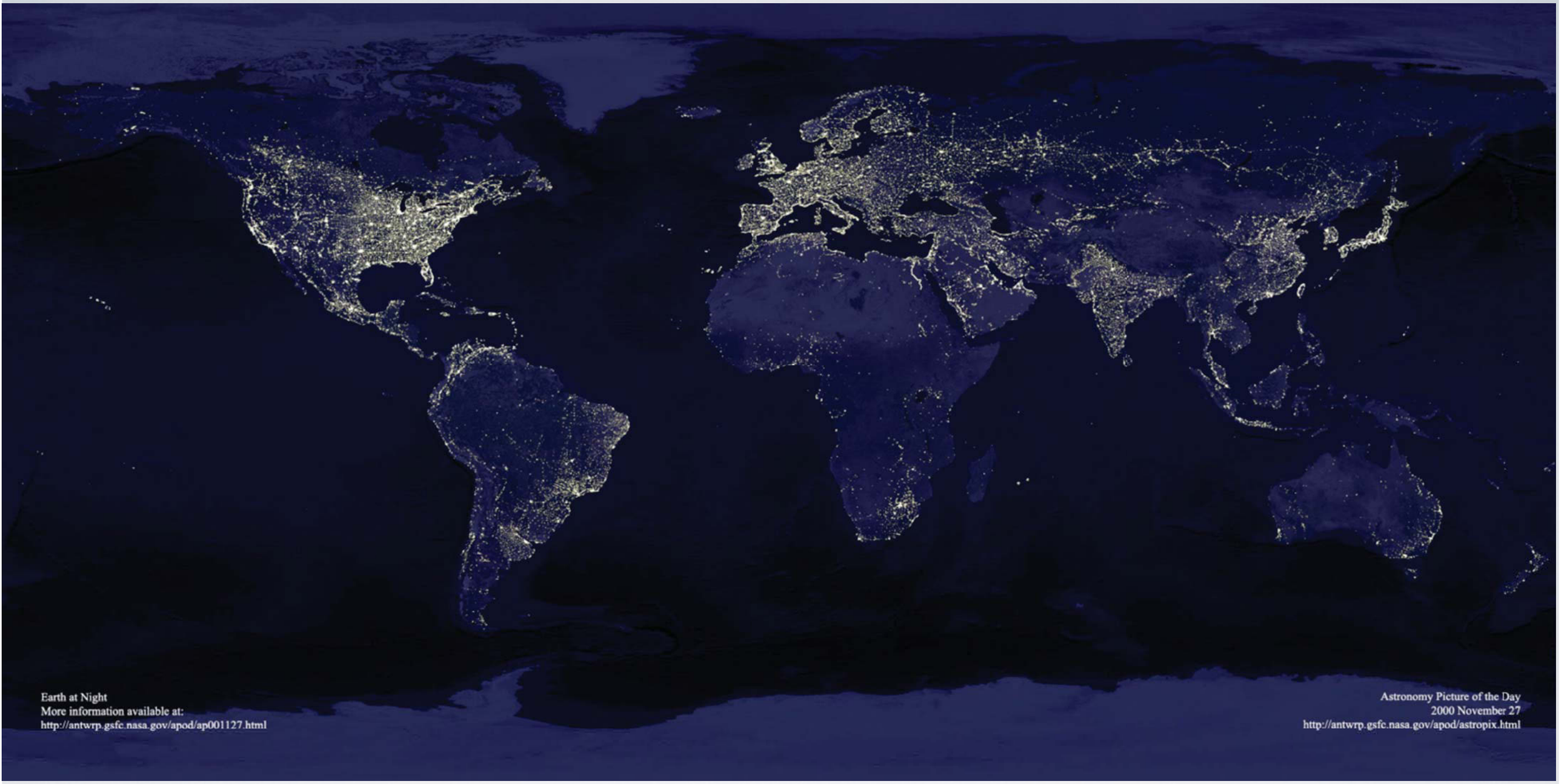
internet users (per 100 ppl)

Nica Haiti UAE USA China D.R. Congo

internet users (per 100 ppl)



TAKEAWAYS?



Public domain image (source: NASA).

[NASA]

Public domain image (source: U.S. CIA).

renewable energy sources:

wind (coast)
geothermal (volcanoes)
hydro (rivers)
solar (equator)
ethanol (sugarcane)

30-70%

2013: 3% oil

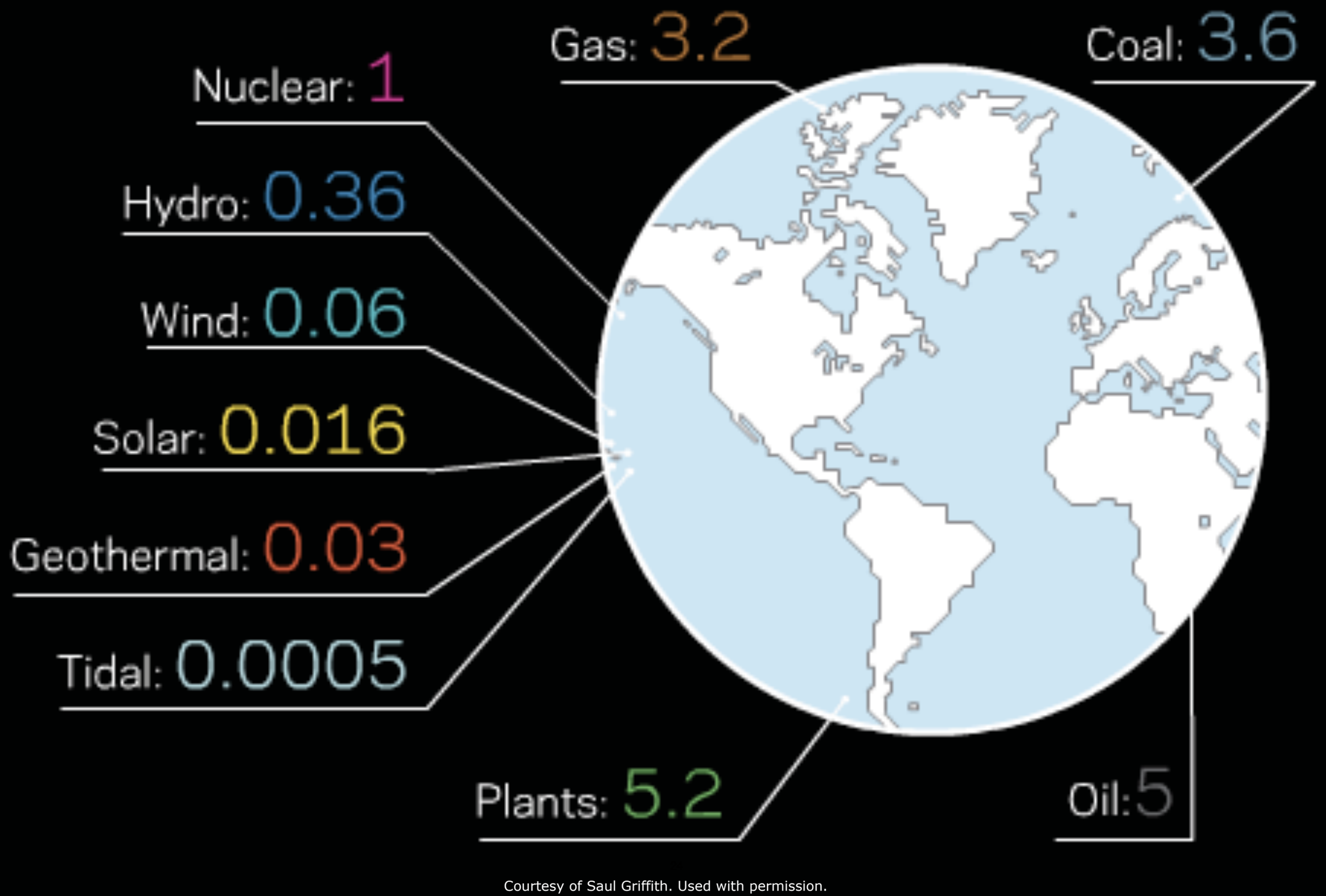
ENERGY 101

[much content from Saul Griffith]

Energy production

Units shown in Terawatts (TW)

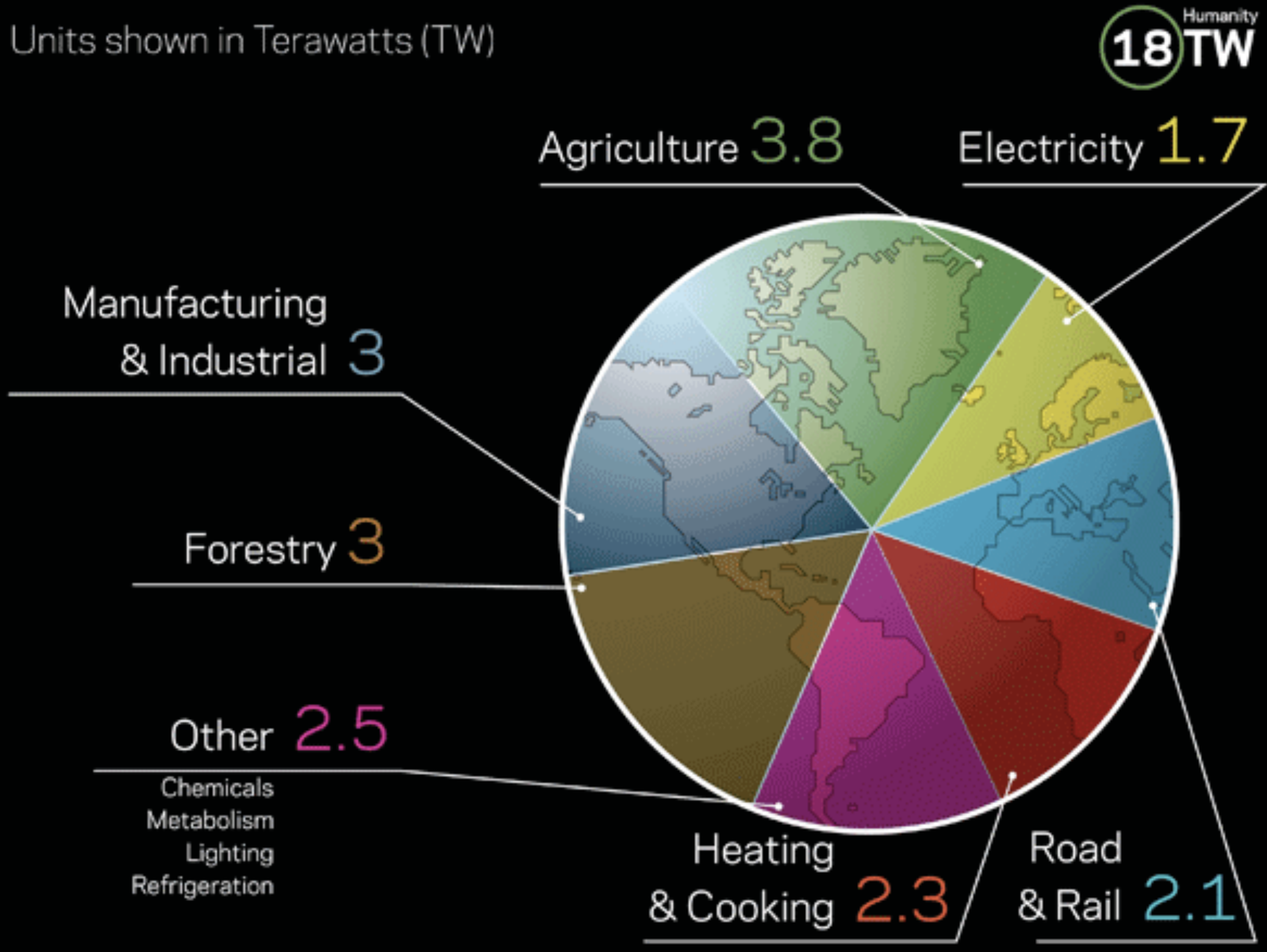
Humanity 18 TW



Courtesy of Saul Griffith. Used with permission.

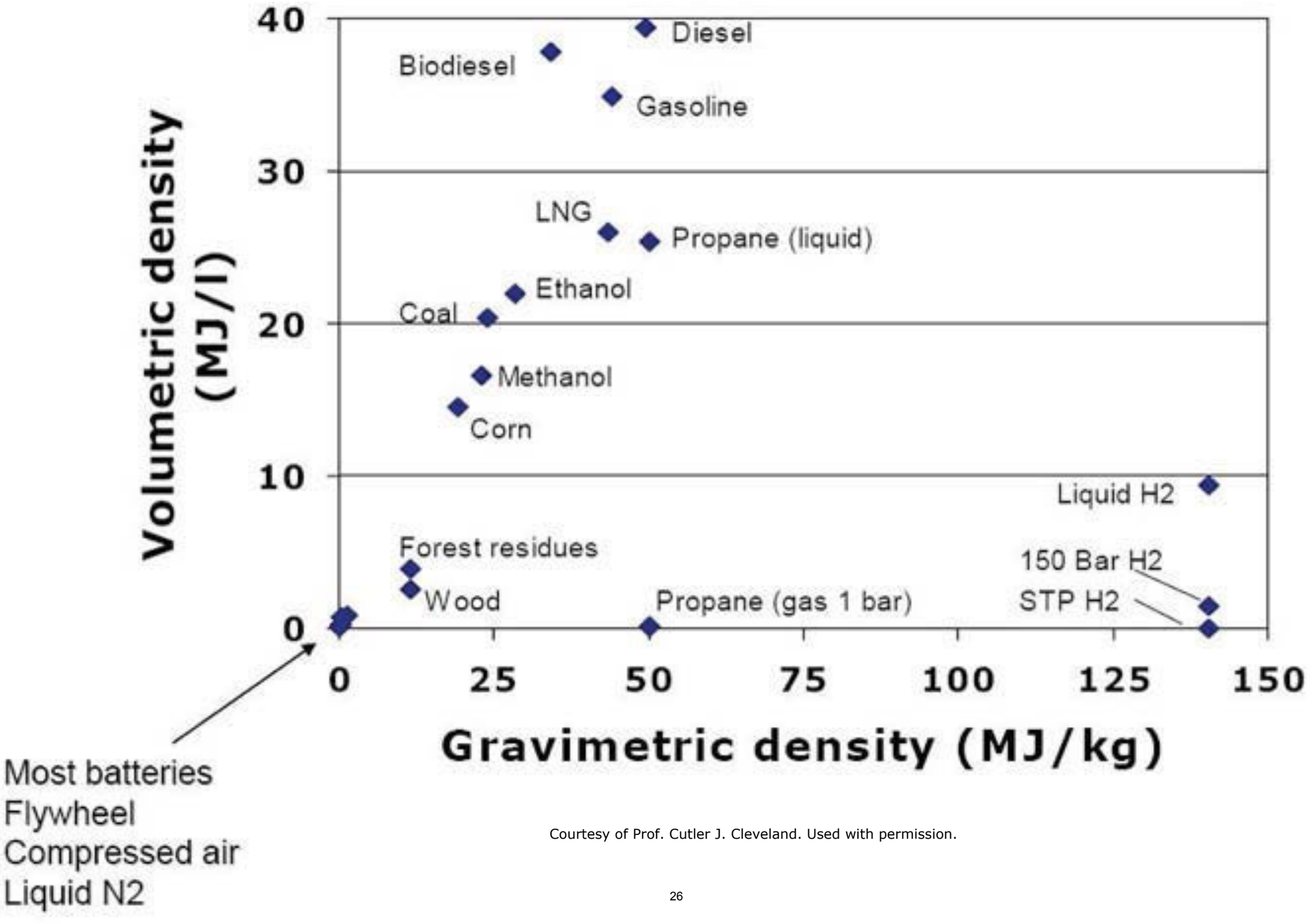
Global Exergy Consumption

Units shown in Terawatts (TW)



Courtesy of Saul Griffith. Used with permission.

Energy Density

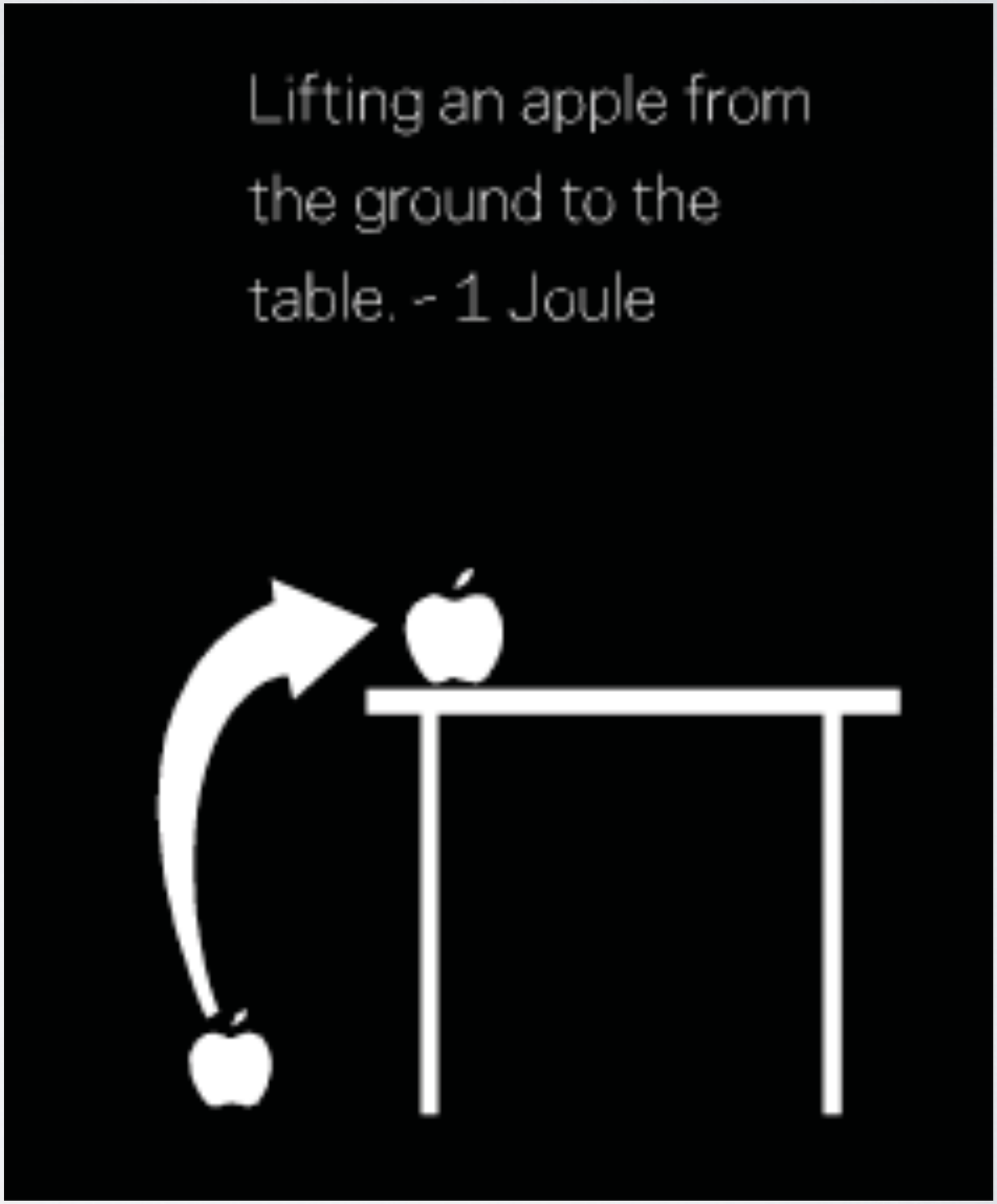


UNITS CHECK-IN

pair up with someone you don't know

WHAT IS ENERGY?

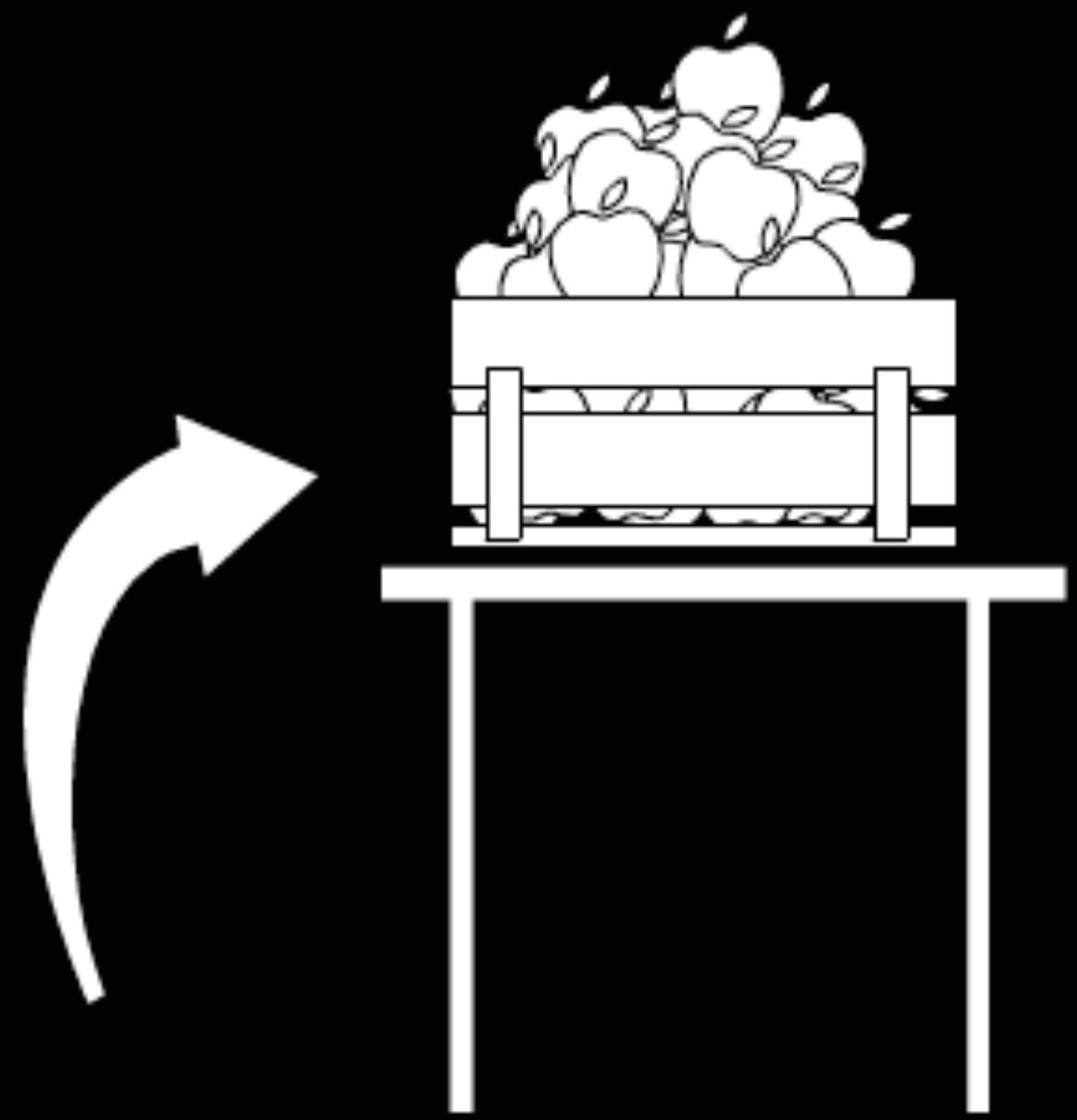
ENERGY



Courtesy of Saul Griffith. Used with permission.

WHAT IS POWER

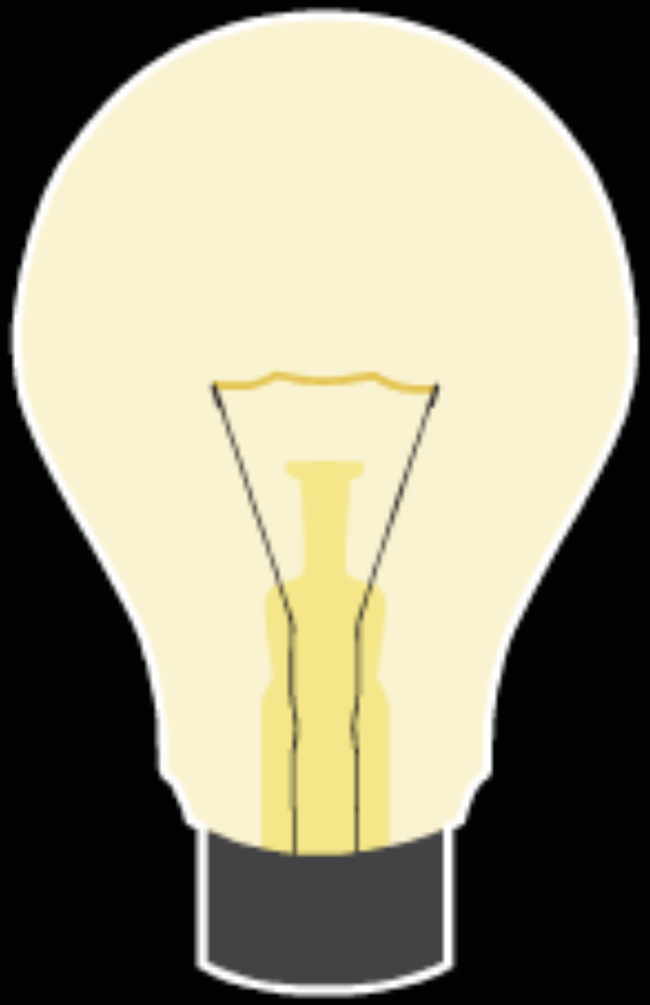
40 apples per second from the ground to the table = 40 Watts.



POWER

Courtesy of Saul Griffith. Used with permission.

Courtesy of Saul Griffith. Used with permission.



Think

in light bulbs....

Courtesy of Saul Griffith. Used with permission.

$$V=IR$$

$$V=IR$$

$$P=VI$$

$$V=IR$$

$$P=VI$$

- Easy book: Practical Electronics for Inventors, Paul Scherz
- Not Easy But Comprehensive Book: Horowitz & Hill, Art of Electronics

ESTIMATION

[much content from Ben Linder]

Estimate the energy stored in a new 9V battery

WHY ESTIMATION?

- look, no be, smart in technical meetings
- gut check your own work and other's
- save time & money

WHY DOES ESTIMATION FEEL SO HARD?

- used to p-sets (right answer)
- used to books and lectures and quizzes (defined realms)
- no resources beyond your brain
- in public, little warning, little time
- open-ended, ill-defined
- multiple acceptable methods and answers
- significant uncertainty
- balanced knowledge of values, quantities, relationships, & things (not just relationships)

EFFECTIVE ESTIMATION ACTIONS

- identify a problem system
- identify a quantity with a system
- provide a value for a quantity
- count a set of things
- compare two systems for a quantity
- identify a relationship between quantities
- change a system scope
- identify a similar system

also, practice!

Public domain image (source: Wikimedia Commons).

Estimate the drag force on a bicycle and rider traveling at 20 mph (9 m/s)

10 minute break!

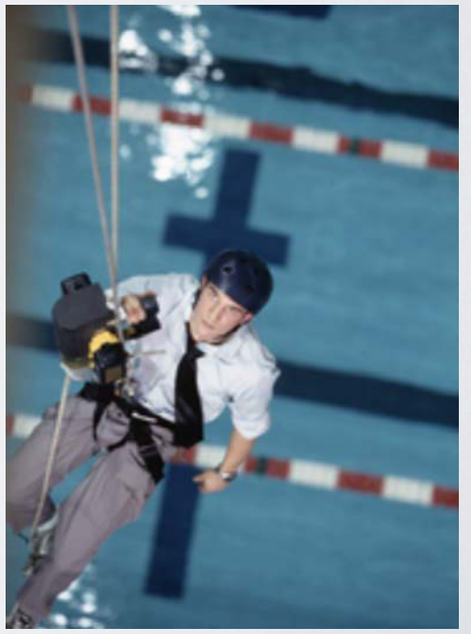
in teams of 2:

how high can a D-cell lift you?

Courtesy of Nathan Ball. Used with permission.

ATLAS Devices powered rope ascender

350 lbs 850 ft, up to 10 ft/sec



Courtesy of Lemelson/MIT Program.
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FINALLY

D-LAB ENERGY

INTRO

D-Lab: ENERGY

Syllabus

Week	Class	Lab	Assignments Due*
Feb 2	Introduction: Energy, Units, Estimation, Energy Usage Worldwide, Class Overview	Human Power Lab	Student Profile & Flashlight Assignment
Feb 9	Energy Storage & Micro Grids Initial Trip Planning	Energy Storage Lab	Reading, PSET#1, Electronics Lab write-up, Trip form
Feb 16	Lighting Community Partner Introduction	Biogas & biodiesel lecture & construction	Reading, PSET#2, Battery Lab Write-up
Feb 23	Solar Thermal & PV **Quiz I**	Solar Panel Construction, Installation, and Operation	Reading, Biogas Lab Write-up, Community Partner Outreach
Mar 2	Wind & Micro-Hydro Trip Planning	Savonius Wind Turbine Construction & Testing	Reading, PSET#3, Solar Lab Write-up
Mar 9	Cooking, Stoves, & Fuel Biogas digester testing	Charcoal Making & Stove Testing	Reading, PSET#4, Turbine Lab Write-up

By 11AM Tomorrow

1. complete online student profile

2. DIY Lantern

Using the given LED (3.6V, 20mAH) and 9V battery provided in class , a resistor from the Edgerton Center Projects Lab, and found materials, construct a lantern. The lantern should be able to turn on and off.

Tip for choosing the resistor: while picking an appropriate resistor in the right ballpark is important, the exact value is not critical. If you can't find the exact value you need, find something within 10-15%.

Grading criteria:
functionality (lights, easy to "Figure out the switch)
aesthetics -- does it look good
creative use of materials
maximizing light

Results of lottery:
You'll have an email
by 11:59 pm Thursday

Bring the lantern to Room E34-211 and place it on a desk on piece of paper with your name, a very quick sketch of your device, and an explanation - including formula - of how you chose the resistor and what value you used.

Homework

Reading

Poor People's Energy Outlook, 2010 by Practical Action

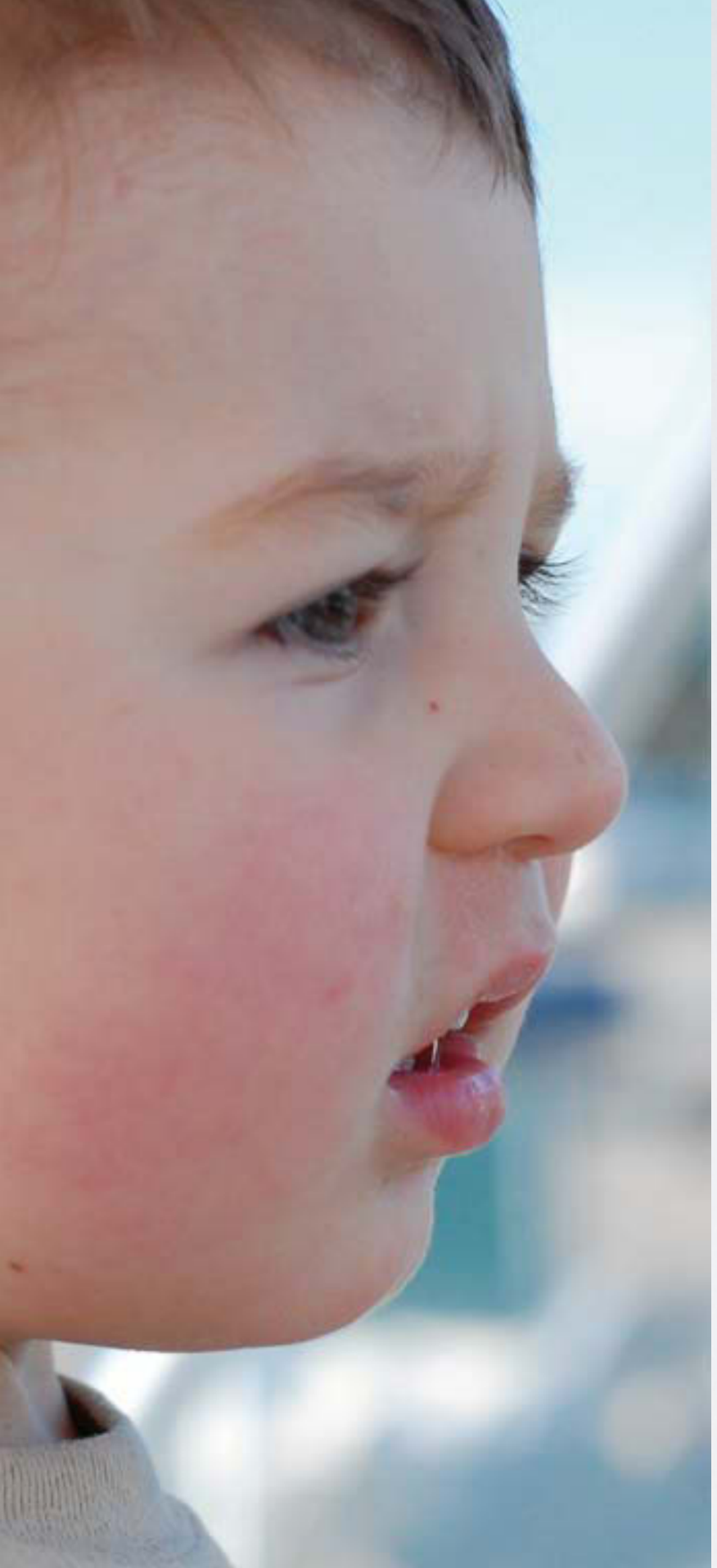
http://www.practicalaction.org/energy-advocacy/ppeo-report-poor-peoples-energy-outlook

read from start to top of p. 38, pp. 50-54, pp. 55-61

write a reaction piece

PSET 1

1. Specific Energies of Fuels
2. Shower Estimation



Muddy Cards!

D-Lab: ENERGY

Friday Lab: Human Power

Next Class: Energy Storage & Micro Grids and trip discussion

EC.711 D-Lab: Energy

Spring 2011