

The Global Calculator:

Exploring a low-carbon future

www.globalcalculator.org

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International
Energy Agency

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国家发展和改革委员会能源研究所
Energy Research Institute, National Development and Reform Commission



What is it?

The Global Calculator

A free and interactive tool that helps you to understand the link between our lifestyles, the energy we use, and the consequences for our climate.



Available at www.globalcalculator.org

How it works?

The Global Calculator

The Global Calculator puts you in charge of the world's energy, land and food systems to 2050

It includes the full range of possible scenarios for the future, as determined by international experts

It instantly works out the implications of your choices so you can see the impact on people's lifestyles, the energy system and the climate

The three principles behind the tool

The Global Calculator

1.Openness – an Excel-based tool which is fully published and available free online

2.Collaboration – built by a global team with input from hundreds of experts

3.Simplicity – modelling the world as simply as possible, while still including all energy, emissions and a full range of future scenarios

Who can use the Global Calculator?

The Global Calculator

Businesses – for long-term planning (e.g. the future of their sector and which technologies to invest in) and to see the impact they can have on emissions (e.g. improving efficiency)

NGOs – informing long-term strategies and campaigns (e.g. lobbying for technologies/changes that have the most impact)

Governments – understanding what the 2°C target means, and using benchmarks from the tool to align themselves with it

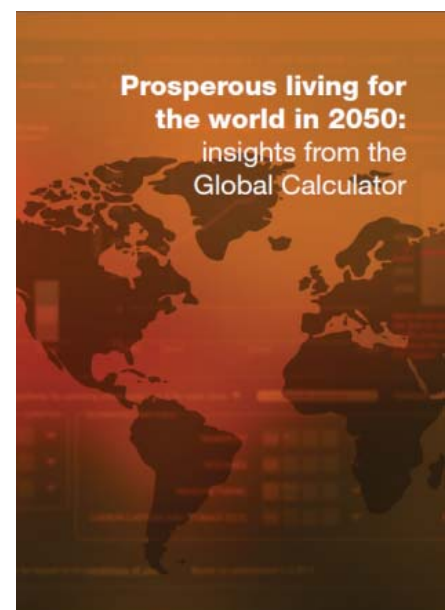
Universities/schools – students can discover the impact of mitigation options themselves.

A positive vision of the future

The Global Calculator

This report uses evidence from the Global Calculator to show that:

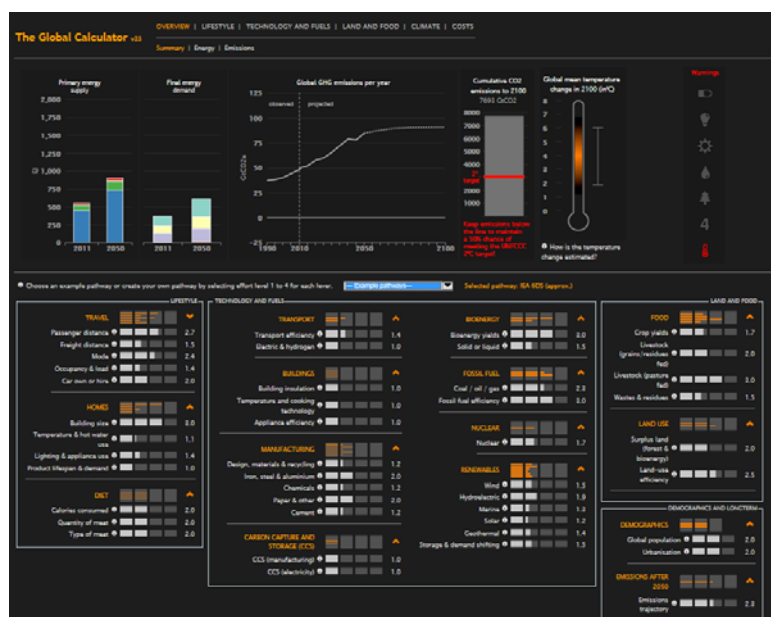
- The world could eat well, travel more and live in more comfortable homes **and** prevent dangerous climate change
- But to do so, we need to transform the technologies and fuels we use
- We also need to make smarter use of our limited land resources and expand forests by around 5-15% by 2050



How does it work?

The Global Calculator

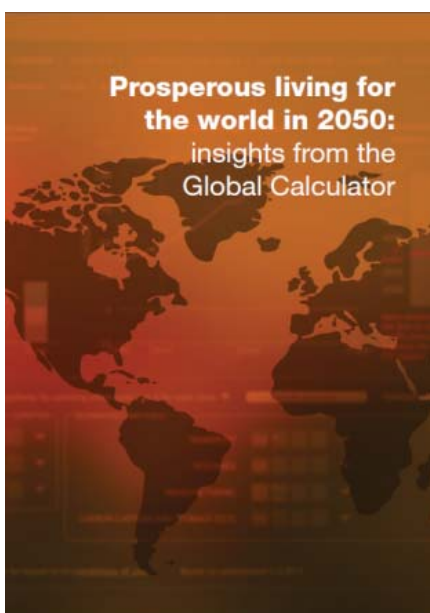
Interactive web interface



<http://www.globalcalculator.org/>

Our report is one version of the future, but there are many others

The Global Calculator



- The Global Calculator allows you to test out options and explore trade offs.
- These organisations have created their own pathways:



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Contents

The Global Calculator

- Introducing the Global Calculator
- Quick demonstration
- Key messages
- Detailed data – manufacturing, transport and electricity
- Mythbusting
- Co-benefits of low-carbon growth

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The Global Calculator

Quick demonstration

How does it work?

The Global Calculator

Interactive web interface



<http://www.globalcalculator.org/>

The “levers”

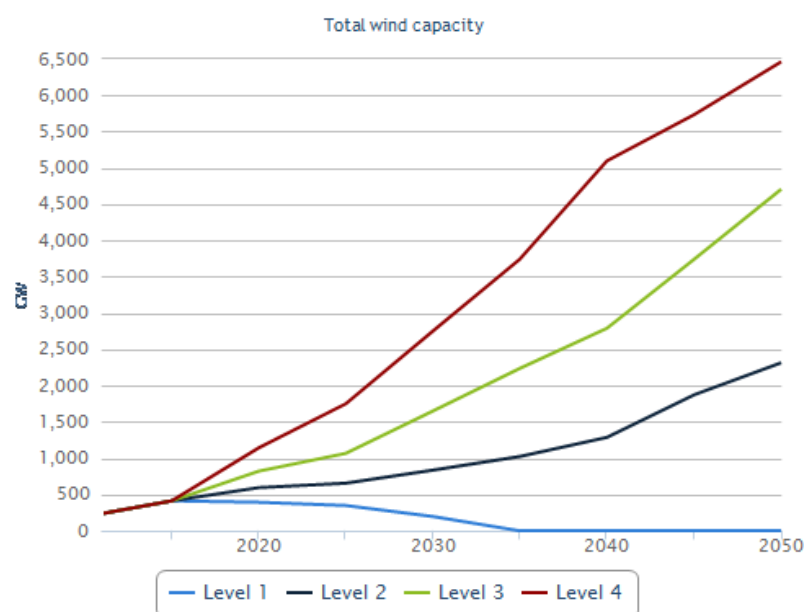
The Global Calculator

- Each lever relates to a type of action to reduce emissions, e.g. building nuclear power stations or using more public transport
- Each lever has four options – levels 1 to level 4 – which the user selects. This represents the full range of what is possible for this action up to 2050:



Example: wind

The Global Calculator



Increasing abatement effort

Level 4:
6466 GW by 2050

Level 3:
4710 GW by 2050

Level 2:
2317 GW by 2050

Level 1:
0 GW by 2050

The Global Calculator

Key messages

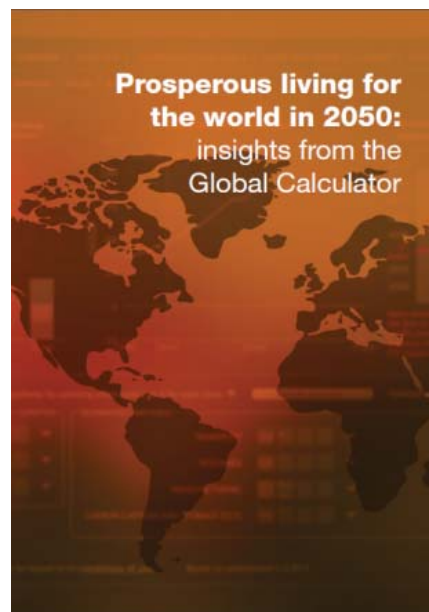
Findings from the Global Calculator

A positive vision of the future

The Global Calculator

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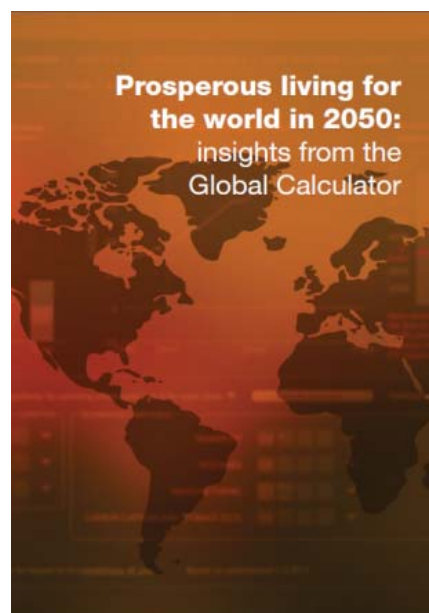
1. The world could eat well, travel more and live in more comfortable homes **and** prevent dangerous climate change
2. But to do so, we need to transform the technologies and fuels we use
3. We also need to make smarter use of our limited land resources and expand forests by around 5-15% by 2050



A positive vision of the future

The Global Calculator

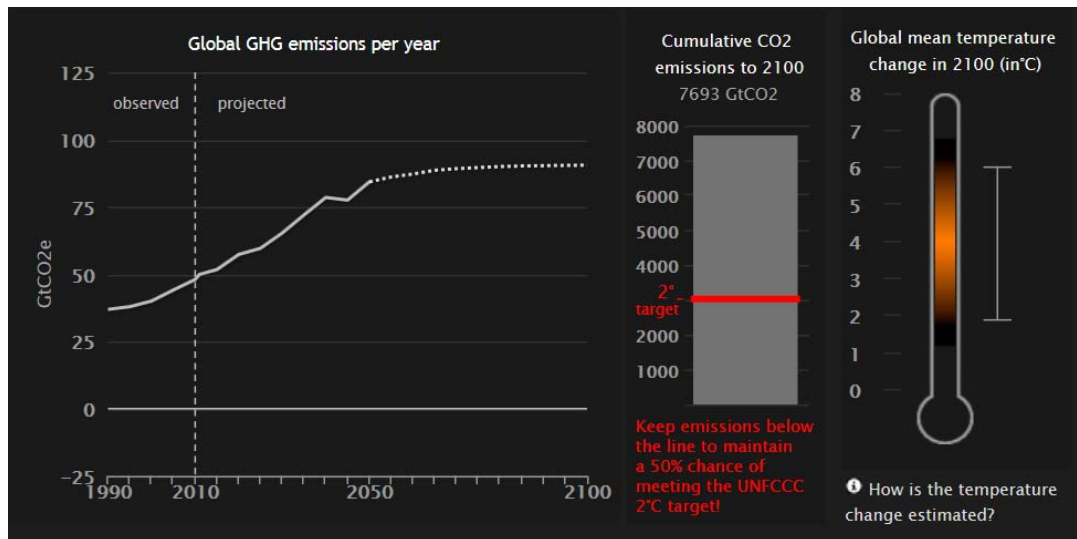
Where did these findings come from?



1. Take a business as usual pathway

The Global Calculator

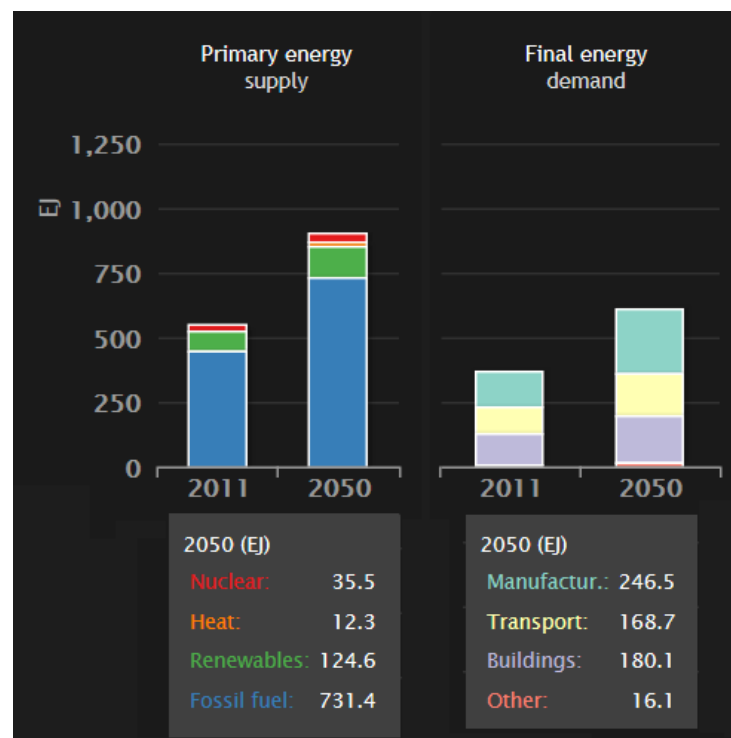
The International Energy Agency's 6DS shows that by 2100, temperatures could rise between 2 and 6°C.



1. Take a business as usual pathway

The Global Calculator

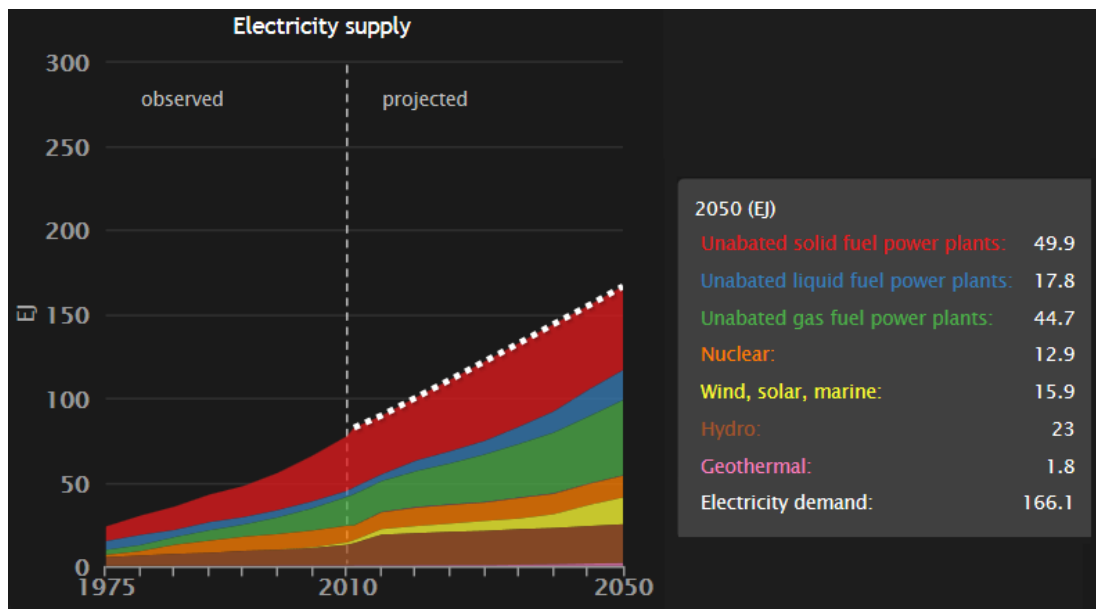
- This is because energy demand is expected to increase significantly in the future, particularly from manufacturing.
- 80% of this demand will be met by burning fossil fuels.



1. Take a business as usual pathway

The Global Calculator

For example, electricity supply comes mostly from coal (red), oil (blue) and gas (green):



2. Keep BAU improvements in people's lifestyles

The Global Calculator

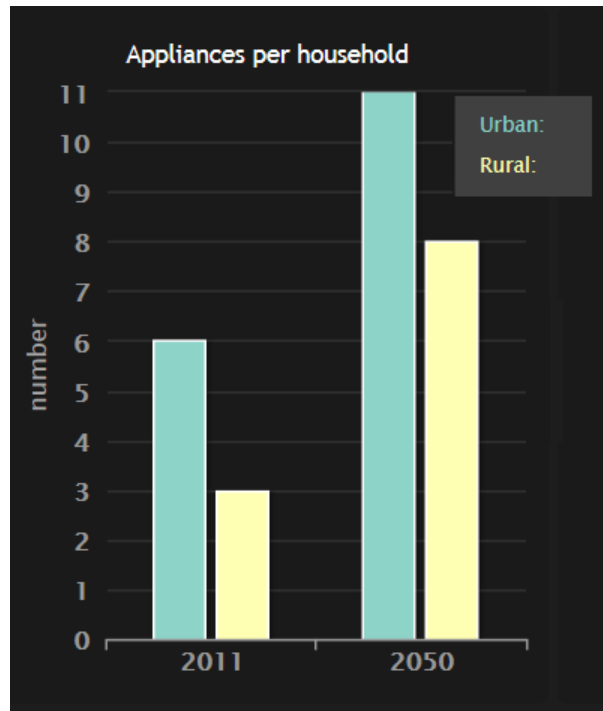
BAU predictions include significant improvements in world average lifestyles, concentrated in the developing world.



2. Keep BAU improvements in people's lifestyles

The Global Calculator

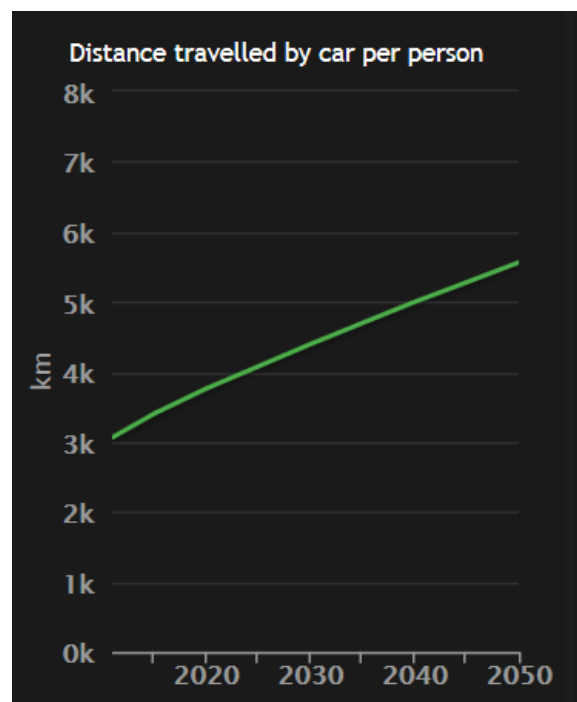
For example, people will live in bigger homes and own more appliances.



2. Keep BAU improvements in people's lifestyles

The Global Calculator

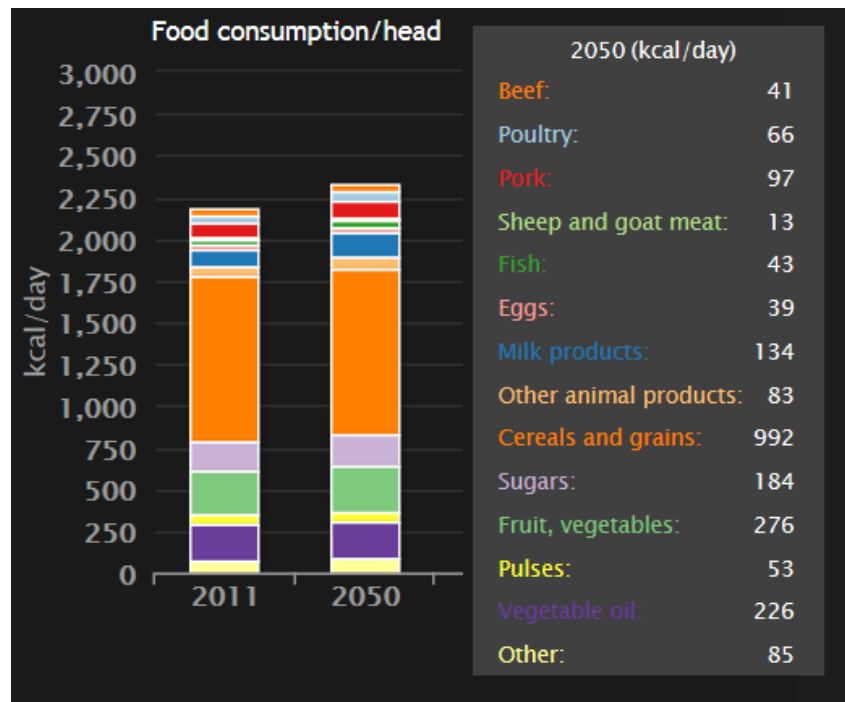
They will travel more, and more of this travel will be by car.



2. Keep BAU improvements in people's lifestyles

The Global Calculator

People will eat more food on average per day, including more meat (UN FAO projection).



3. Change the technologies and fuels we use

The Global Calculator

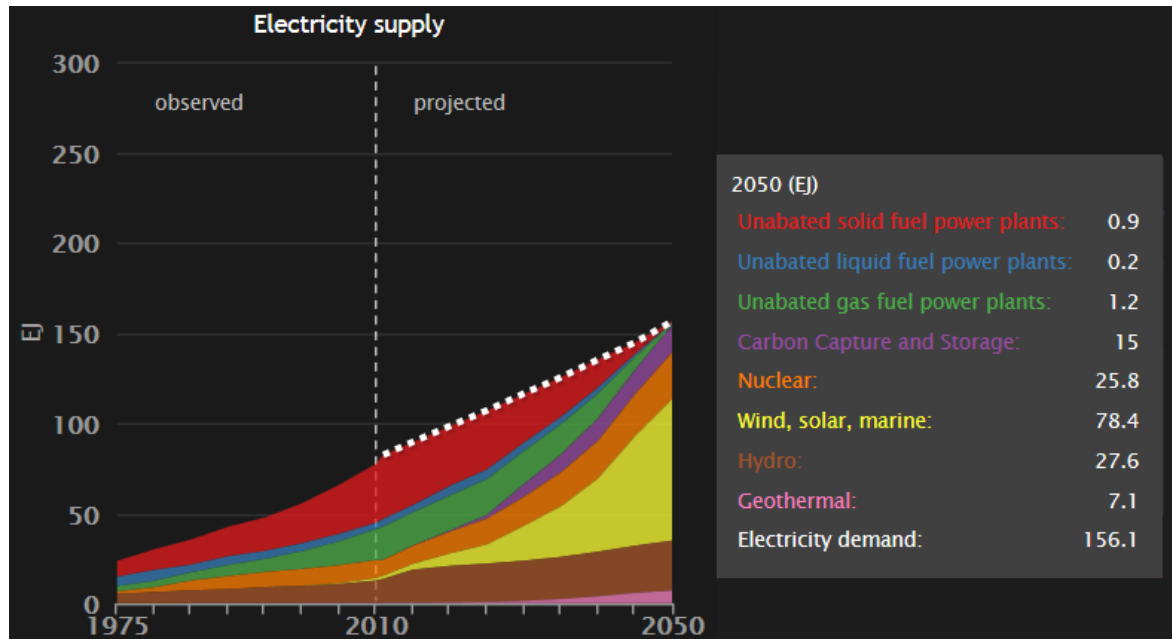
- To keep BAU improvements in world average lifestyle **and** still meet the 2°C target, we must use more efficient technologies and low-carbon sources of energy.
- This require a massive and urgent effort (level **2.8**) across all sectors – electricity, buildings, transport and manufacturing.



3. Change the technologies and fuels we use

The Global Calculator

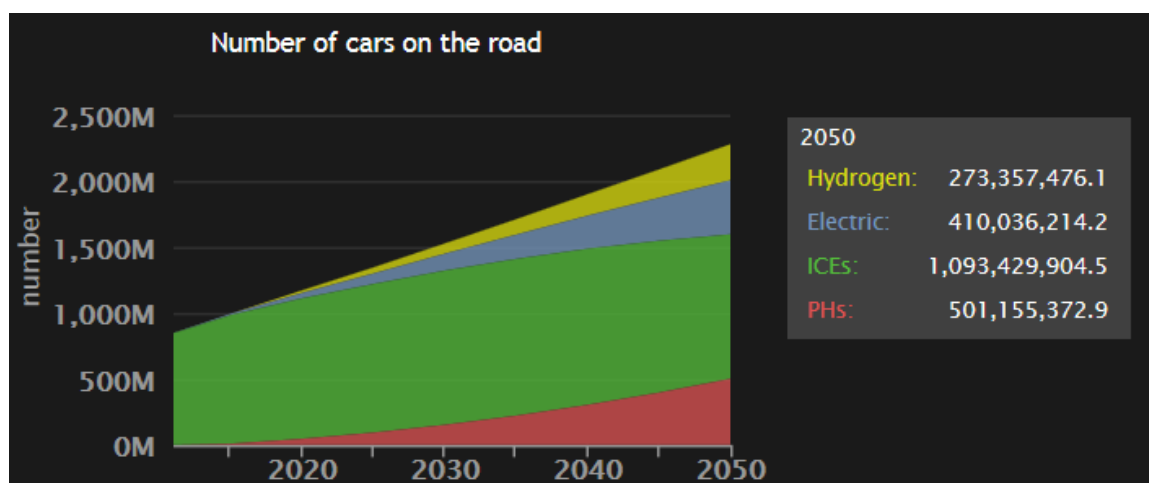
The electricity sector must phase out unabated coal oil and gas by 2050. For example:



3. Change the technologies and fuels we use

The Global Calculator

Vehicles will need to become much more efficient. And up to 35% of cars will need to be electric- or hydrogen-powered by 2050.



4. Make smarter use of our land

The Global Calculator

- We must protect and expand our forests globally by around 5 to 15% by 2050 because forests act as a valuable carbon sink.
- However, the world's population is growing so will need more food in the future, and we may use bioenergy crops as well. This will put pressure on our limited land resources.



4. Make smarter use of our land

The Global Calculator

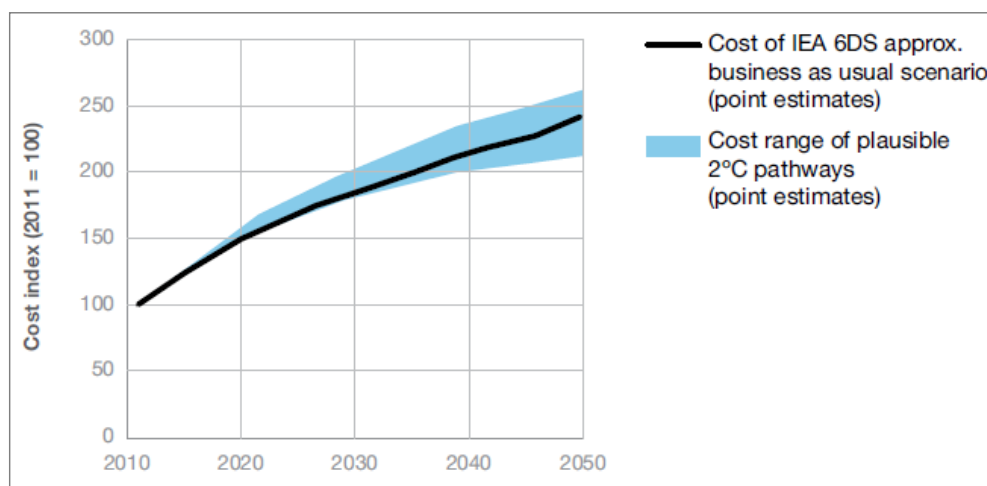
- We need crop yields to increase by 40 to 60% by 2050.
- Livestock yields will also need to increase.
- Alternatively, eating less meat on average would also reduce pressure on forests.



5. How much will this cost?

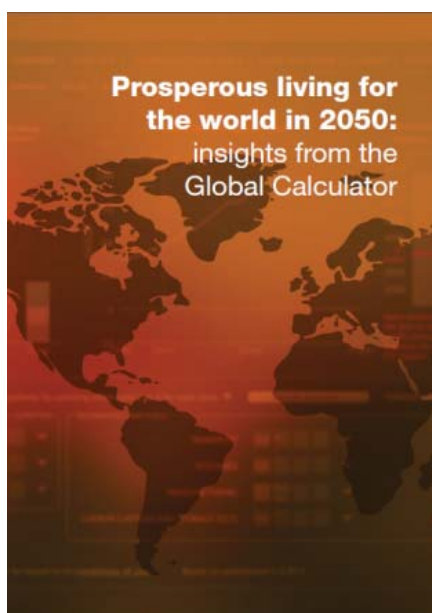
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- From 2% of GDP (\$2 trillion annually) cheaper to 3% of GDP (\$4.2 trillion annually) more expensive
- This includes capital, operating and fuel costs only – not the cost benefits of low-carbon development



Our report is one version of the future, but there are many others

The Global Calculator



- The Global Calculator allows you to test out options and explore trade offs.
- These organisations have created their own pathways:



International Energy Agency



Mythbusting

Q: Can we just switch from coal to gas?

**The Global
Calculator**

A: No.

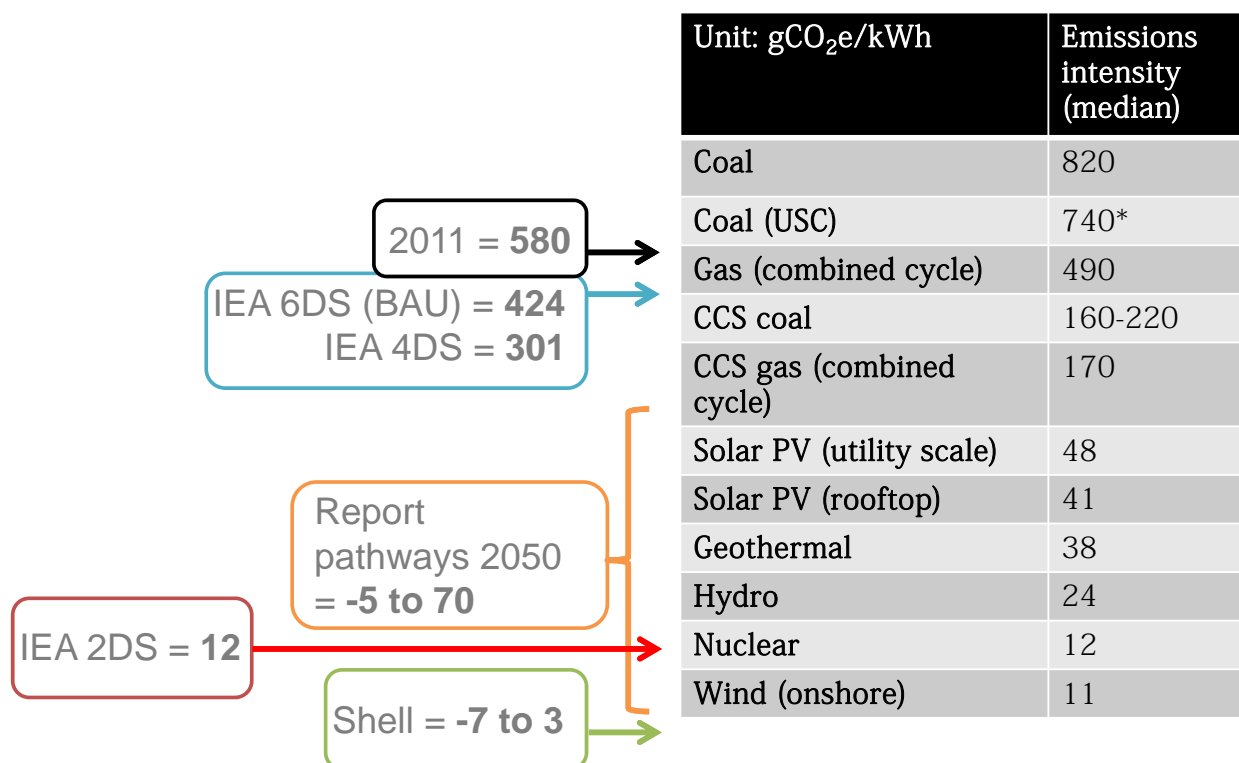
All unabated fossil fuels contribute to climate change.

A really efficient gas plant emits 350 gCO₂e/KWh, and we need to reach near 0 gCO₂e/KWh by 2050 for electricity.



Electricity: Why move away from fossil fuels?

The Global Calculator



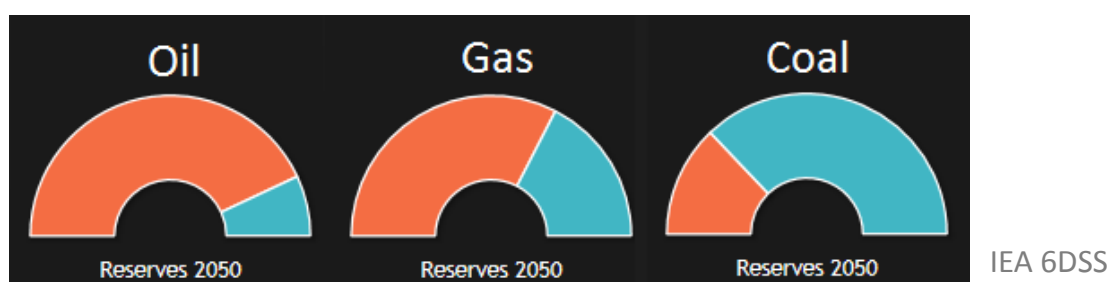
Q: Can we wait until we use up the fossil fuels we have?

The Global Calculator

A: No.

Unfortunately, we **cannot** rely on running out of fossil fuel as a means of abating climate change. The world has enough fossil fuel resources to put the world at risk of a global mean temperature of over 6° C by 2100.

For example, under BAU, there is still a lot of coal left in 2050:



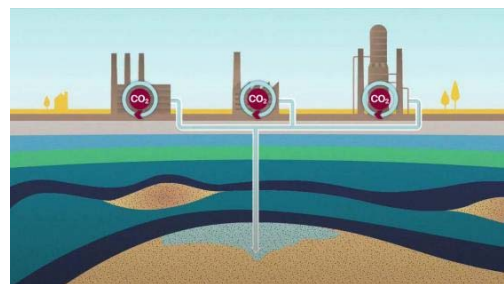
Q: Can we just suck the carbon out of the atmosphere?

The Global Calculator

A: No.

We also cannot rely on futuristic technologies to take carbon out of the atmosphere to solve the climate problem. These are unproven technologies.

The best evidence is that they could save 10 GtCO₂e/year by 2050, equivalent to only 10% of total under BAU.



Q: Can we just curb population growth?

The Global Calculator

A: No – reducing population growth has a significant impact on emissions, but it is not enough on its own.

The UN estimates that the global population will increase from 7 billion today to 10 billion in 2050.

Curbing population to the UN's lower estimate (8 billion) would only save around 10 GtCO₂e/year by 2050 (10% of BAU).



Question & Answer

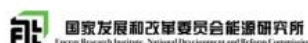
International Forum for Sustainable Asia and the Pacific
July 12-13 2016

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Why take action?

The co-benefits of low-carbon growth

Documents

The Global Calculator



[The Global Calculator](#)

MS Excel Spreadsheet, 17.71MB

This file may not be suitable for users of assistive technology. [Request an accessible format.](#)



[Prosperous living for the world in 2050: insights from the Global Calculator](#)

PDF, 1.44MB, 20 pages

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[The Global Calculator: sector metrics from 2°C pathways](#)

PDF, 168KB, 4 pages

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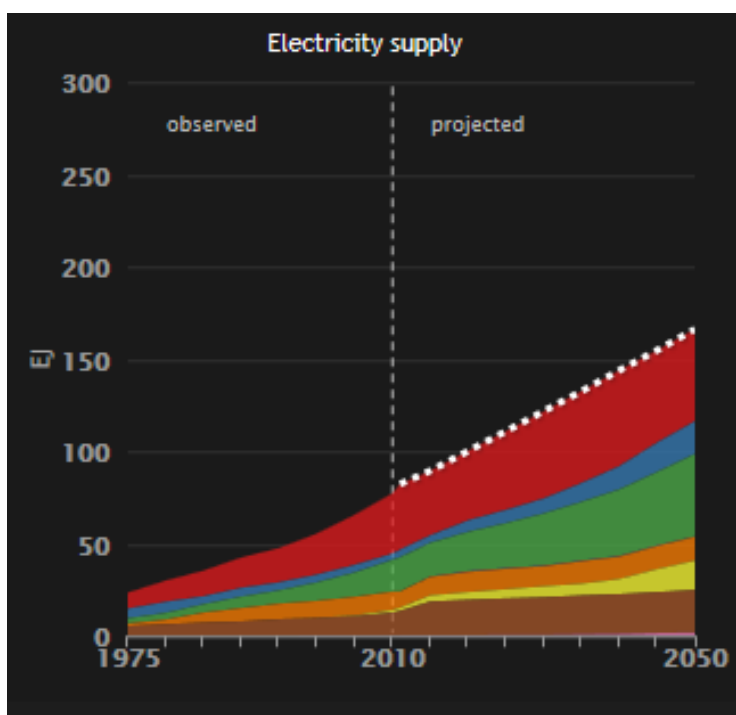
[Explanation of global calculator scenarios](#)

PDF, 87.8KB, 3 pages

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Detailed data from our metrics report: Electricity

Electricity: business as usual

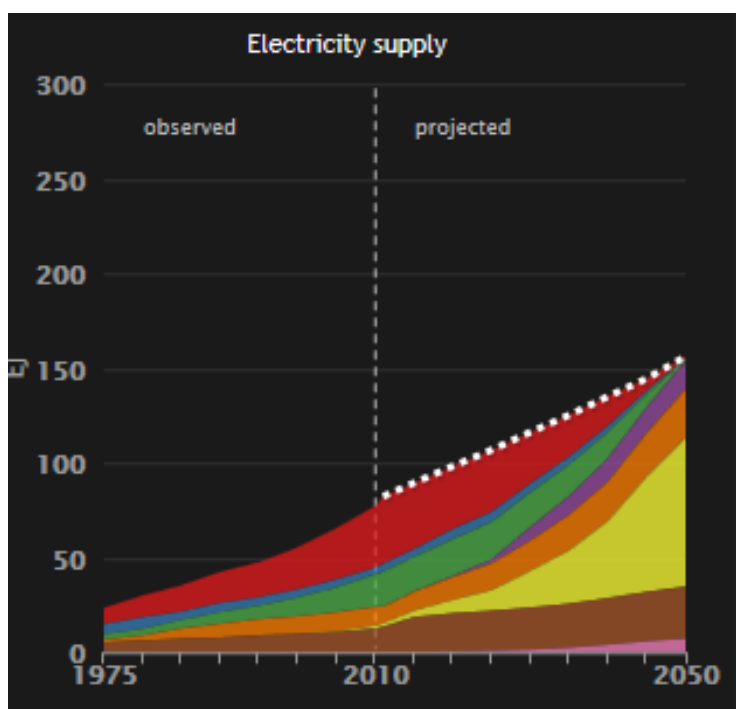


2050 (EJ)

Unabated solid fuel power plants:	49.9
Unabated liquid fuel power plants:	17.8
Unabated gas fuel power plants:	44.7
Carbon Capture and Storage:	0.2
Nuclear:	12.9
Wind, solar, marine:	15.9
Hydro:	23
Geothermal:	1.8
Electricity demand:	166.1

Electricity: report pathways

The Global Calculator



2050 (EJ)

Unabated solid fuel power plants:	0.9
Unabated liquid fuel power plants:	0.2
Unabated gas fuel power plants:	1.2
Carbon Capture and Storage:	15
Nuclear:	25.8
Wind, solar, marine:	78.4
Hydro:	27.6
Geothermal:	7.1
Electricity demand:	156.1

Distributed effort scenario

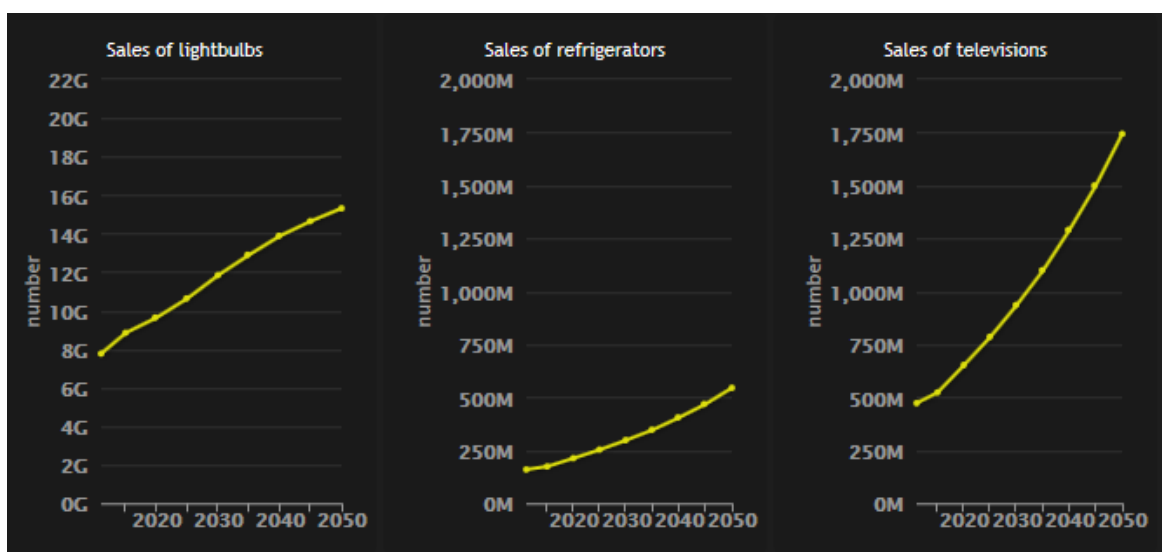
Electricity in more detail

The Global Calculator

Unit: GW	2011	2050 IEA6DS (BAU)	GC report pathways	2050 IEA2DS	2050 IEA4DS (current policies)	Shell pathways (3° c)
Coal/Biomass	1875	5595	9 - 905	253	3771	0-20
Liquid (oil)	383	2426	18 - 184	48	1422	0-10
Gas	1451	4279	119 - 197	521	3447	0-11
CCS	0	16	490 - 1487	1487	206	443-2594
Nuclear	364	479	685 - 1030	1030	685	479-1030
Wind	238	1159	2317 - 4710	2556	1854	2317-3274
Hydro	970	1694	1750 - 2101	1855	1785	1525
Solar	71	441	2204 - 4149	2982	1102	7941- 23107
Geothermal	11	69	172 - 289	155	103	52-69

Detailed data from our metrics report: Manufacturing

Manufacturing – sales can go up
like BAU



Distributed effort scenario

But appliances must be more efficient

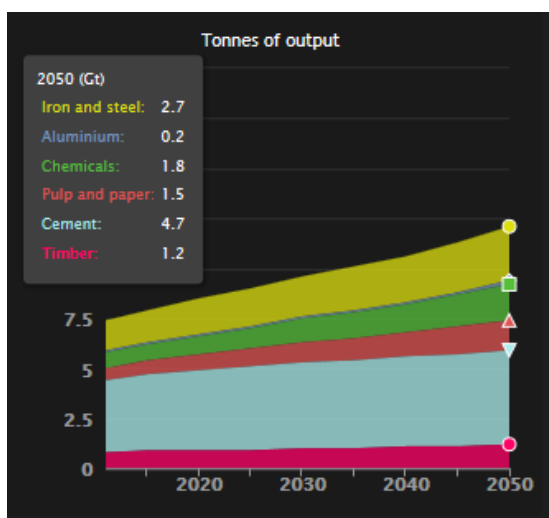
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- Efficiency of appliances increased 1.7% per year from 1990 to 2009
- This increase will need to be sustained globally from now until 2050

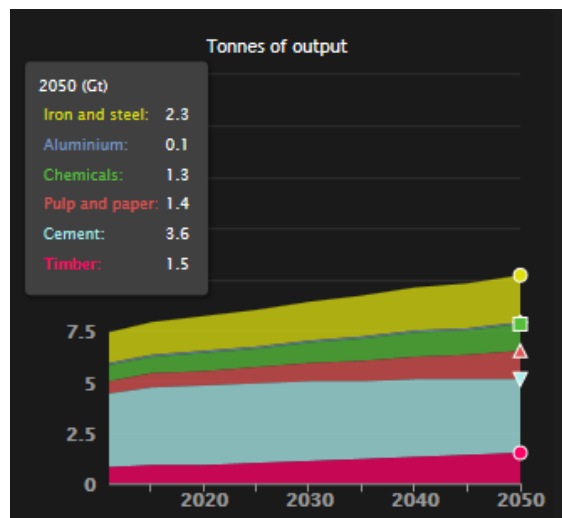
	2011	2050 Level 1	2050 Level 2	2050 Level 3	2050 Level 4
Power used by average urban TV (W)	250	243	208	192	174
Power used by average urban refrigerator (W)	66	54	45	40	34

And production of raw materials should lower than BAU

The Global Calculator



BAU



Distributed effort

Why? Design, material switch and recycling lever

The Global Calculator

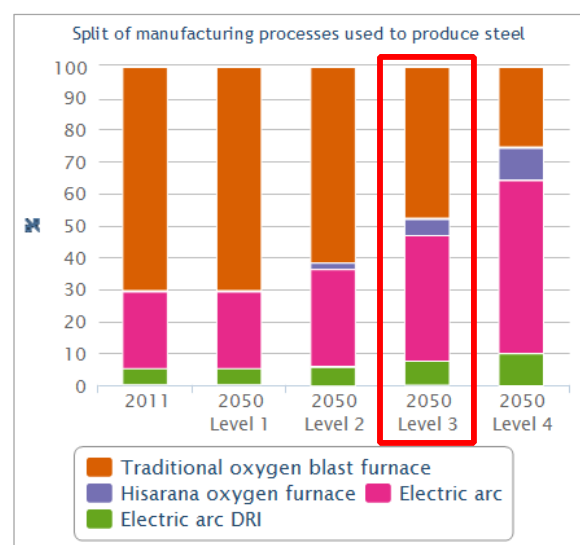
The production of raw materials is very energy and emissions intensive. This lever has the biggest impact by reducing demand per product through:

- **Better design** – ~20% less steel, chemicals, aluminium and cement needed per product
- **Material switching** – using less GHG-intensive products like wood (carbon sink) replacing ~4% of steel and ~8% of cement
- **Recycling** – steel, chemicals and paper recycling should increase by ~25%

Reducing manufacturing emissions: steel

The Global Calculator

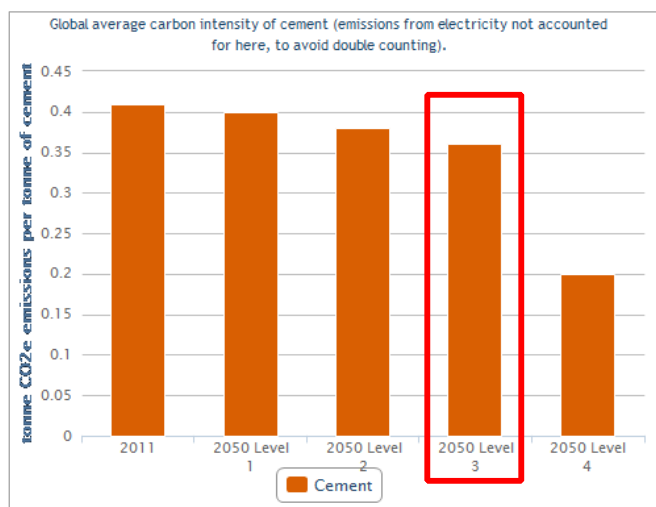
- **New technologies** - These use less energy and produce less CO₂, and can process more scrap.
- **Fuel switching** – using biomass (~15%), hydrogen (~7%) and gas (~3%) rather than coal.



Reducing manufacturing emissions: cement

The Global Calculator

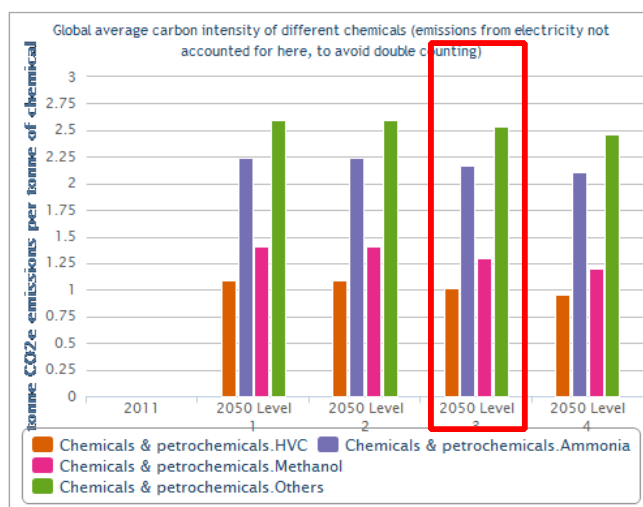
- **Spreading today's best practice worldwide** – Resulting in 16% energy efficiency gains.
- **Fuel switching** – using biomass (~46%) instead of coal



Reducing manufacturing emissions: chemicals

The Global Calculator

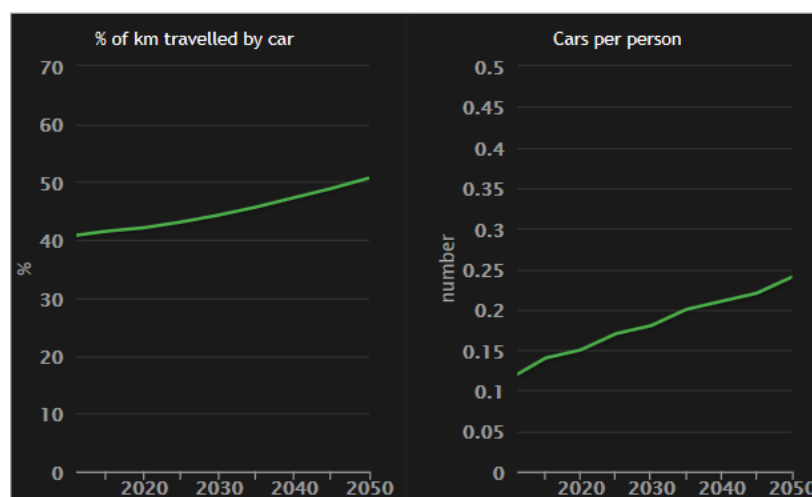
- **Spreading today's best practice worldwide** – Resulting in 9% energy efficiency increase for high-value chemicals (plastics)
- **Fuel switching** – using gas (~20%) and biomass (~10%) instead of coal for plastics.
- **CHP** – combined heat and power used in ~15% of plants.



Detailed data from our metrics report: Transport

More cars on the road

- From 852 million in 2011 to 1.4–2.3 billion in 2050
- Also more cars per person: from 0.12 in 2011 to 0.15–0.24 in 2050
- Proportion of domestic travel by car from 40% to 45–50%

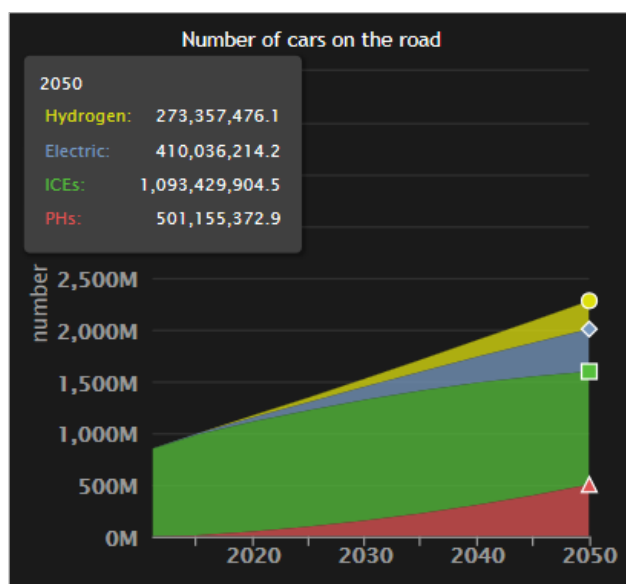


Distributed effort
scenario

But lower emission cars

The Global Calculator

- But more new car types:
 - 230–460m electric
 - 0–340m hydrogen
 - 230–570m plug-in hybrid
- And car efficiency increases 52–55% (improving more quickly than recent trends)
- There are similar improvements in freight transport efficiency



Distributed effort scenario