Future Directions in Energy

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39th MIT Global Change Forum

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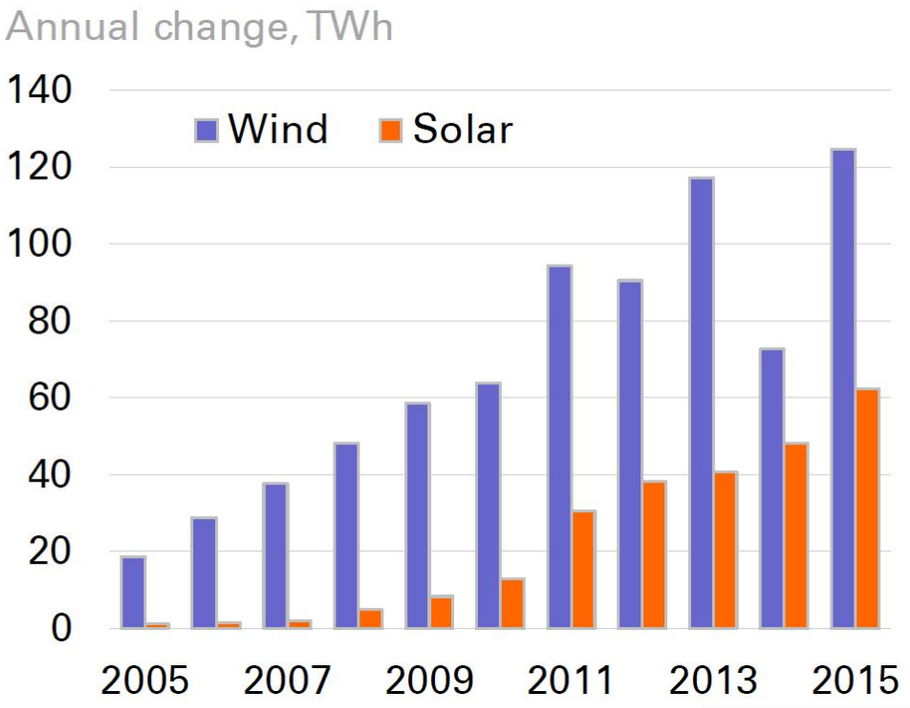
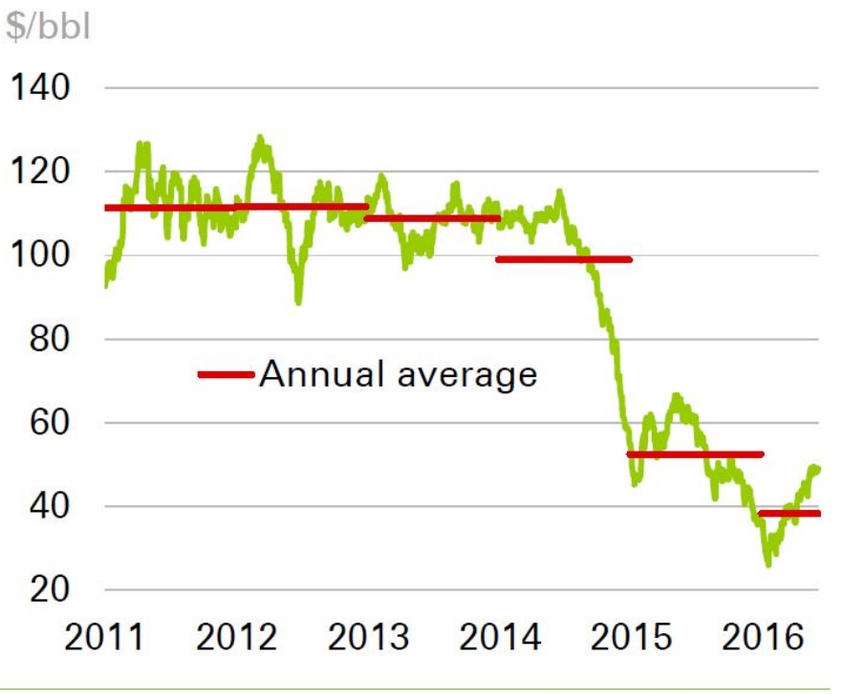
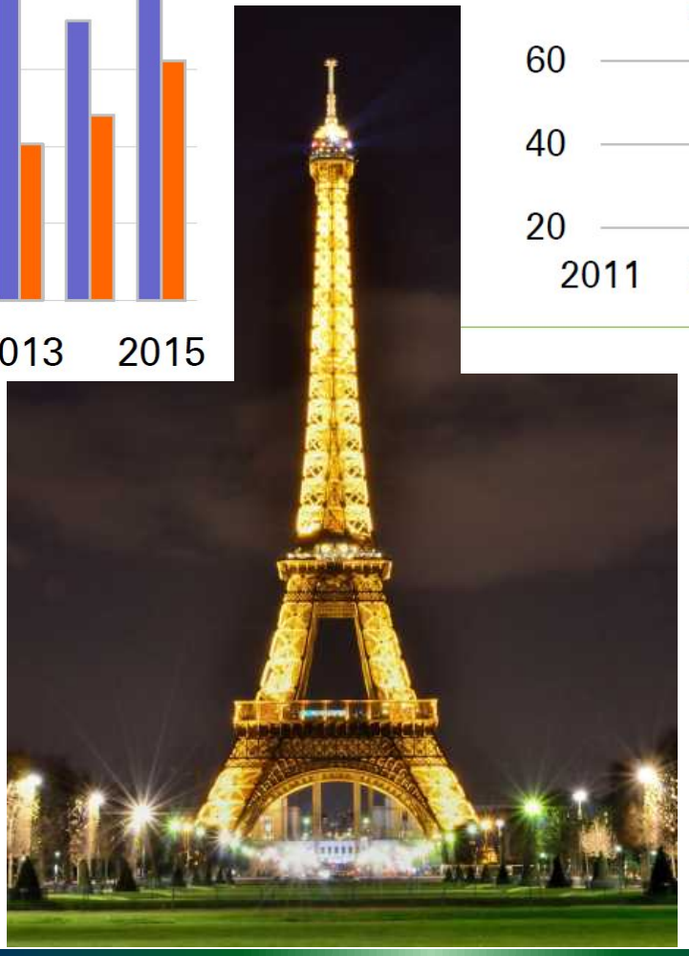
Setting: Renewables Up, Oil Price Down, Paris Agreement







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Fossil fuel groups warned not to ignore Paris accord

Pilita Clark, Environment Correspondent

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"If governments stick to that commitment, fossil fuel companies will either have to find ways to stop greenhouse gas emissions from their products, or shift into renewable energy, or go out of business."

Oil and Gas

New Divisions and Businesses at Oil&Gas Companies

Total – New Energies

Statoil – New Energy Solutions

Shell – New Energies (and Integrated Gas)

also
ExxonMobil – CCS, Eni – Solar, Saudi Arabia – National Transition Plan "Vision 2030"…

but…

BP – "Beyond Petroleum" (in 2000) and Alternative Energy

Transportation

May 2016:
Toyota invests in Uber;
VW invest in Gett (VW boss announced that VW will be world-leading mobility provider by 2025);
GM invests in Lyft;

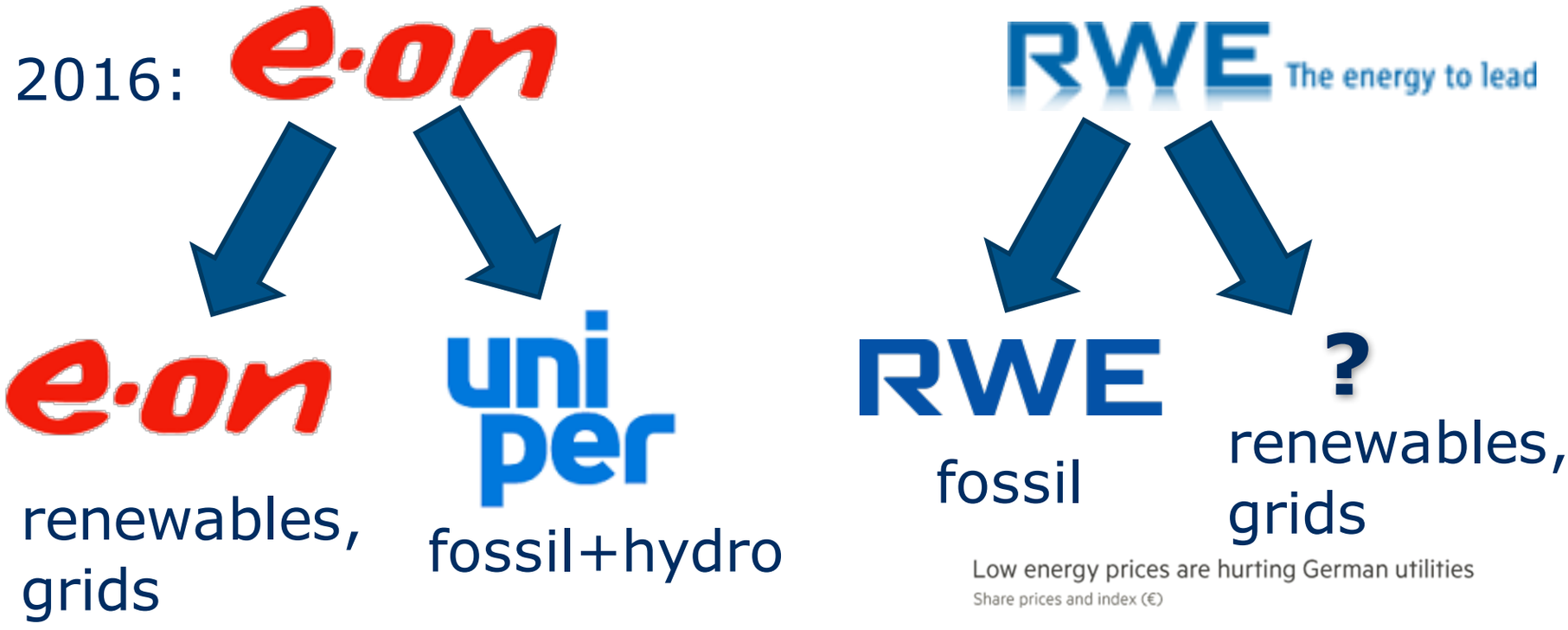
Saudi Arabia invest in Uber ($3.5 billion).

Google, Apple…

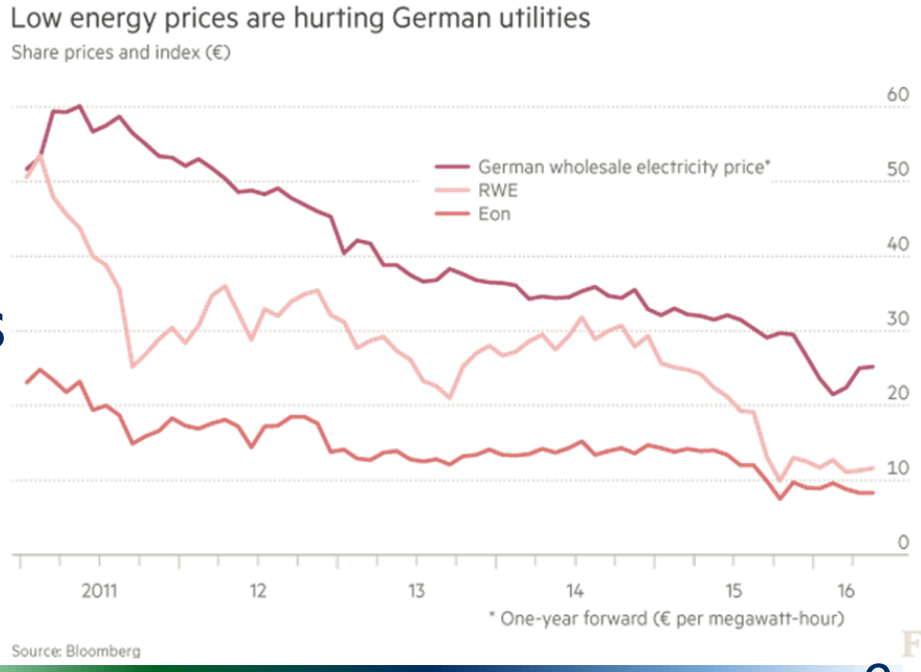
But… in 1999, Ford's CEO Jac Nasser:
"…outsource the dull task of assembling cars and reinvent (Ford) as a mobility company, selling transport as a service."

Power utilities

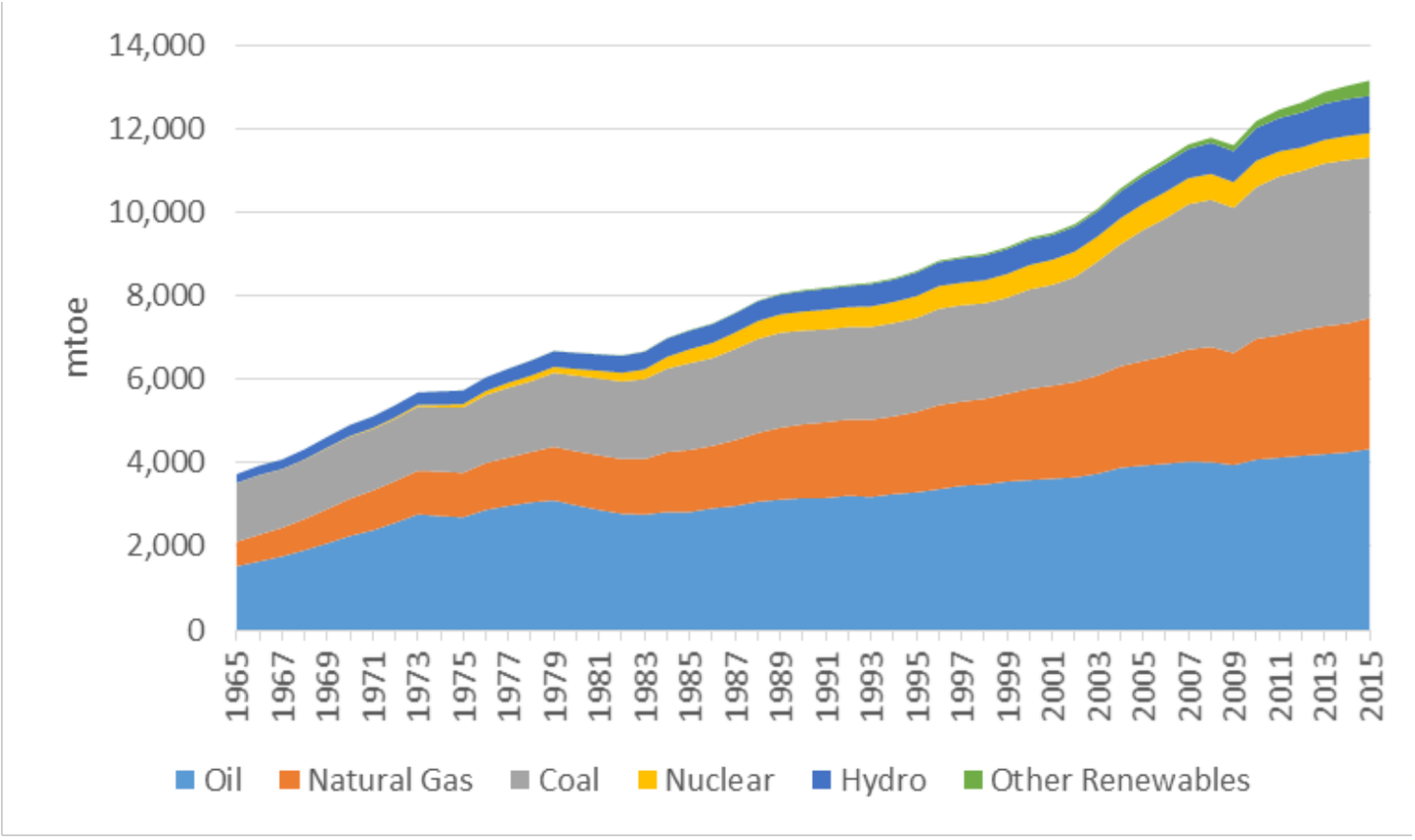
2016:



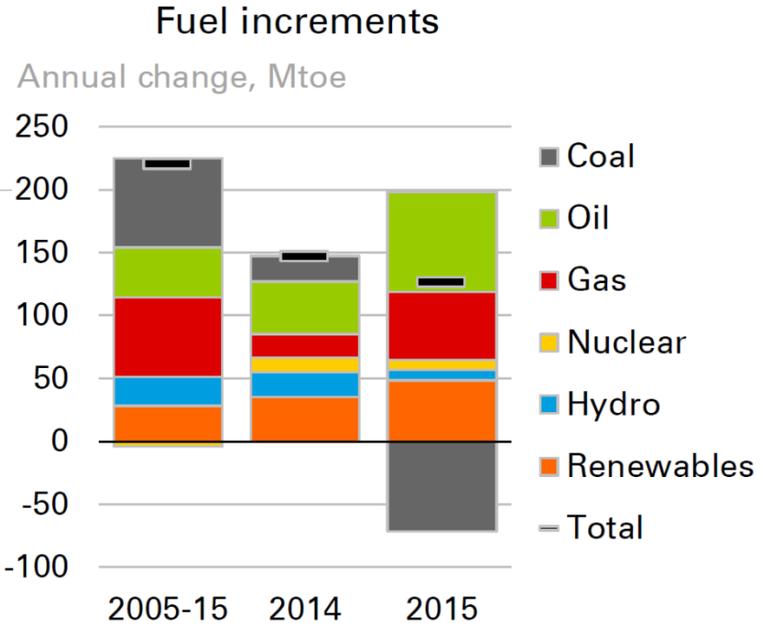
RWE, E.On, GE, Statoil, Siemens, Vattenfall – "we can make offshore wind competitive with coal and gas power by 2025…"
"if the EU provides support…"



Energy Question



Global Primary energy use.
Data source: BP (2016).

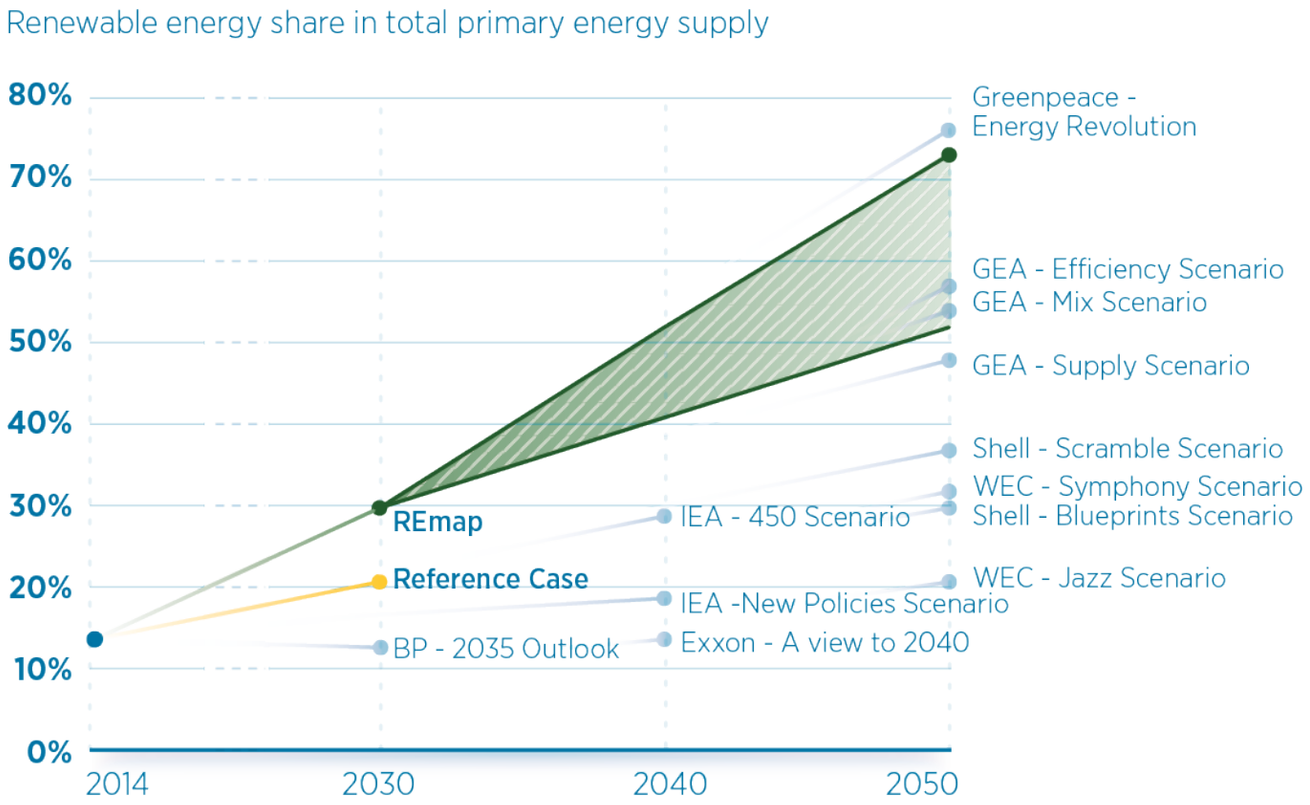


Data source: BP (2016).

"Apples to Oranges": Sometimes comparisons are between "best guesses", aspirational goals, and "what if" scenarios…

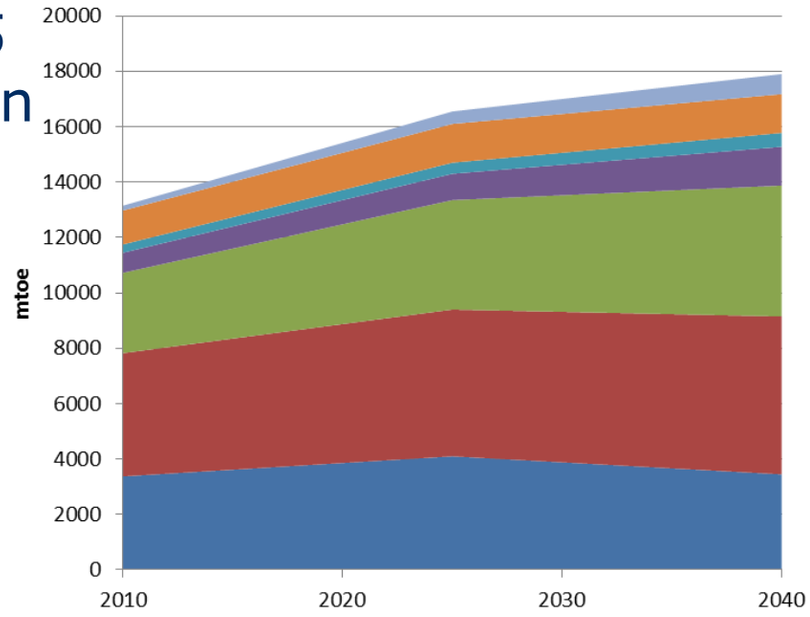
Example: International Renewable Energy Agency - IRENA (2016)

FIGURE 19 Renewable energy share in total primary energy supply based on REmap and various energy scenarios, 2014-2050

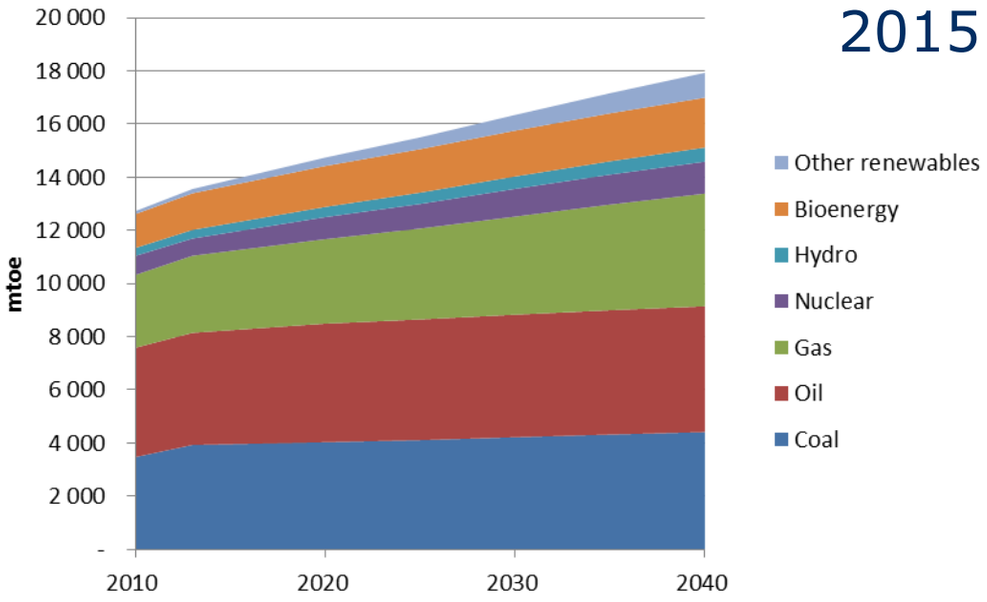


“Best guesses” – ExxonMobil, BP, “New Policies” – IEA, “Outlook” – MIT Joint Program

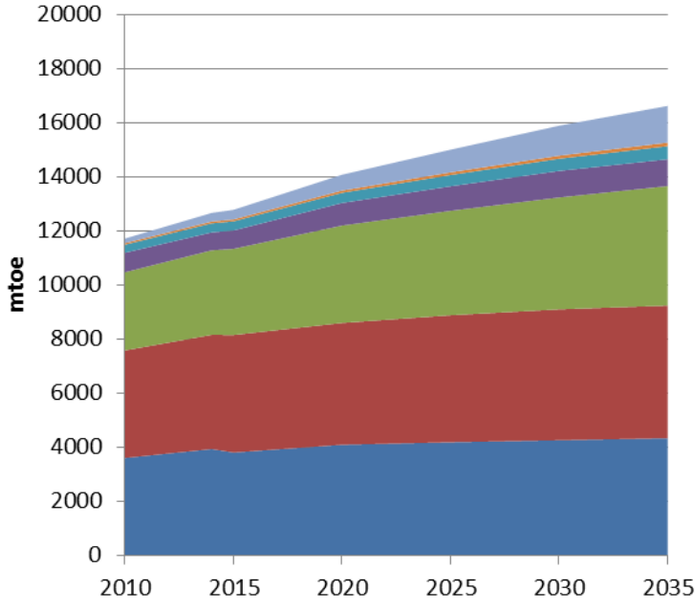
2015 Exxon



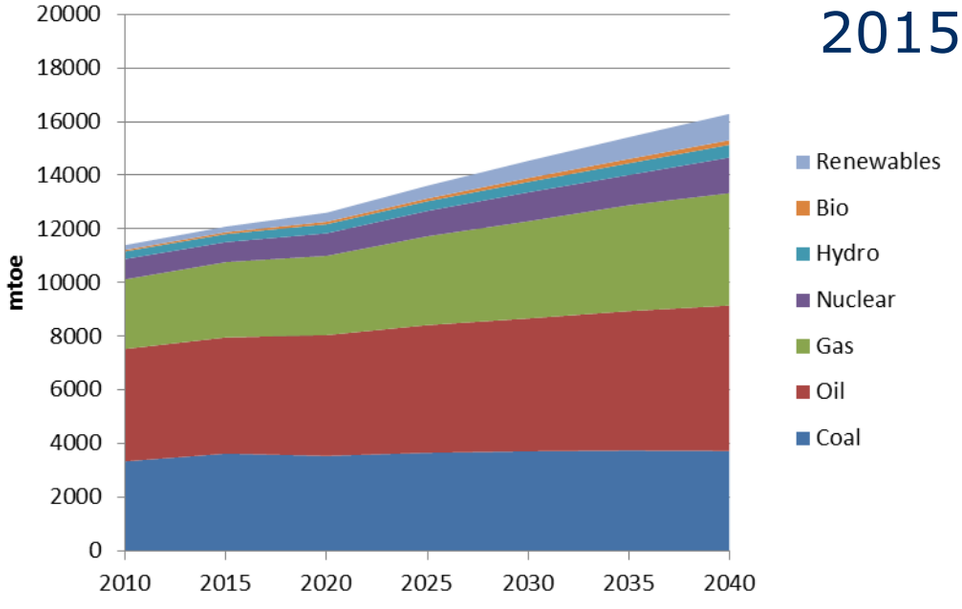
2015 IEA



2016 BP



2015 MIT



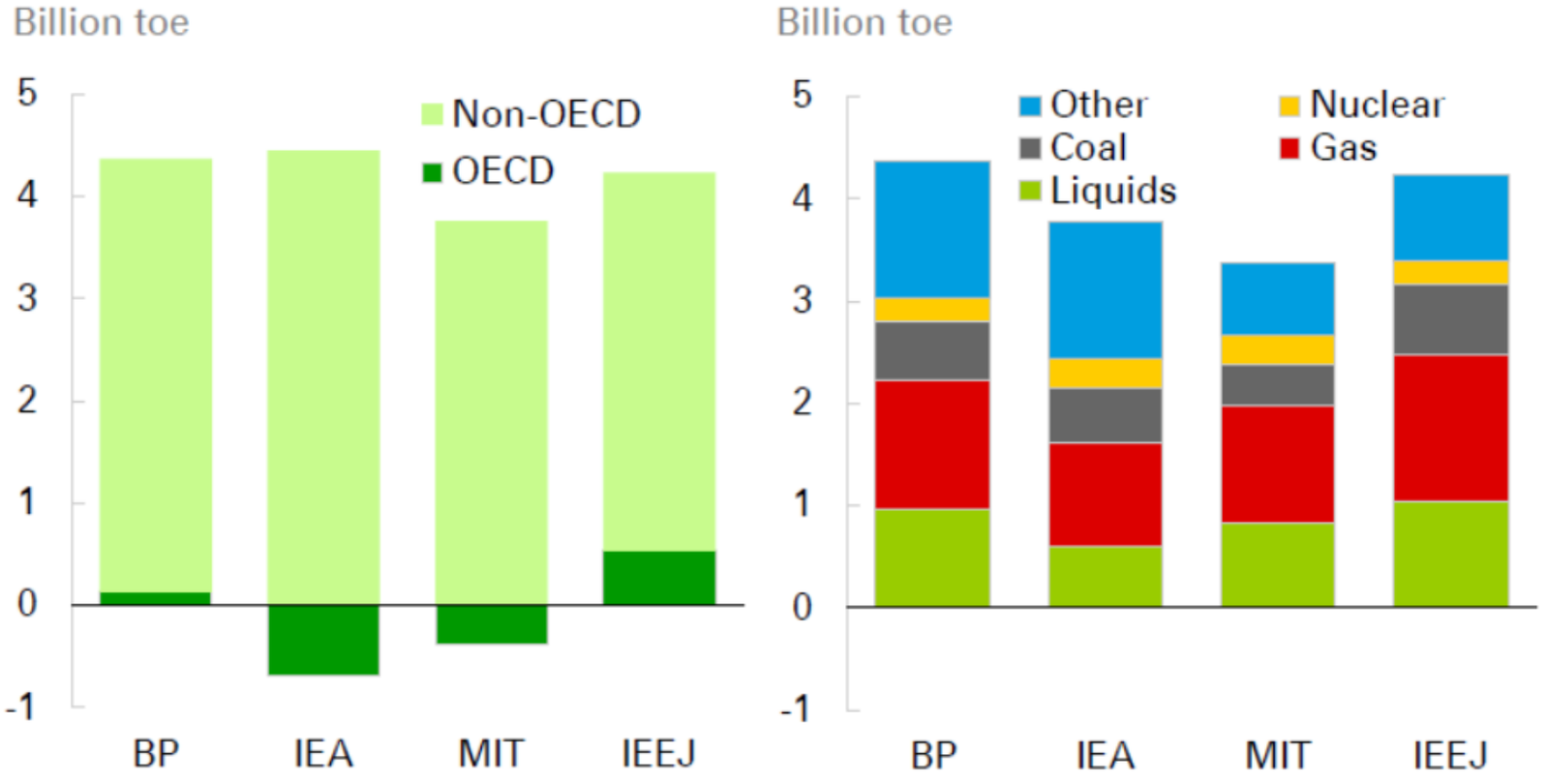
Energy Outlooks:

Annex

Comparison with other energy outlooks

bp

Growth of energy consumption, 2010-30



2016 Energy Outlook

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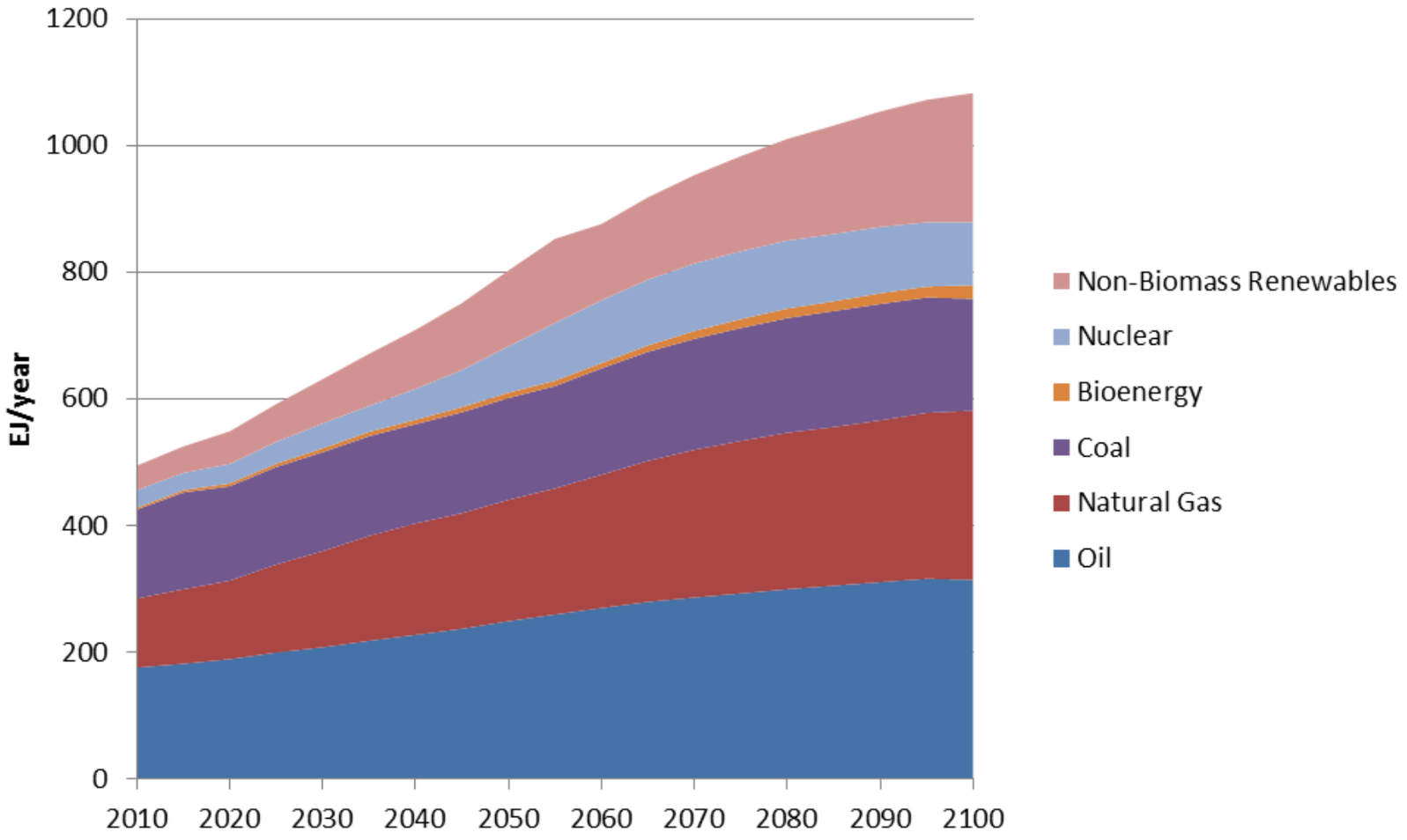
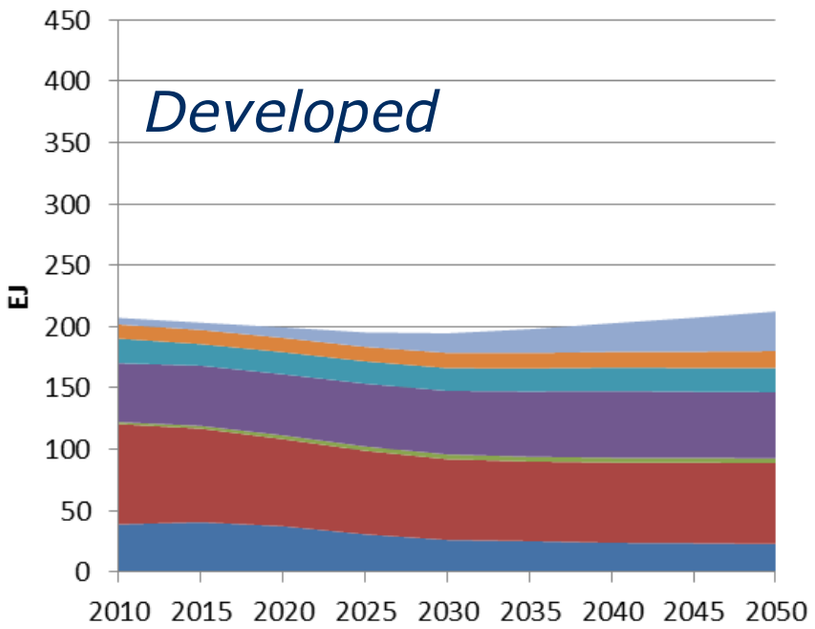
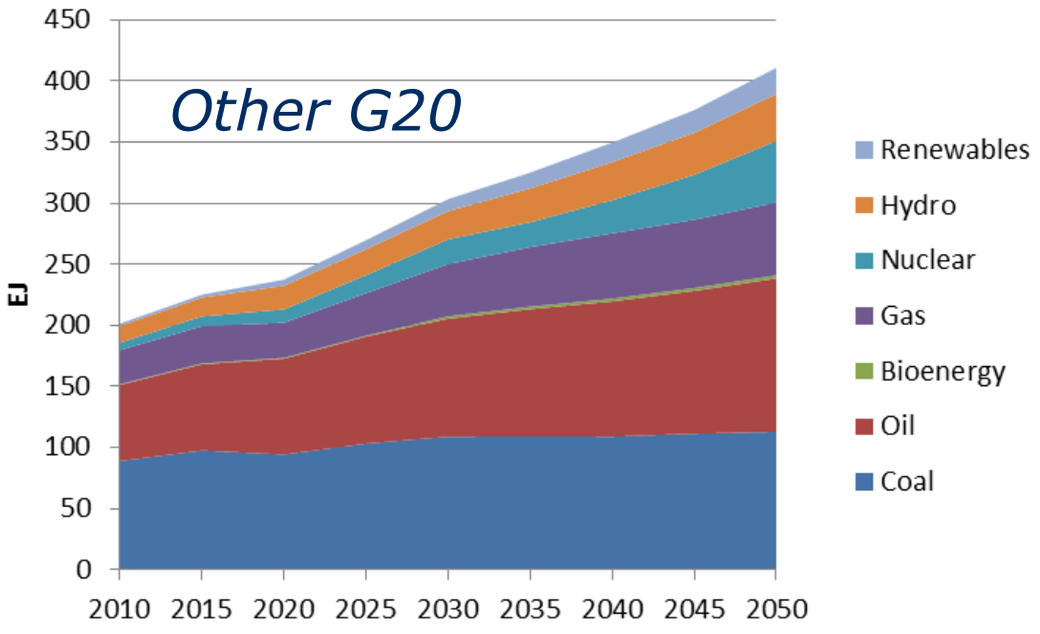
MIT JP Outlook 2015 (No additional policy after COP-21 targets)

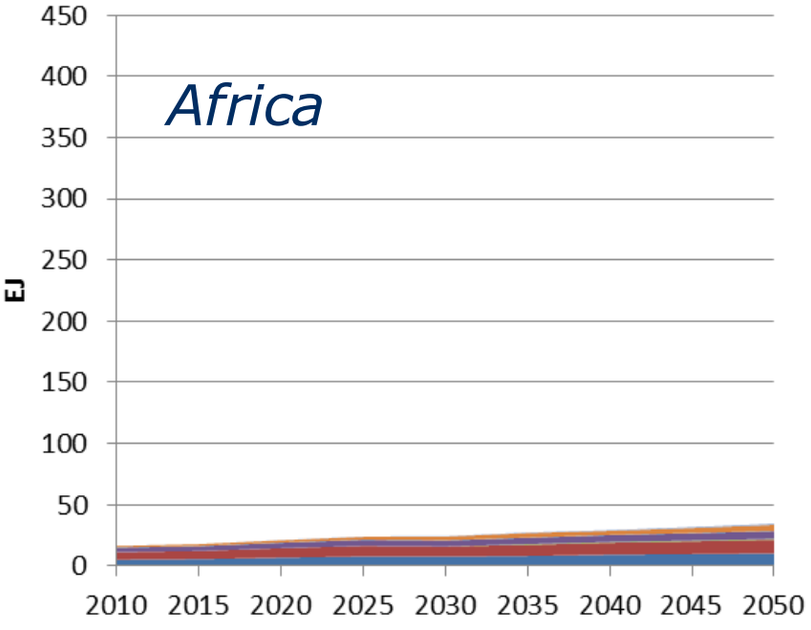


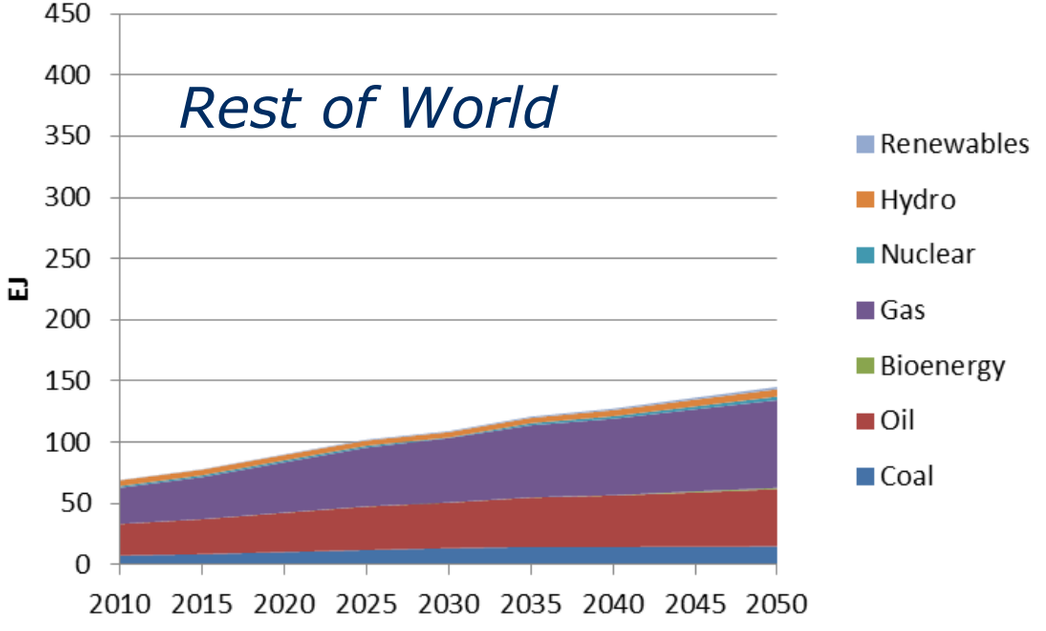
Global energy use: Most energy comes from the same sources currently utilized: oil, natural gas, coal.

Energy Use by region



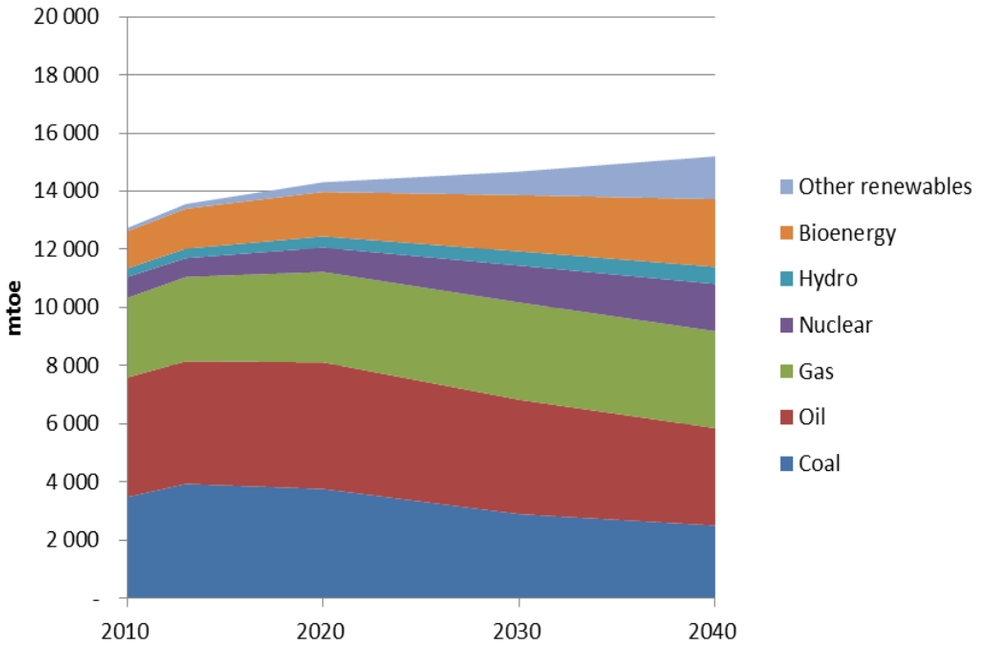


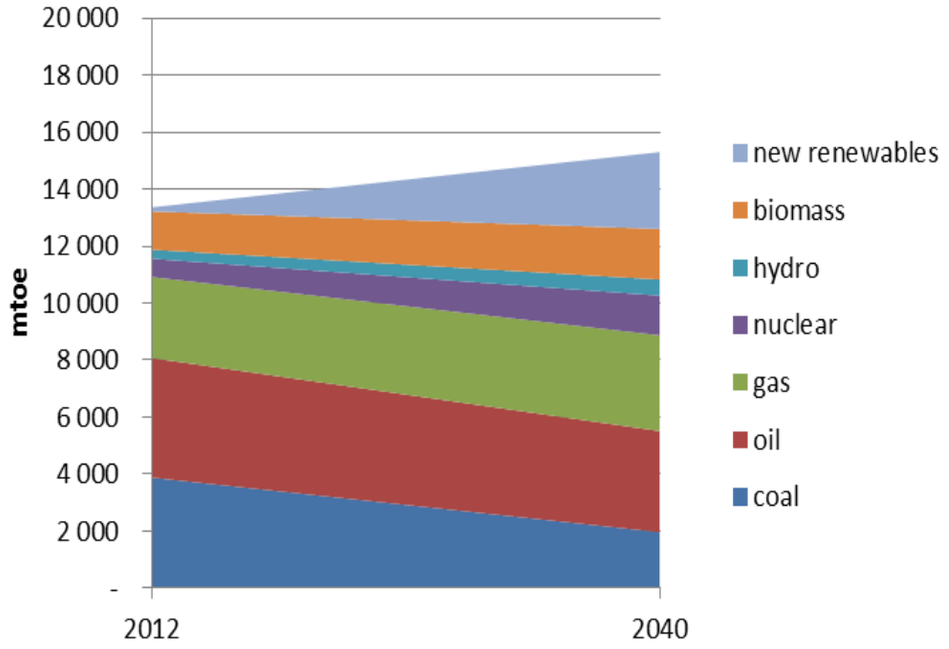




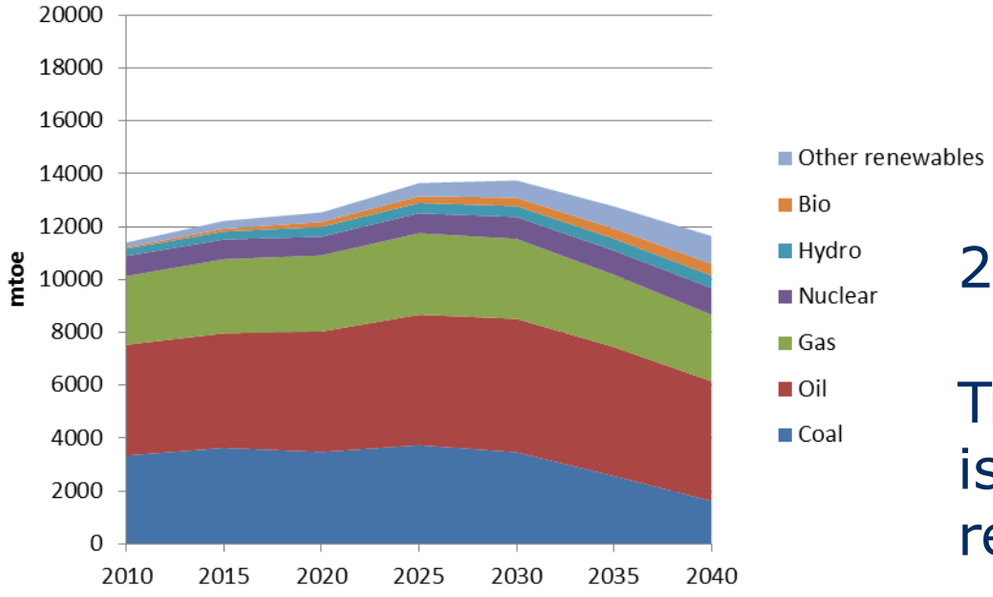
“450” – IEA, “2C” – MIT Joint Program, “Renewal” - Statoil

2015
IEA





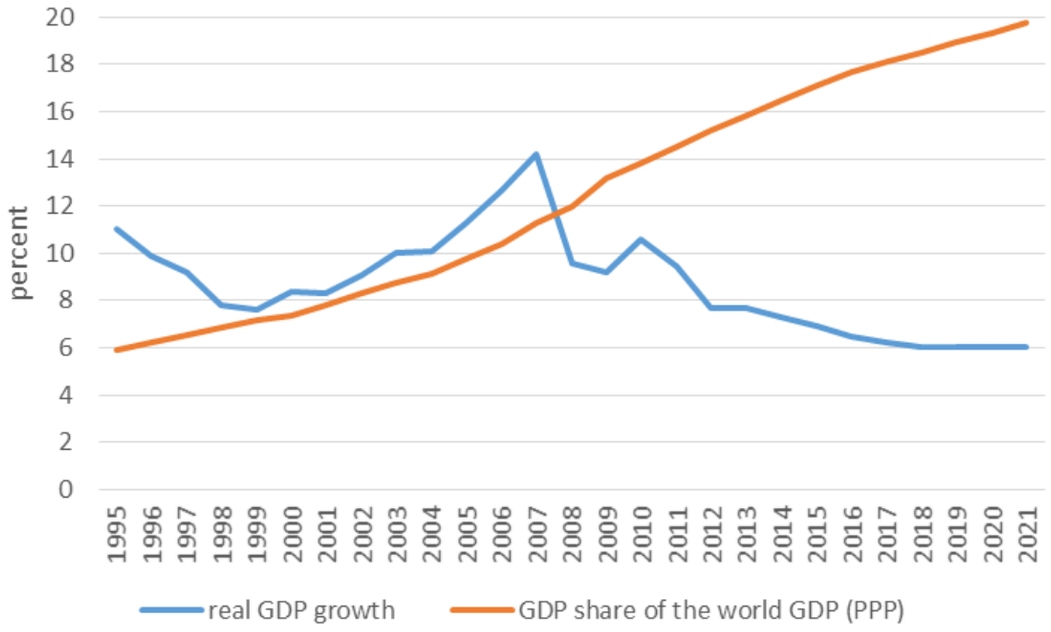
2015 Statoil,
only 2012 and
2040 are reported



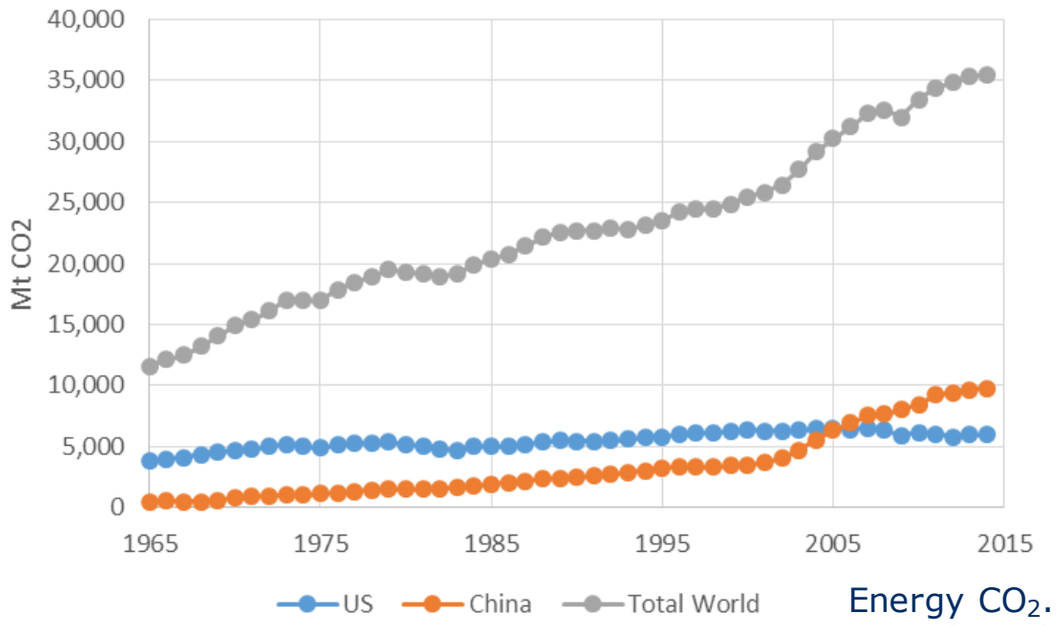
2015 MIT

Traditional biomass
is not explicitly
represented in the model

China's Shares of Global GDP, Energy, and CO_2

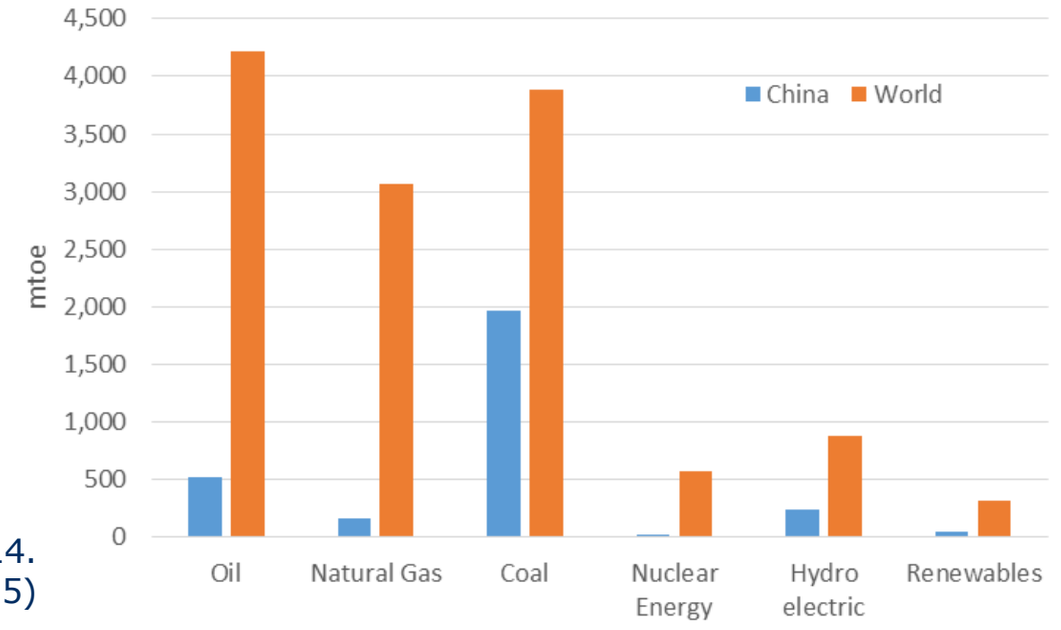


GDP growth. Data Source: IMF (2016)



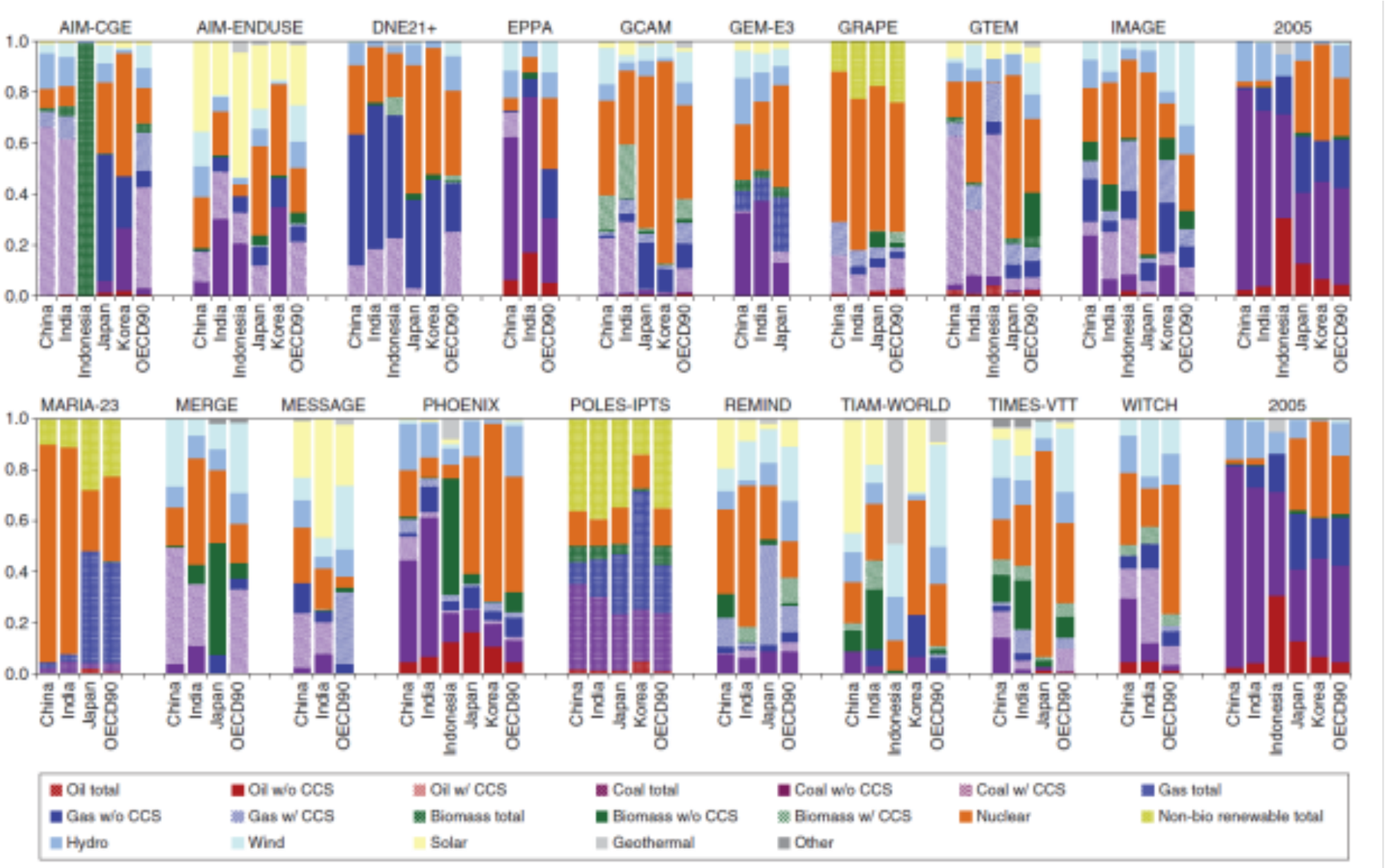
Energy CO_2.
Data source: BP (2015)

China in The World (2014):
17% of GDP; 27% of CO_2;
23% of energy.



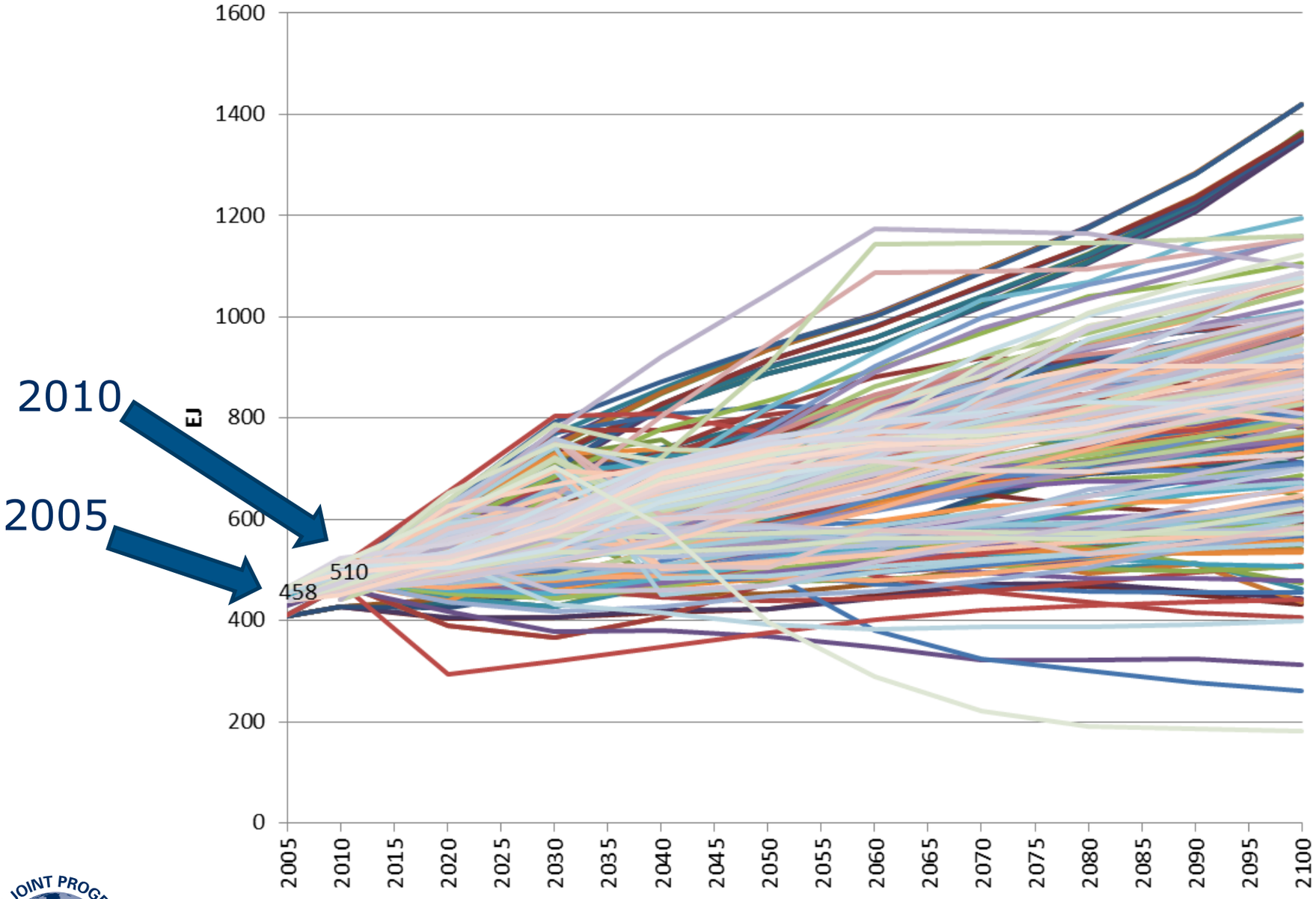
Primary energy use in 2014.
Data source: BP (2015)

Asia Modeling in 2050: Electricity Generation by Type ($30/5%)



Source: Krey (2014) WIREs Energy and Environment

2C Scenarios from IPCC AR5: Global Primary Energy

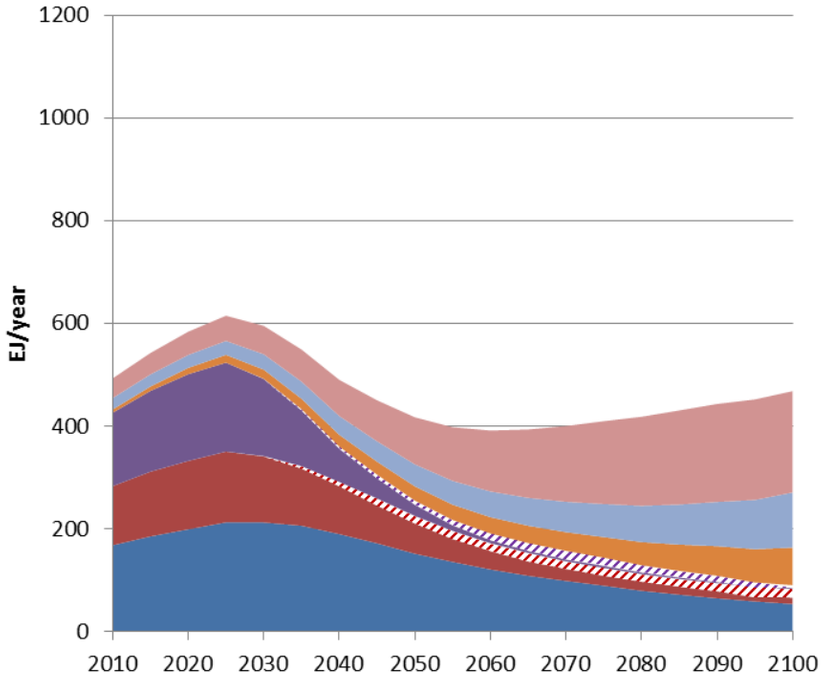


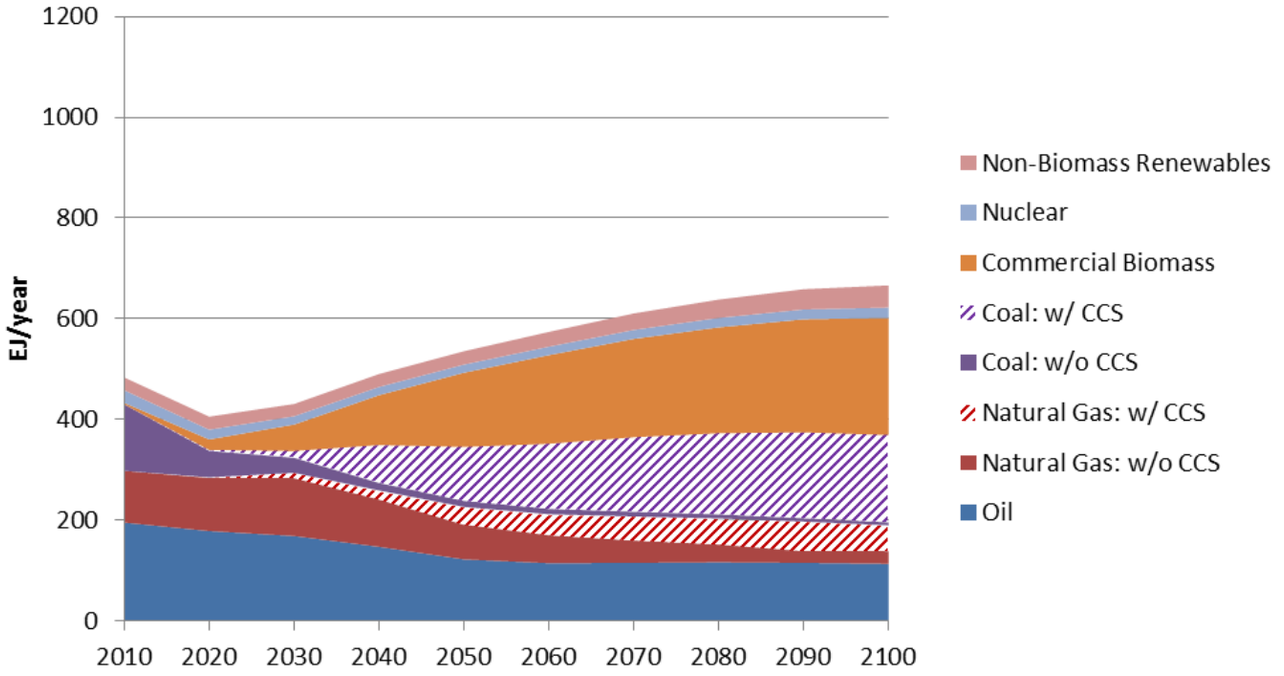
Combining scenarios from different groups

392 of 2C scenarios out of 1,184 total scenarios in AR5

"spaghetti diagram"

2C Targets: Technology options are affected by policy instruments and cost assessments





2014 – Less optimism about CCS,
More optimism on nuclear,
renewables and energy efficiency

Based on EPPA results for US
CCSP (2007)

2050 global shares of power generation:

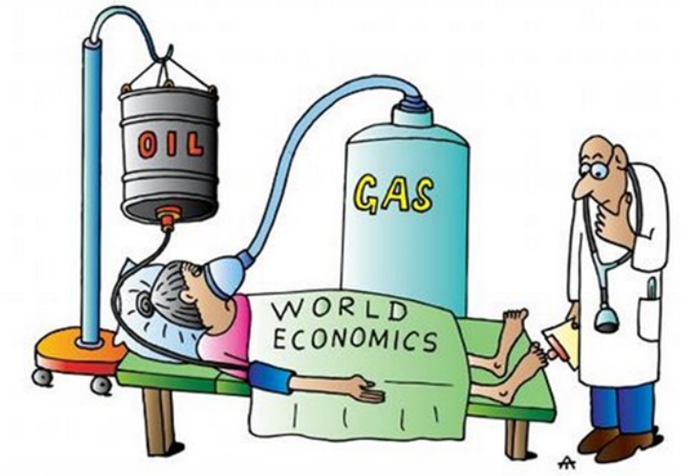
2007 study –- fossil – 75%, renewables – 15%

2014 study –- fossil – 30%, renewables – 50%

Additional Dimension: Energy Geopolitics

Key recent developments:
1) Saudi Arabia decisions affected oil and natural gas markets;
2) Asian demand slows down;
3) EU tries to reduce its dependence on Russian gas;
4) Expectations of Iran's supplies;
5) Expectation of natural gas price war in the EU (Russia vs US LNG).

Additional dimension:
A move to low-carbon energy.



Current Natural Gas ("Bridge Fuel") Headlines

Asian LNG prices

U.S. export projects (first LNG cargo – to Brazil - from $11bn Sabine Pass), Australia export projects ($54 bn Gorgon is ready, several more to come);
China demand, Japan nuclear.

EU supply

US LNG, EU-Russia tensions (Gazprom reports the 2015 as the largest share of Russian gas in the EU), Turkish Stream, Southern Gas Corridor; Poseidon; North Stream II;Tesla pipeline; Eastlink pipeline.

Russia-China Deal

Power of Siberia, Power of Siberia -2 (Altai), Sakhalin.

Mediterranean

Turkish Stream, TANAP-TAP, Egypt's Zohr field;
Israeli plans for Leviathan and Tamar; Iran.

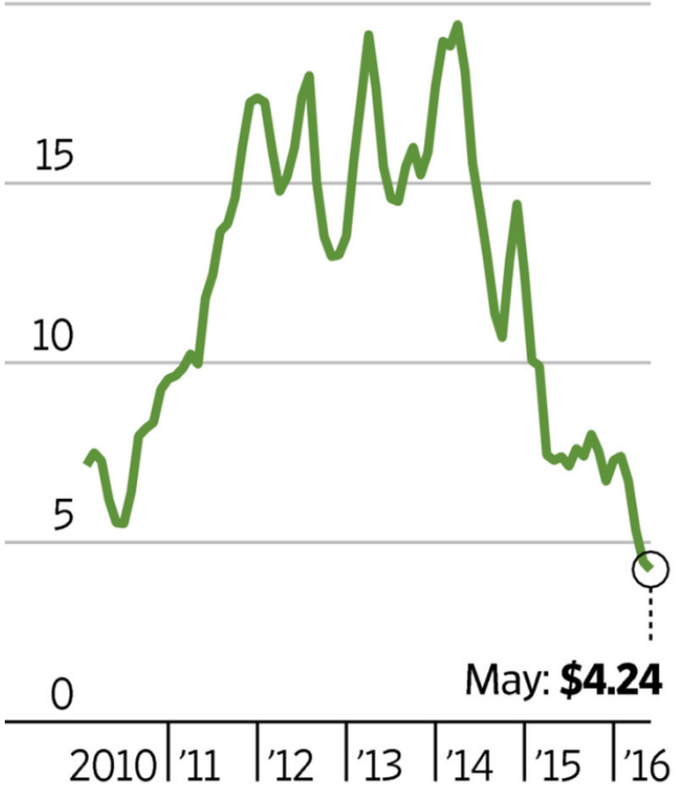
Asian LNG prices

Fizzling Out

The price of liquefied natural gas in Asia has collapsed.

Average monthly LNG price

$20 per million BTUs



Source: Platts

THE WALL STREET JOURNAL.

Conclusions

Aggressive climate stabilization targets (2-3C) require drastic changes in energy mix.

Future costs and the resulting technology mixes are uncertain. (MIT JP continues to explore: Mobility of the Future, CCS study, renewables, nuclear, biomass, BECCS, natural gas…)

Policy: Target emissions reductions from any source, rather than focus on boosting certain kinds of renewable energy.

Many decisions will continue to be driven by oil and gas geopolitics.

Thank you

Questions or comments?
Please contact Sergey Paltsev at paltsev@mit.edu.

http://globalchange.mit.edu/