GLOBAL PROSPECTS OF CO2 EMISSIONS IN POWER GENERATION AND CARBON MITIGATION ROLE OF NATURAL GAS

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Presentation's structure

Power-related CO2 emissions: recent evolutions and main drivers

Long-term power sector prospects: Electricity demand and supply

Future of power-related CO2 emissions and role of natural gas

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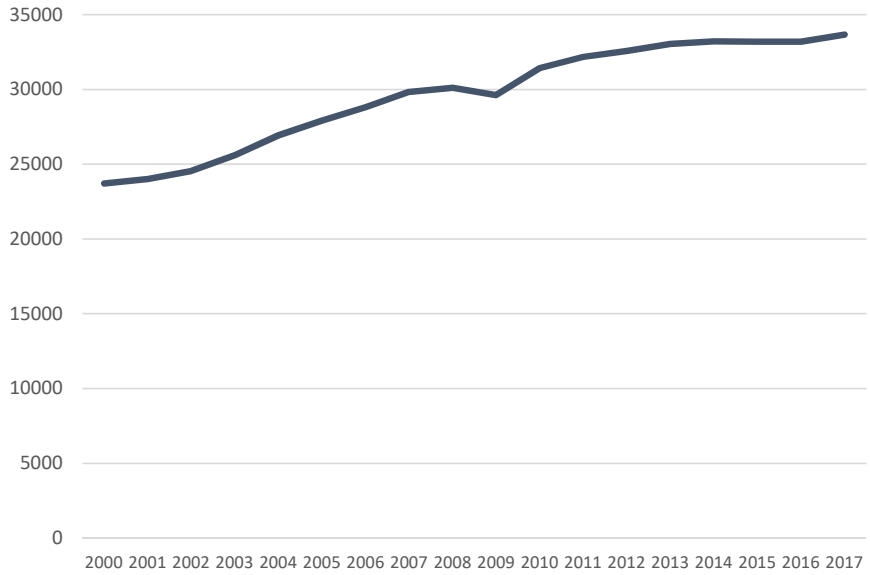
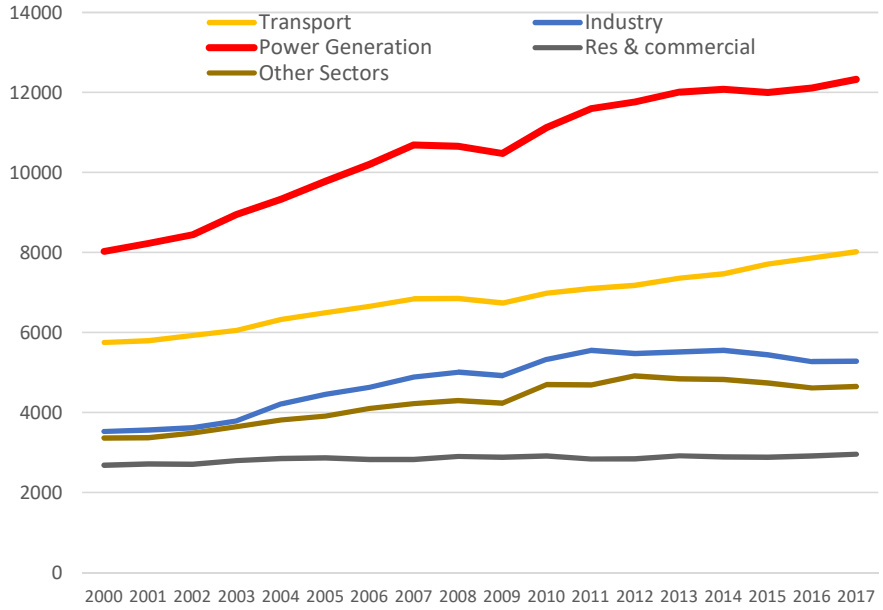
Recent evolution of CO2 emissions: a key role of power generation in shaping the global emission's trajectory

Global energy-related CO2 emissions (MtCO2)



CO2 emissions by sectors (MtCO2)



- Global emissions recovered with growth in 2017 after three consecutive years of relative stabilization.
- Power generation was a key contributor in this shaping this trajectory. Emission from power sector increased by 1,75% in 2017.

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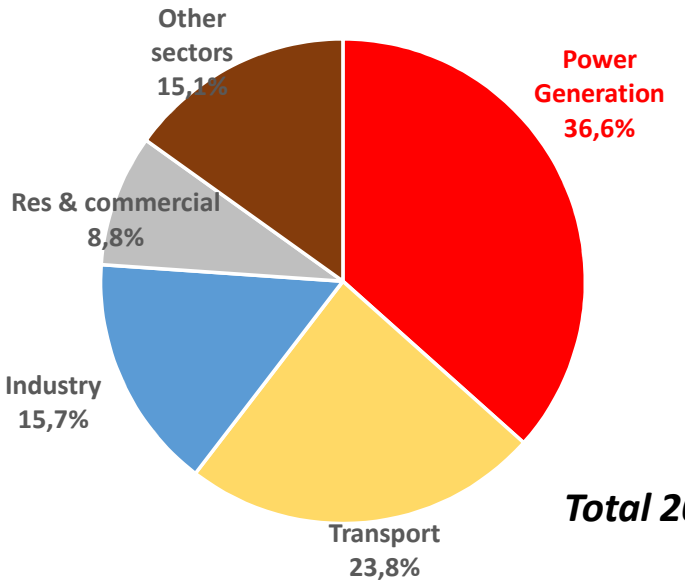
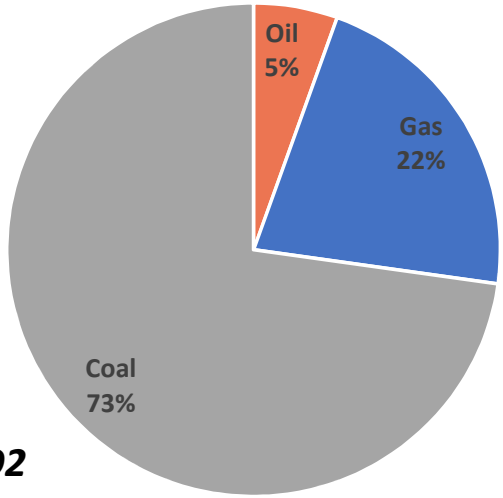
Power sector has a large potential to mitigate CO2 emissions

Global energy-related CO2 emissions by sector



Global energy-related CO2 emissions by fuels



Total 2017 emissions: 33.7 GtCO2

Power generation mitigation potential is driven by:

- Dominance of coal as the most carbon-intensive fuel.
- Existence of large spectrum of proven and competitive technologies to produce electricity with less carbon emissions.
- Increasing role of electricity in final energy consumption.
- Orientation to implement policy measures and initiatives targeting the power sector.

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Power-related emissions drivers: Decomposition analysis

Decomposing power-related emissions

Intensity factors: emission coefficients of fossil fuels and thermal efficiency of power plants.

Structure factors: substitution between fossils fuels; changes in renewables and nuclear shares

Activity or scale factors: power generation output.

$$Ctot = \sum_{i}^{gas;oil;coal} Emf_i * Eff_i * Fshares_i * NUCshares * RENshares * PG$$

The change in total power-related emissions for a specified period of time is decomposed according to the Logarithmic Mean Divisia Index (LMDI) additive version (Wang et al, 2015)

$$\Delta Ctot = \sum_{i}^{gas;oil;coal} \Delta C\_emf_i + \Delta C\_eff_i + \Delta C\_Fshares_i + \Delta C\_NUCshares + \Delta C\_RENshares + \Delta C\_PG$$

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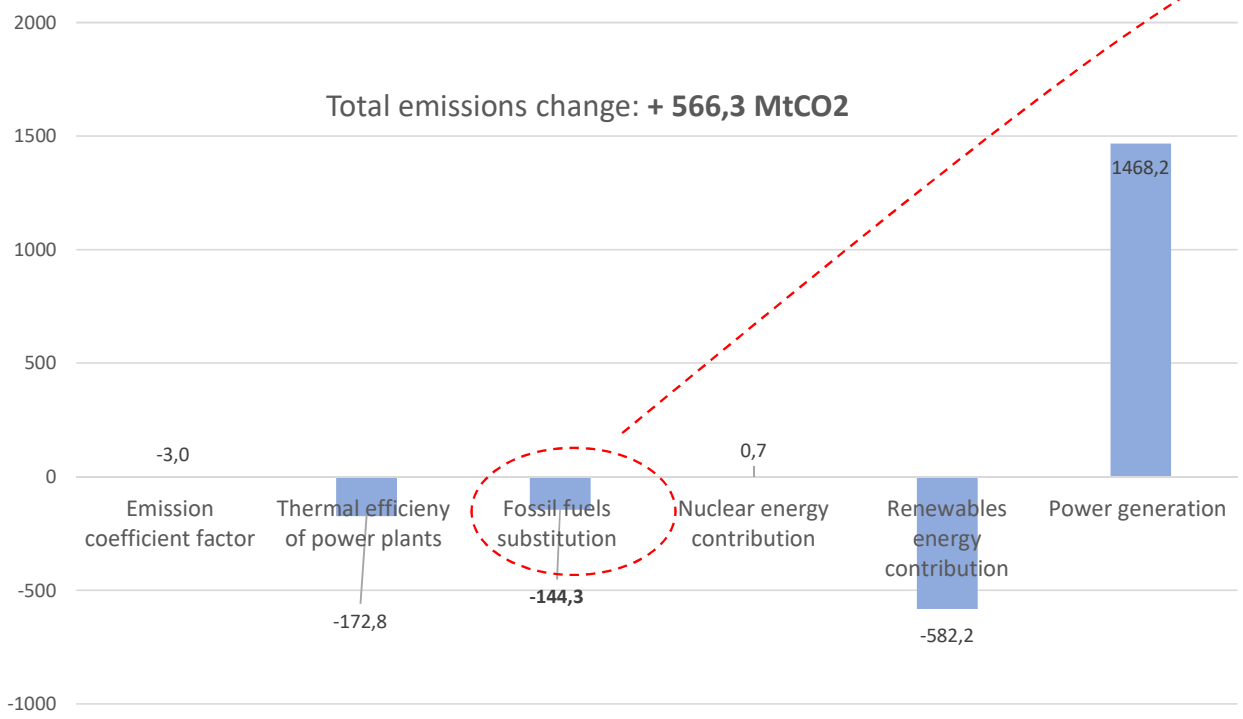
Increase of power generation largely drives emissions' growth. But strong mitigating effect of renewables, efficiency and substitution

Contribution of various factors in driving global power-related CO2 emissions' change between 2012 and 2017 (MTCO2)



Substitution between fossil fuels (especially penetration of natural gas against coal) played a role in compensating the upside effect of power generation activity on global emissions.

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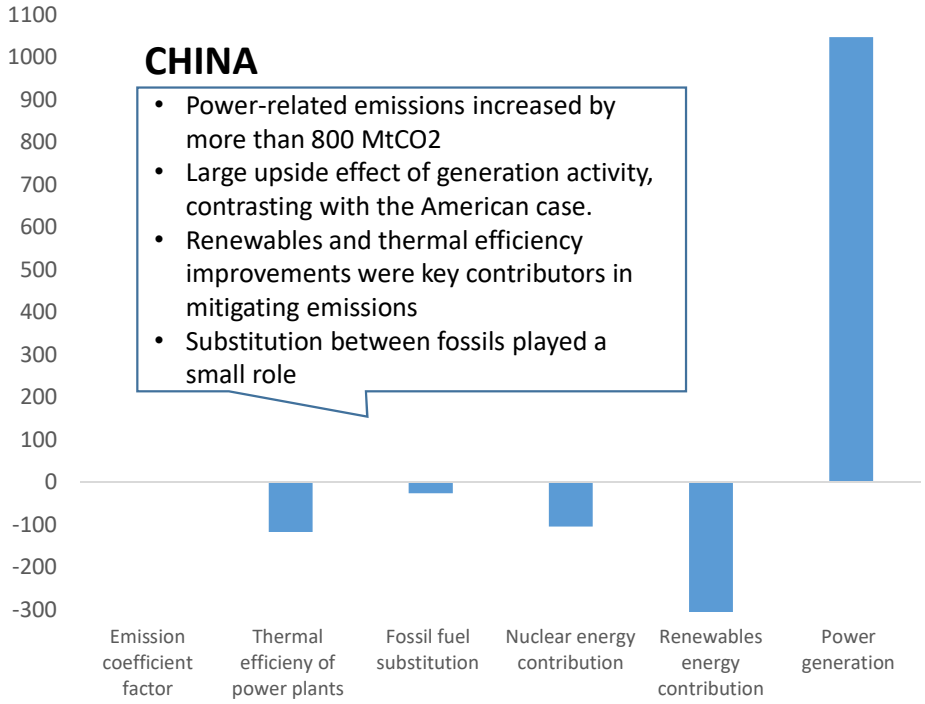
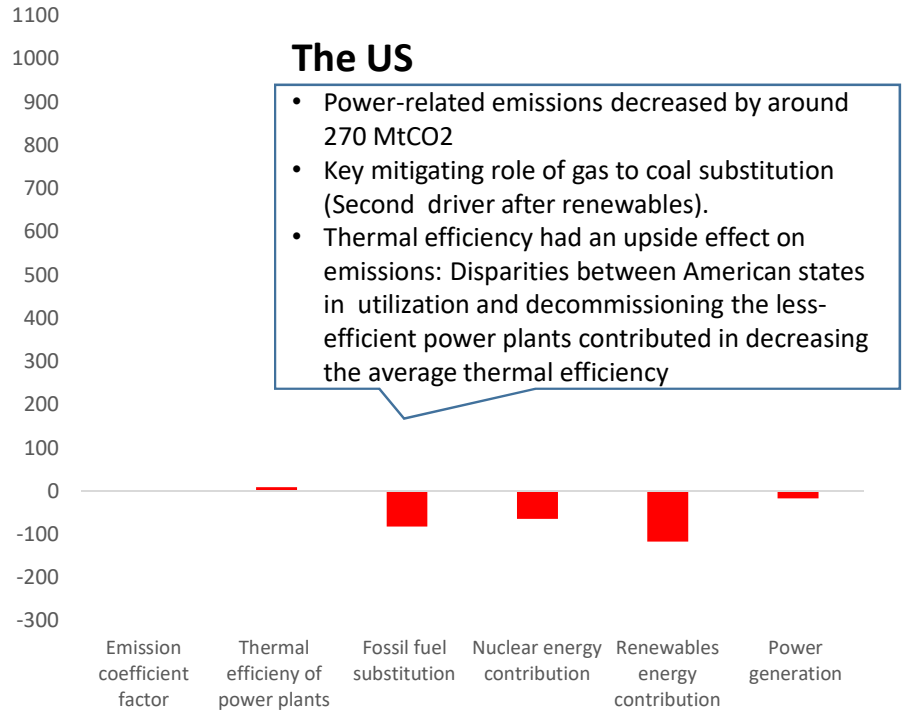
Significant difference in the contribution of different drivers between countries and regions: the US and Chinese cases

Contribution of various factors in driving power-related CO2 emissions' change between 2012 and 2017 (MTCO2)



CHINA

- Power-related emissions increased by more than 800 MtCO2
- Large upside effect of generation activity, contrasting with the American case.
- Renewables and thermal efficiency improvements were key contributors in mitigating emissions
- Substitution between fossils played a small role



The US

- Power-related emissions decreased by around 270 MtCO2
- Key mitigating role of gas to coal substitution (Second driver after renewables).
- Thermal efficiency had an upside effect on emissions: Disparities between American states in utilization and decommissioning the less-efficient power plants contributed in decreasing the average thermal efficiency

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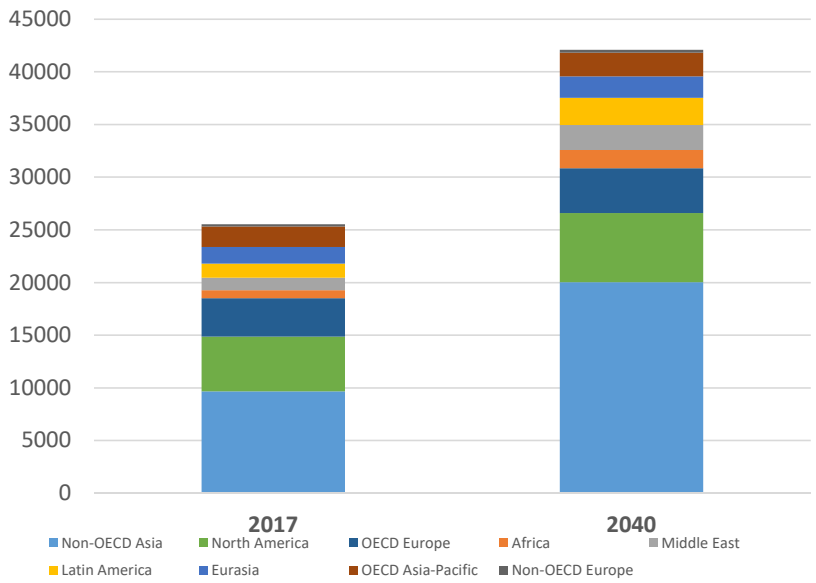
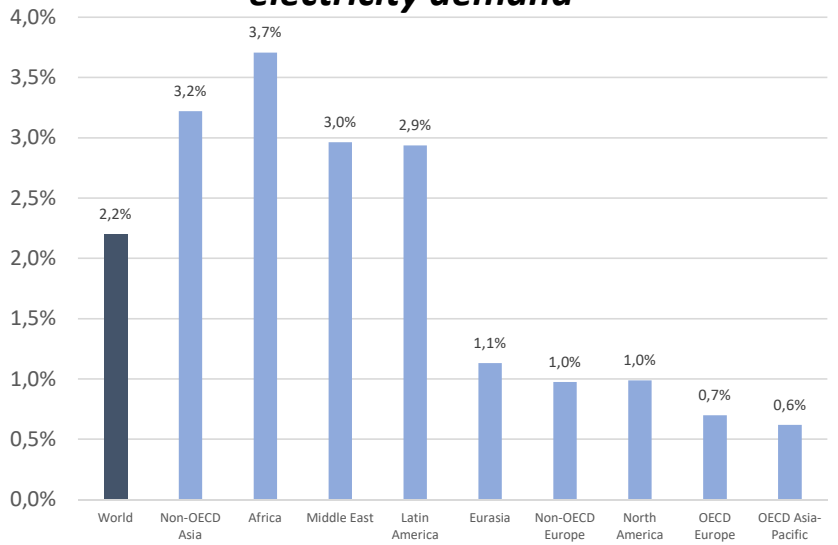
Global power sector prospects*: Electricity demand

Electricity demand by regions (Twh),



2017-40 Average Annual Growth Rates of electricity demand



- Electricity demand expected to increase by more than 2/3, driven by non-OECD regions (Particularly, non-OECD Asia which represent around 48% of demand by 2040).
- Despite at much lower pace, electricity demand will continue to grow in OECD regions, supported by economic progress and increased electrification

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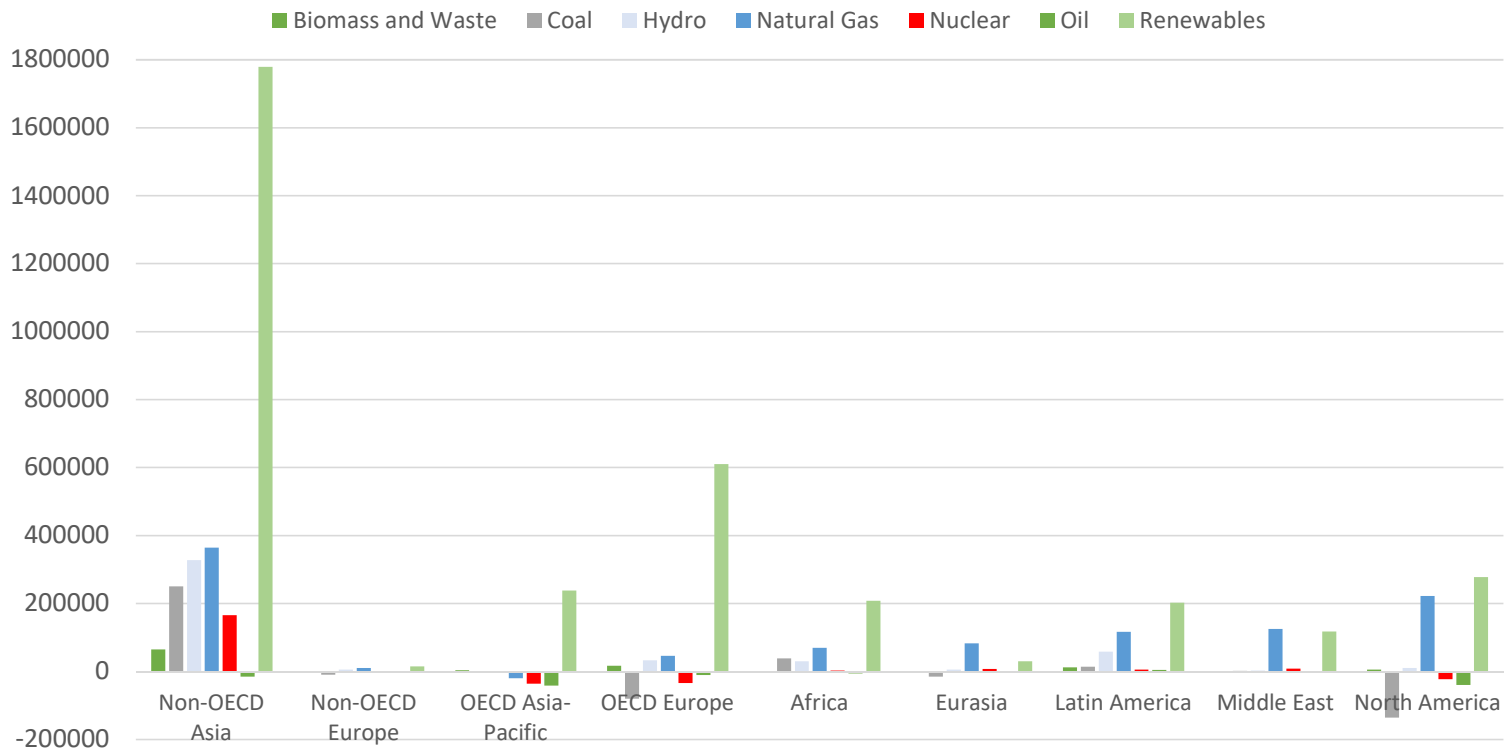
* All the forecasts are based on the 2018 GECF Global Gas Outlook assumptions on economic, energy price and policy developments in the reference case. These forecasts use the power module of the GECF Global Gas Model

Global power sector prospects: Power capacities

Incremental power capacities by region and source of energy between 2017 and 2040 (MW)



- Global renewables to increase by 3200 GW, nearly 58% of the 2017-2040 incremental total capacity.
- Gas power capacities will see the second largest increase, with important substitution to coal, especially in North America and OECD Europe

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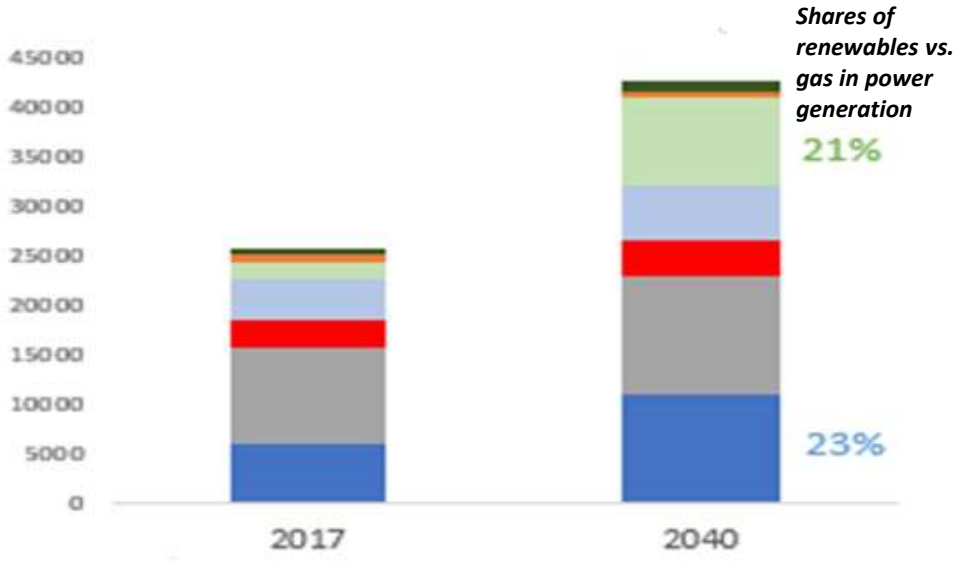
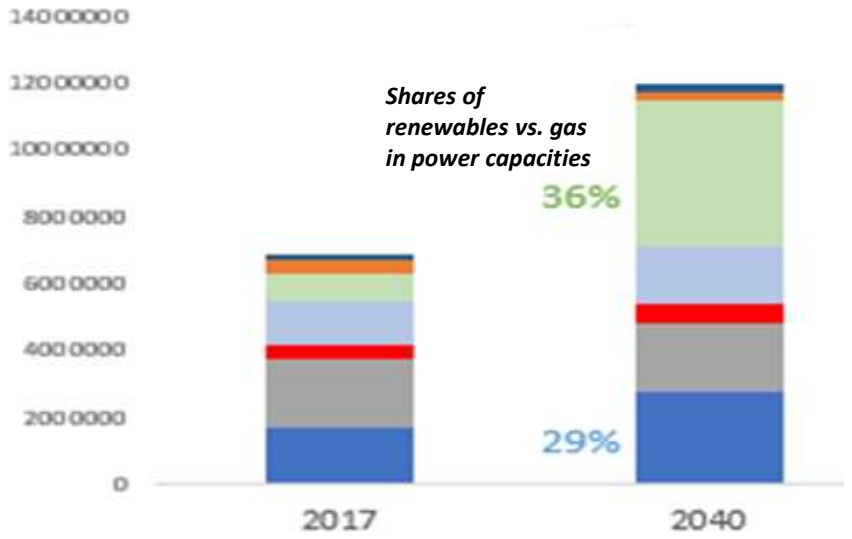
Global power sector prospects: Electricity generation vs. power capacities

Global power generation (Twh)



Power capacities (MW)



Gas Coal Nuclear Hydro Renewables Oil Biomass and Waste

Compared to renewables (excl. hydro and biomass), gas is expected to have higher contribution in power generation despite much less capacities.

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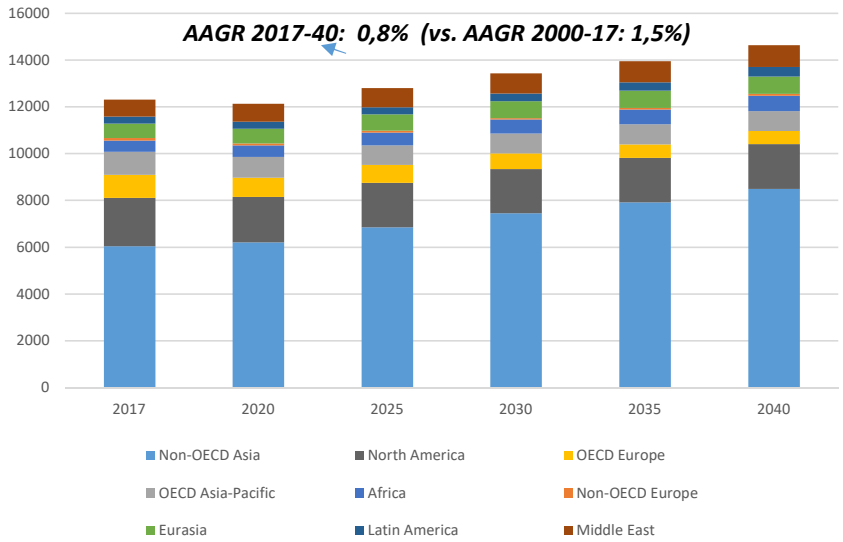
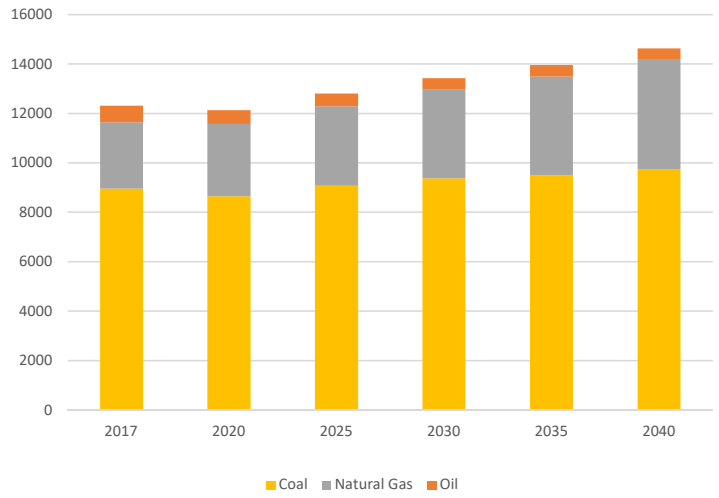
Power related emissions will observe large slowdown, but still expected to increase, dominated by coal in emerging regions

Power-related CO2 emissions forecasts by regions (MtCO2)



Power-related CO2 emissions forecasts by fuels (Twh)



- Non-OECD Asia is the major contributor in emissions' increase, and would represent around 58% of emissions by 2040.
- Despite large substitution dynamic, emissions from coal-fired plants are expected to grow and to reach 2/3 of the power emissions by 2040.

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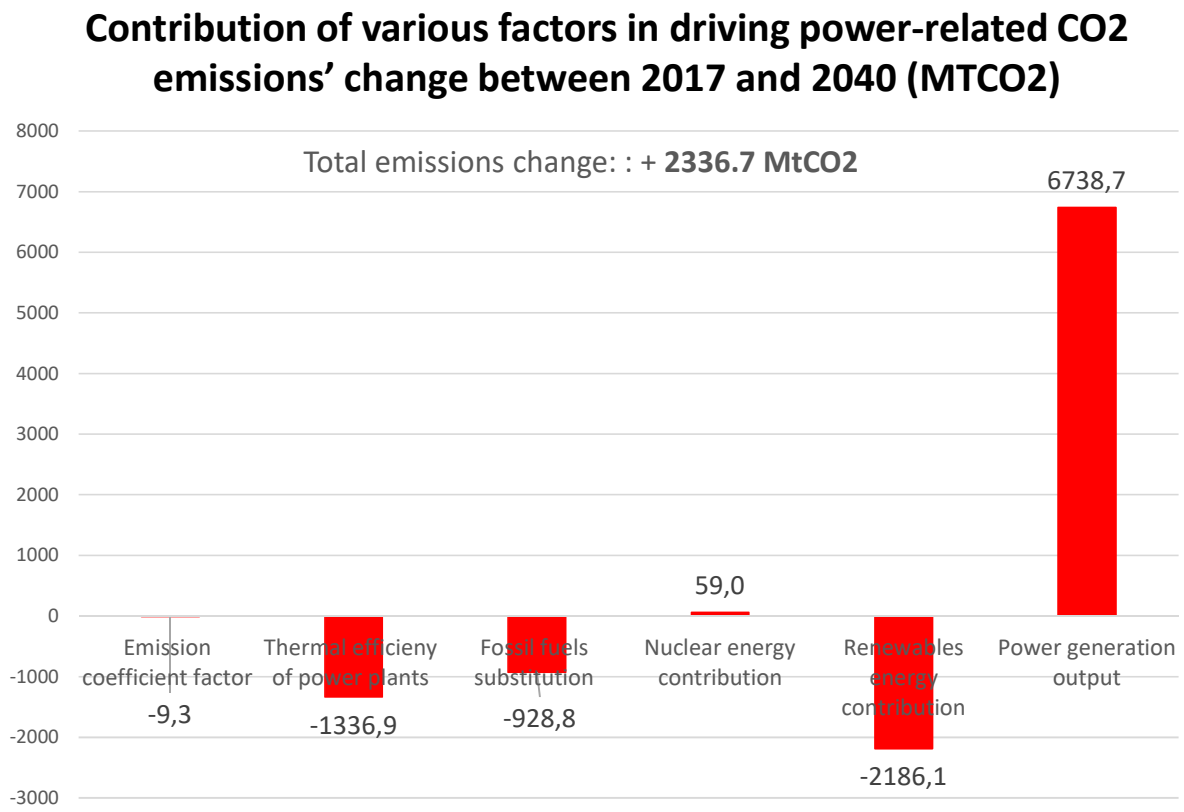
Drivers of future global power-related emissions



- Emissions growth largely supported by expected global increase of power generation activity
- Respectively, renewables, thermal efficiency and substitution between fossils will counterbalance this generation activity effect.
- Nuclear decrease expected to play a small role: Decline in Europe, North America and OECD Asia to be offset by an increase of nuclear in emerging countries (China in particular)

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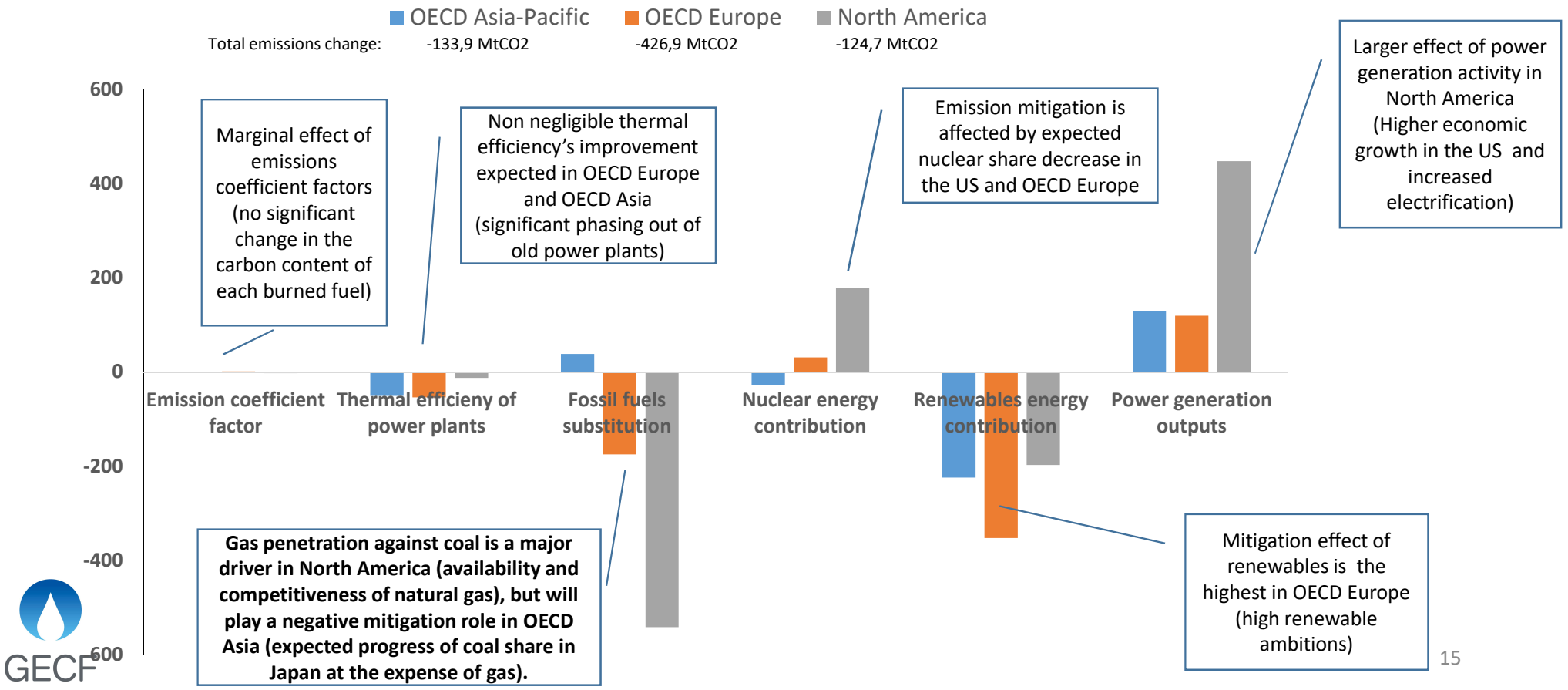
Drivers of future power-related emissions in OECD regions

Contribution of various factors in driving power-related CO2 emissions' change between 2017 and 2040 (MTCO2)



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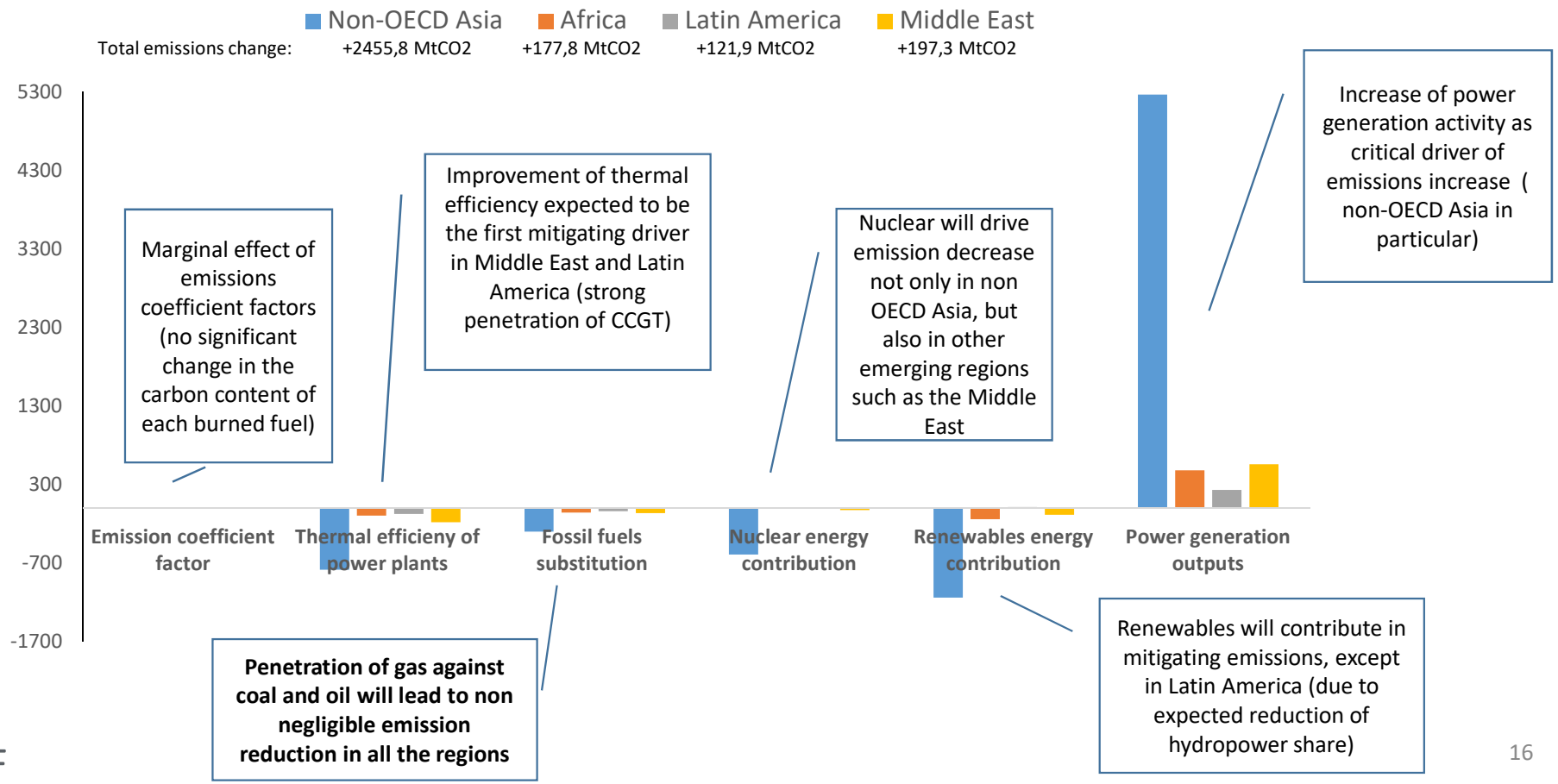
Drivers of future power-related emissions in non-OECD regions

Contribution of various factors in driving power-related CO2 emissions' change between 2017 and 2040 (MTCO2)



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Conclusion

- Power generation sector will contribute significantly in slowing down global CO2 emissions. However, large disparities exist between regions.
- Increase of electricity production to support growing economies and population and rising electrification of final energy usages, is set to play a crucial role in driving emissions' growth in the emerging and developing regions.
- Power generation's increase is still expected to have an effect in developed regions, where electricity demand is anticipated to grow, though at moderate levels.
- Substitution of natural gas to more carbon-intensive fossils is expected to have a significant effect in mitigating CO2 emissions, in addition to thermal efficiency's improvement and renewables development.
- More than this substitution effect, natural gas also plays a role in improving thermal efficiency of power plants and enabling flexibility for the deployment of renewables.

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Thank You!

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