2. Decarbonisation Opportunities and Challenges for Industry in APEC

APERC Workshop

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Outline

- 9th APEC Energy Demand and Supply Outlook: scenario assumptions for industry
- Industrial products are essential for high living standards
- Making clean energy machines; implications for industrial energy use
- Decarbonisation pathways
  - → Material efficiency
  - → Energy efficiency
  - → Fuel switching
  - → Carbon capture
- Conclusions

The forthcoming 9th APEC Energy Demand and Supply Outlook

The Reference scenario (REF)

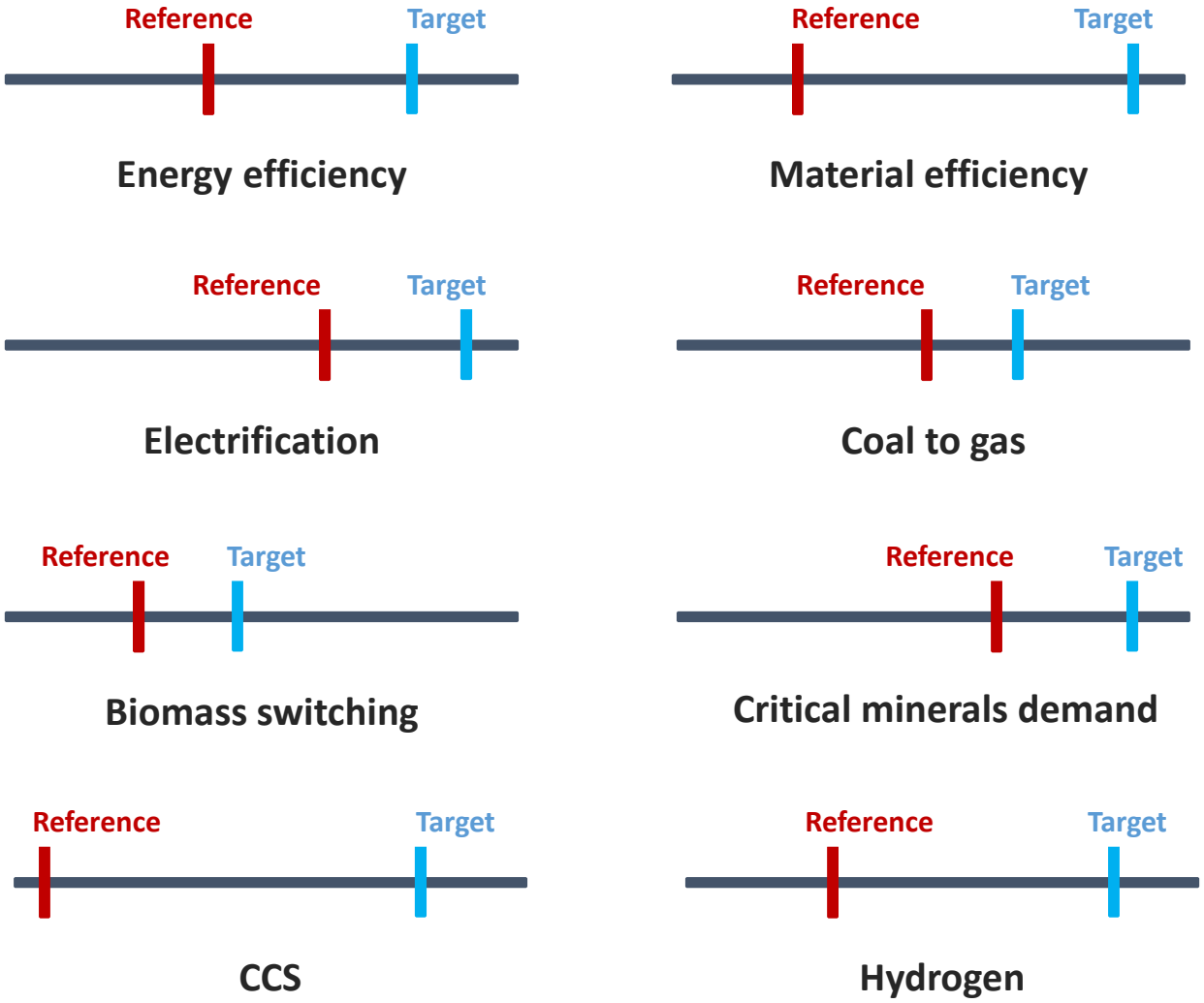
- A set of economy-specific pathways where existing policies are retained, and new policy measures are included if and only if they are supported by implementation details.
- In the absence of details, energy intensity, fuel switching, investment, technology deployment, and energy supply are assumed to loosely follow historical trends.

The Target scenario (TGT)

- Illustrates a hypothetical pathway for each economy towards realising energy-related policy targets, even if implementation details are not available.
- When details are not available, economy targets provide directional guidance and a general sense of policy priorities to inform assumptions.

Currently ramping up modelling to send to APEC economies for review in the first half 2024

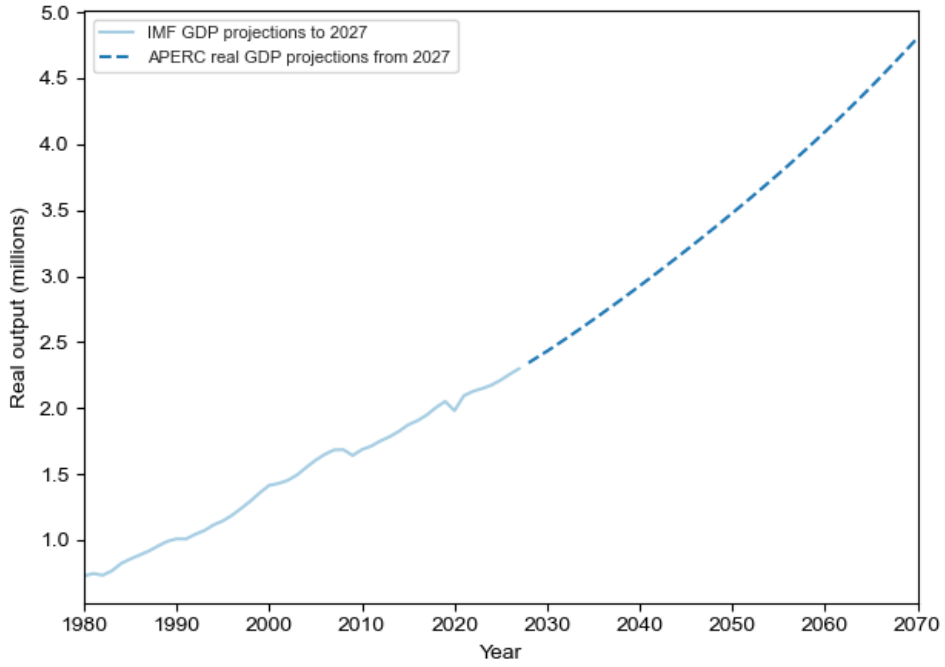
Key industry assumptions – illustrative



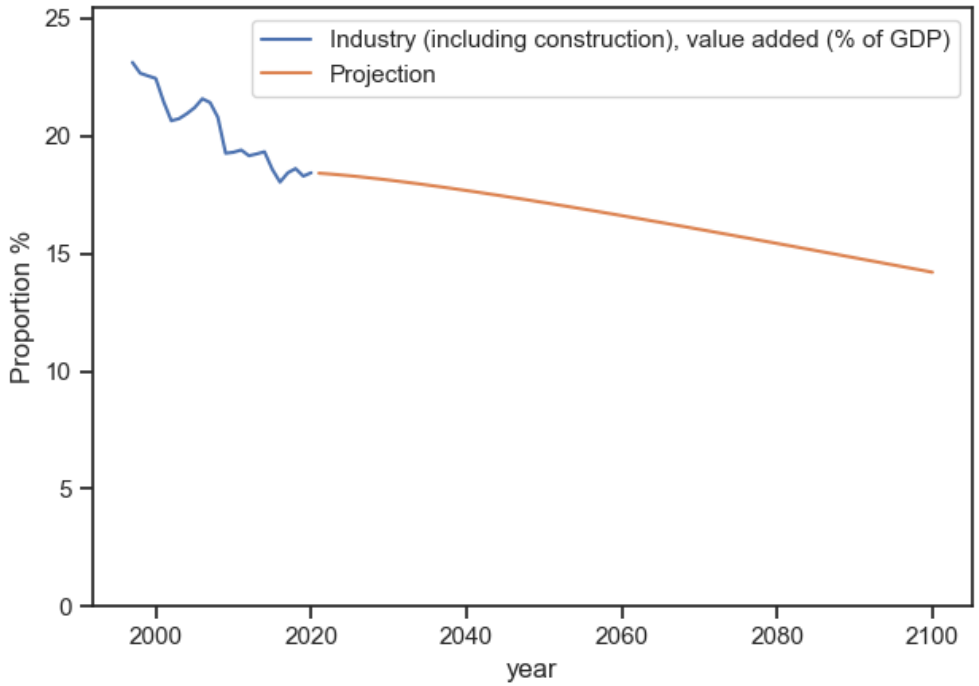
- Increased decarbonisation ambitions drive many of the assumptions decided upon for the **target scenario.**
- The choice of assumptions is economy specific, considering existing industrial production capacity, geography, current fuel mix, etc.
- There are more assumptions than those shown here.

Industrial products are essential for high living standards

Economic growth projections, US



Industry share of GDP projections



- GDP (and population) projections are important for industrial activity projections
  - → APERC uses multiple approaches to estimate activity at the industry subsector level
  - → Certain economies rely more on imports than domestic production

- Though the share of manufacturing and industry output to GDP typically shifts to a decline, industrial output can remain prominent in terms of absolute production levels
  - → Moving to a more service-based economy doesn't necessarily solve emissions challenges

One of the precursor challenges in decarbonising an economy

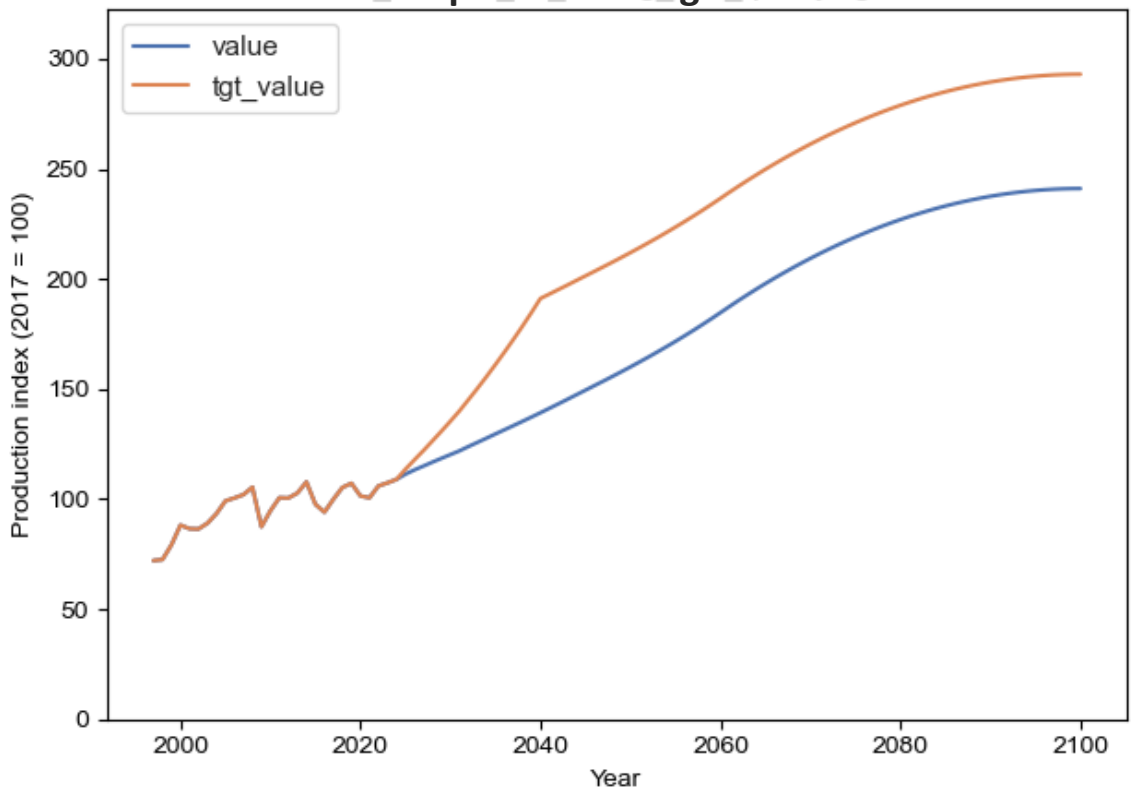
Decarbonising power, transport, and other sectors, requires additional industrial activity to produce 'clean machines' and build longer transmission networks

- Preliminary modelling assumes greater minerals mining activity and metals processing in **target scenario**

  -> Most of the additional activity above the **reference baseline** is assumed to occur in the next two decades

- Additional activity varies from economy to economy, depending on mineral resources and viability of increased metals processing capacity

Canada minerals mining activity, including increased activity assumptions for target scenario



Homing in on the magnitude of increased activity – The IEA NZE scenario

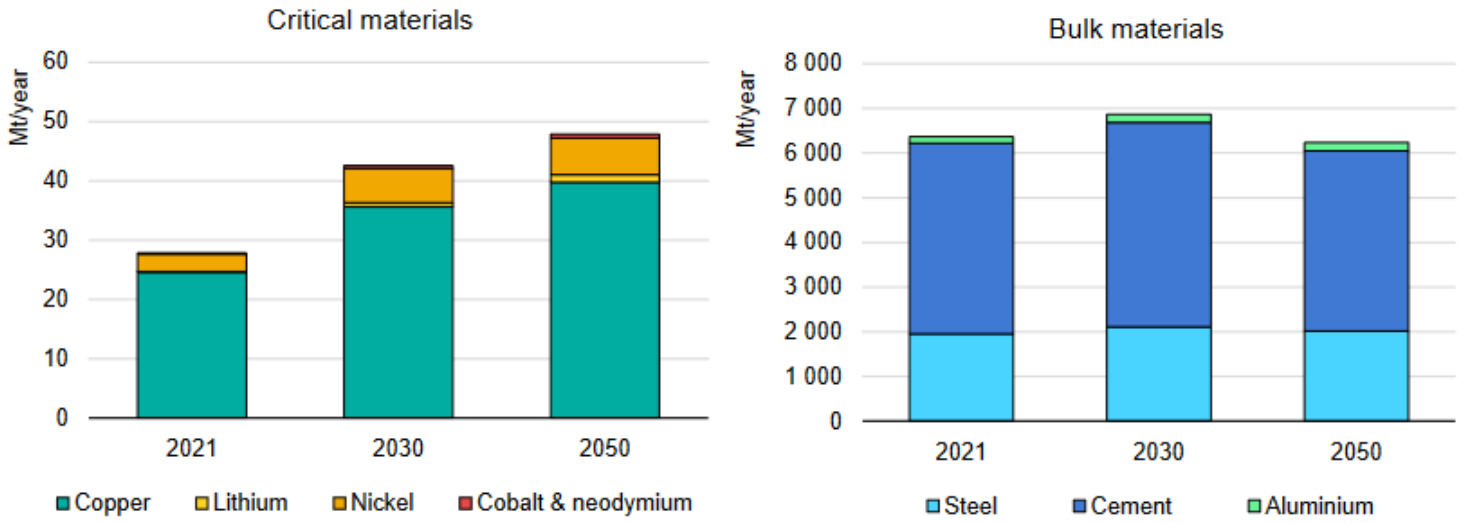
- Gains in material efficiency are more than offset by the rapid pace of deployment of clean energy technologies (IEA)

- Critical material demand by clean energy technologies more than triples to 2030

  → When other uses are included, total demand increases by two-thirds

- The IEA NZE scenario is ultimately more ambitious in terms of decarbonisation than our **target scenario**

Figure 3.2 Total global material demand by type in the NZE Scenario



Source: IEA analysis based on USGS (2022).

In the NZE Scenario, deployment of clean energy technologies rapidly increases demand for critical materials, while material efficiency curbs growth in demand for bulk materials.

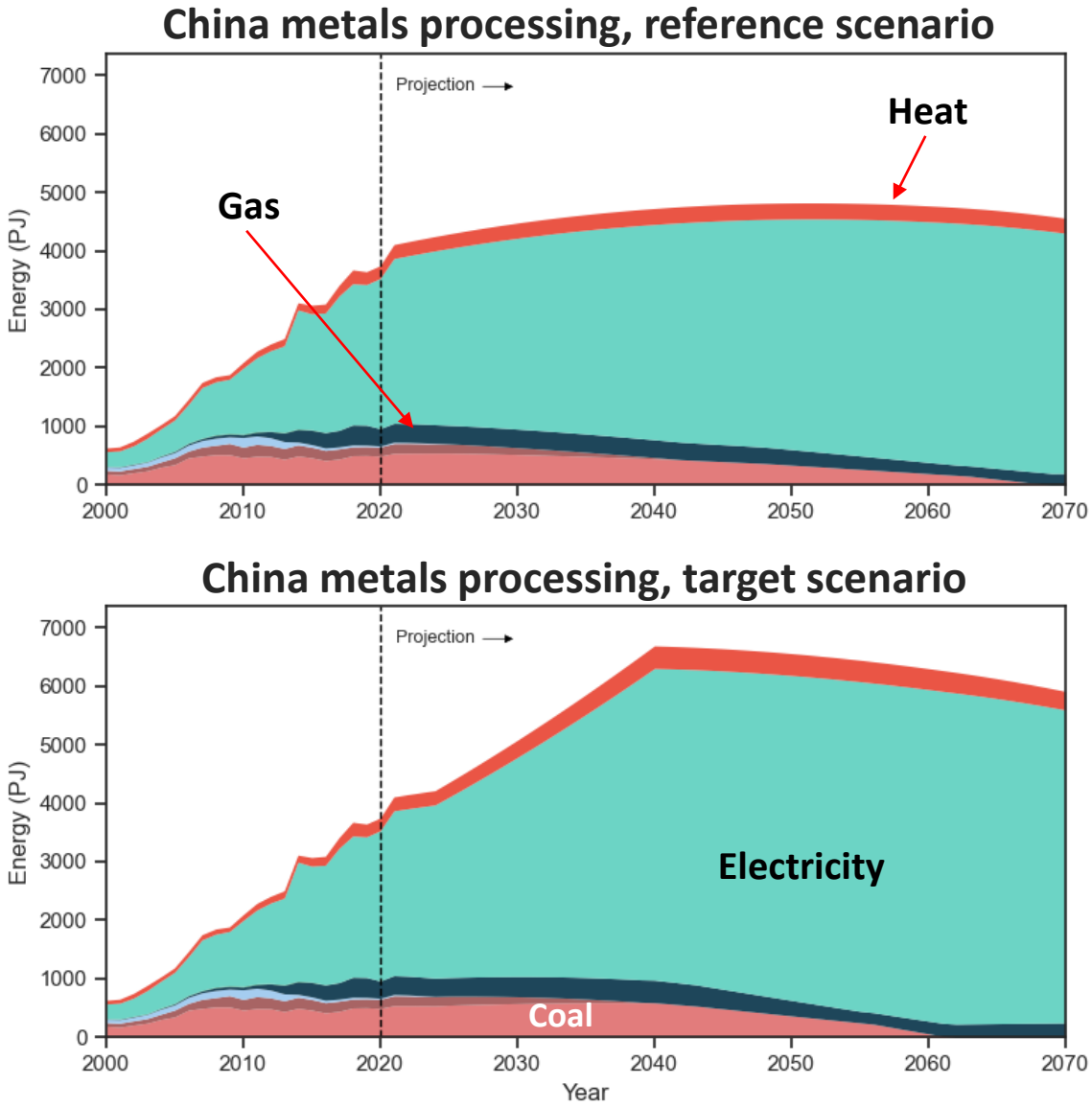
Target scenario – Decarbonisation leads to a significant increase in energy consumption in some sectors

- For many economies this will mean higher activity and energy consumption in:

1. Minerals mining

2. Non-ferrous metals

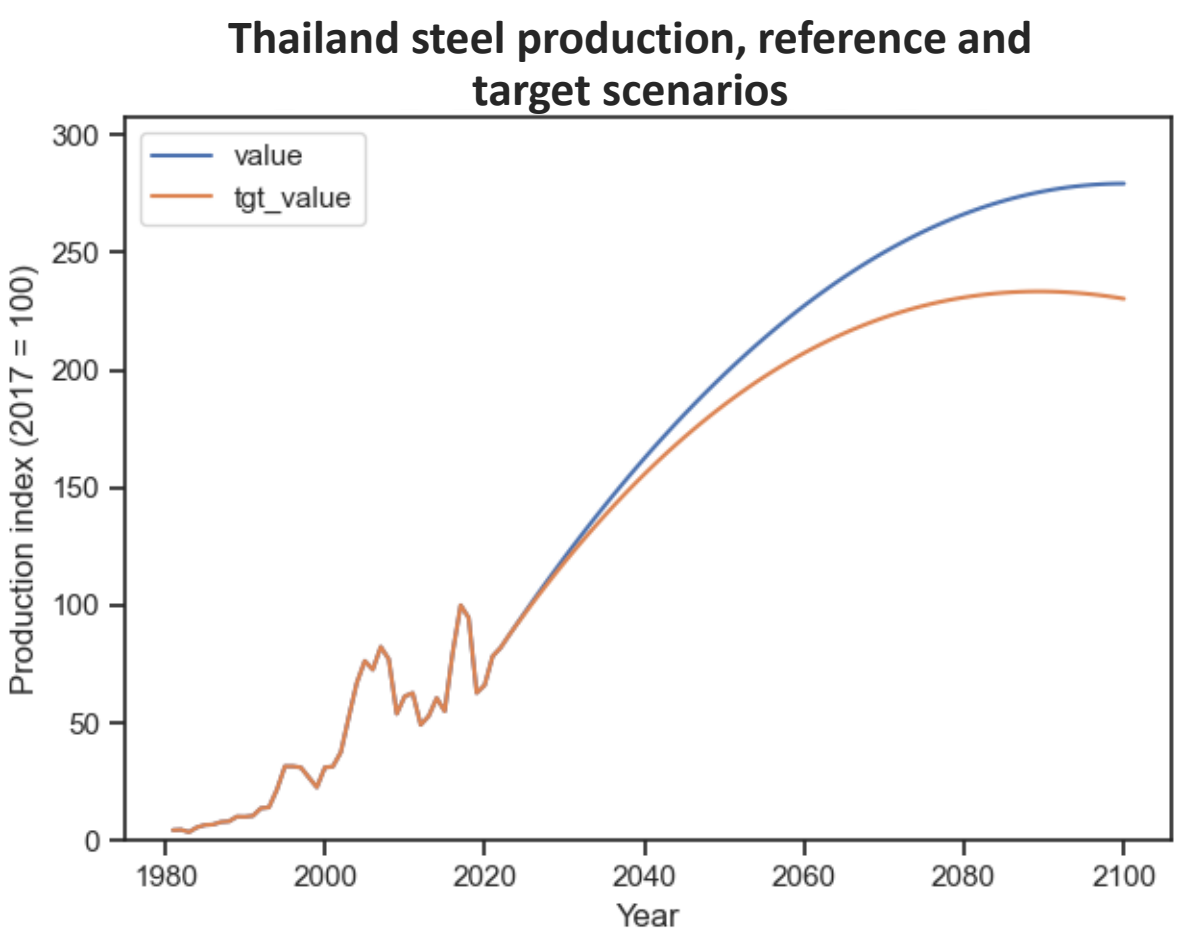
- This projection assumes that permitting, regulatory, investment, etc. challenges are resolved



Beyond increased industrial activity required for clean machines – How will industry decarbonise?

- Material efficiency
  - Innovation in end-uses of products
  - Recycling
- Energy efficiency
- Fuel switching and new production methods
  - Electrification
  - Coal to gas
  - Biomass
  - Hydrogen
- Carbon capture and storage (and/or utilization)

Material efficiency: Innovation and recycling contribute to lower production requirements

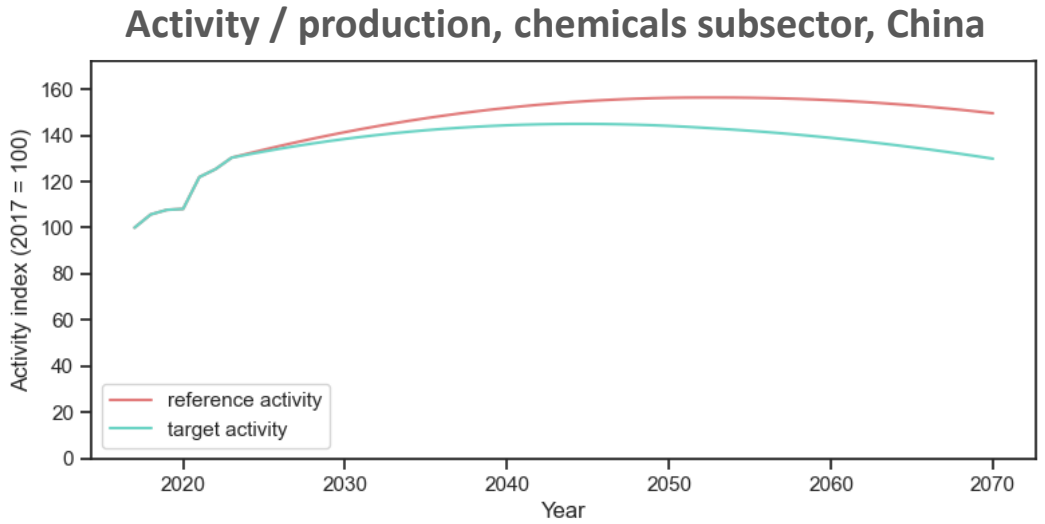


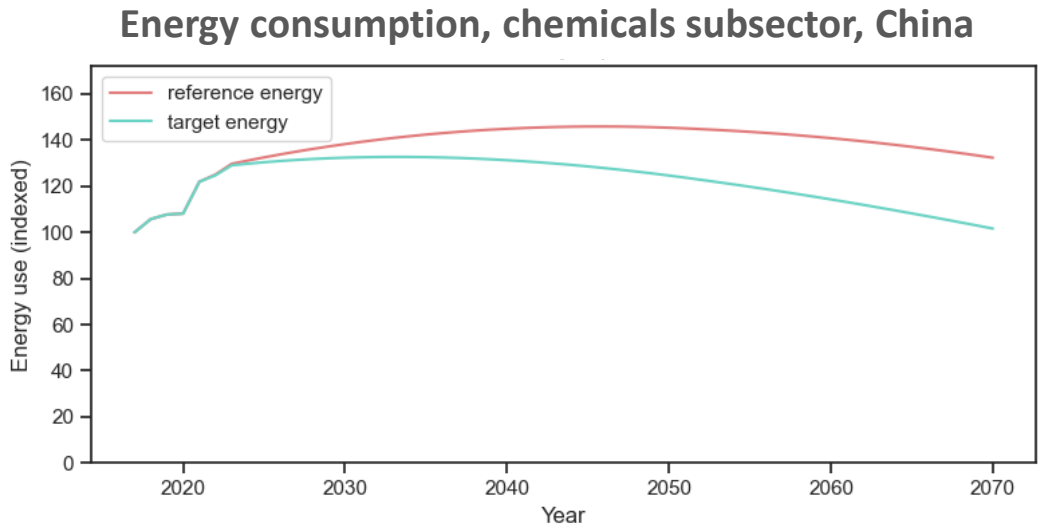
Part of the decarbonisation challenge can be solved by end-uses using less of the materials that heavy industry produces (particularly steel, cement, and chemicals)

- In addition to end-use innovation, less virgin production is required through greater rates of recycling

  → This approach is less viable for emerging economies with less existing infrastructure

Moving from activity to energy consumption: energy efficiency





- The upper chart shows activity/production. The lower trajectory in the **target scenario** is due to material efficiency

→ Energy intensity assumptions convert these activity trajectories into energy consumption trajectories (lower chart)

- Historical trends inform the energy efficiency estimates and is the basis for our **reference scenario**

- Best available technologies and economy context (e.g. current installed capacity) determine realistic energy intensity improvements that can be achieved in the **target scenario**

The challenges and opportunities for fuel switching – shouldering the burden that efficiency cannot bear

- For heavy industry there are **limits to fuel switching** with current best available technologies

  → Coal to gas or to biomass or biomethane can play a role

- Innovation means **electrification** options will become increasingly available for a wider range of industrial applications

- Innovation will also likely bear fruit for **hydrogen**, primarily as a reduction agent in steel making, but also for co-firing in applications that require high heat

  → There are also pilot projects for co-firing burners with ammonia, potentially to a 100% mix rate

Electrification is feasible for applications in heavy industry

- Electrification is already feasible for industrial processes that require low to medium heat

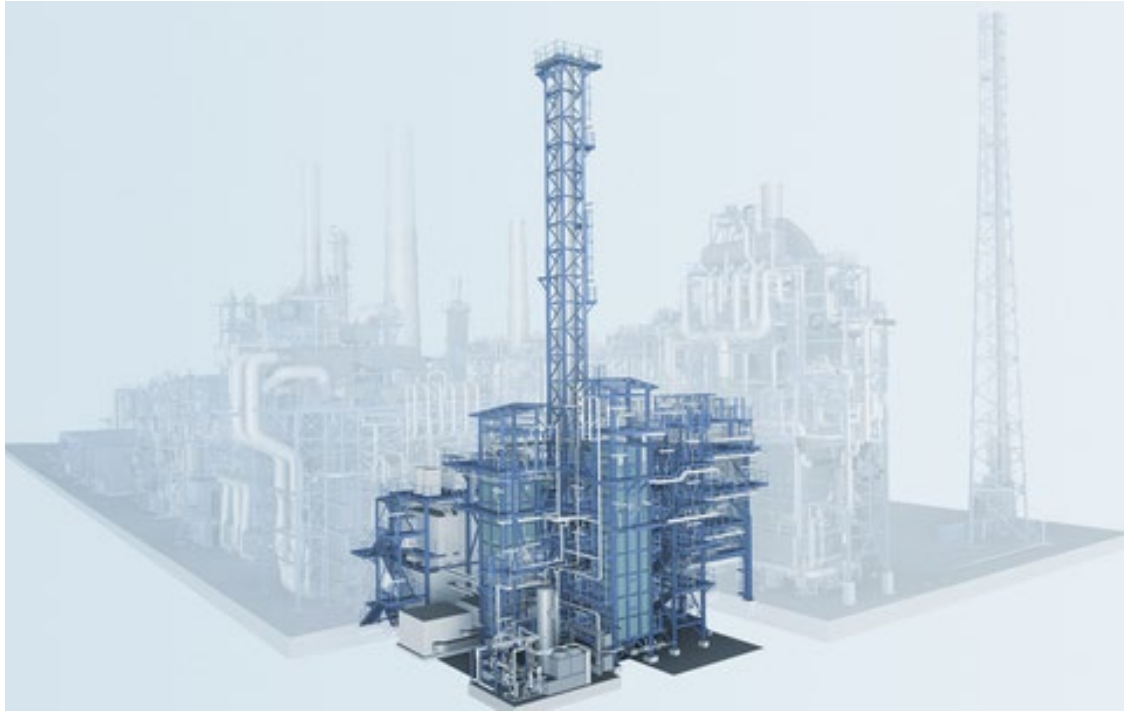
  → Electricity cost or policy support motivates or enables this switch

- There are multiple pilot projects for electrified steam crackers in Europe.

  → Ludwigshafen: World first demonstration plant

- Electrification of cement kilns is also technically possible

  → Roto Dynamic Heater (RDH) kiln in Europe



Innovation

The assumption that electricity cannot deliver high heat is being challenged

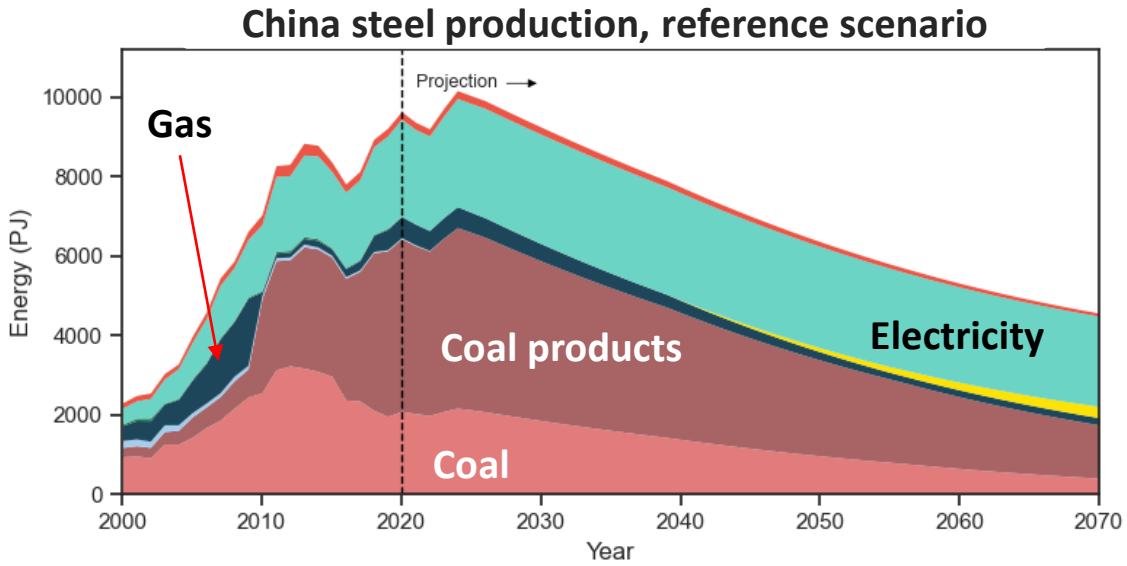
Hydrogen in the steel sector – An uncertain future

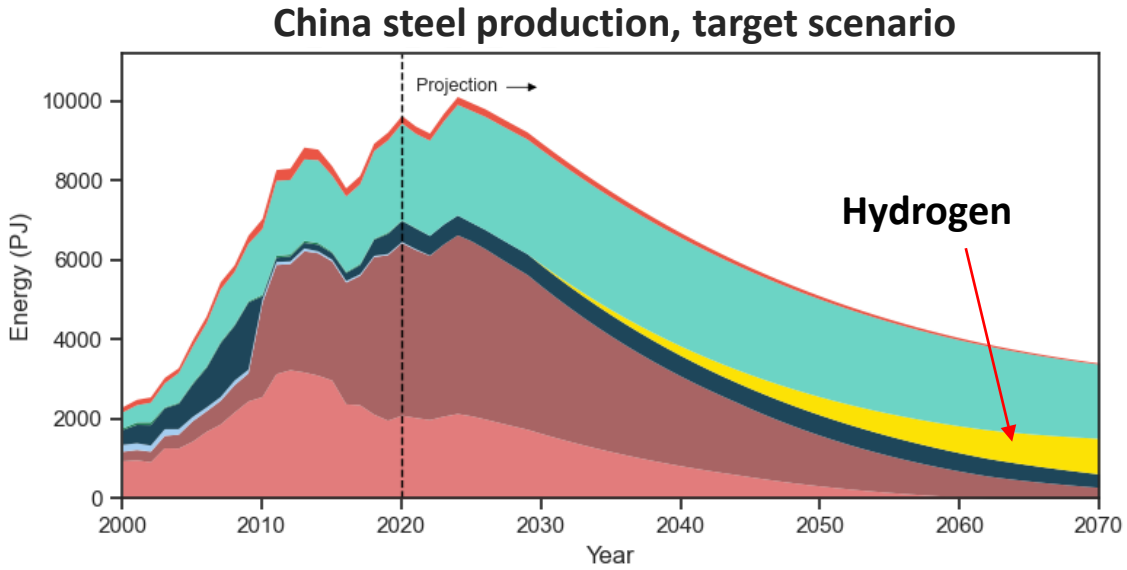
- Inherently uncertain future when it comes to hydrogen, especially for demand applications, like in steel making

- Optimistic scenario: hydrogen could begin to displace coking coal that is transformed into coke for steel making beginning in 2030 in certain economies (**target scenario**)

- These new steel plants could primarily run on hydrogen and electricity

  → Whether or not these new production modalities could replace recently built steel plants in Asia is very uncertain, particularly if hydrogen supply is limited





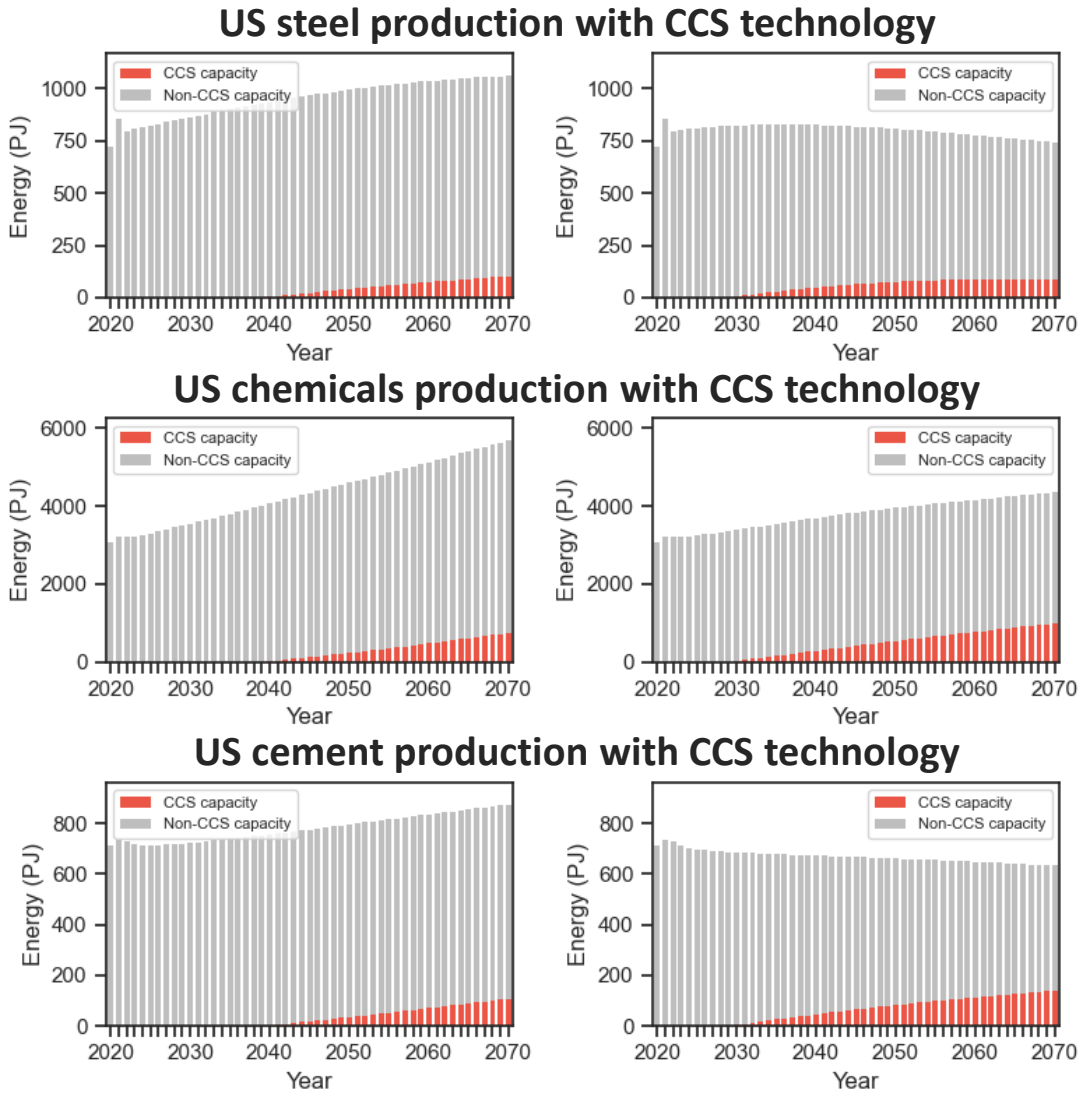
More uncertainty – The role of CCS in heavy industry

- There is no clear winning technology to decarbonise industry → All options are on the table

- Carbon capture technologies are a viable option in certain geographical locations

  →CCS makes the most sense for industrial facilities located closely to storage reservoirs and EOR fields

- CCS is assumed to play a larger role in chemicals and cement subsectors, beginning in the 2030s in certain economies, in the optimistic **target scenario**



A word about costs on the road to decarbonisation

- Certain decarbonisation options will almost always be more expensive, ignoring the influence of externalities
  - → CCS technologies
  - → Hydrogen based production modalities

- These expensive options will only be deployed with policy support
  - → Policy support is assumed to be highest in the 9th Outlook **target scenario**
  - → Current support offered via policies within the Inflation Reduction Act (US) and Green Transformation (Japan) is a taste of what is required

The challenge:

Meeting decarbonisation goals while achieving increased standards of living

Conclusions

- Industry is the hardest sector to decarbonise
- This is made more difficult in a decarbonisation world that requires increased critical minerals and critical materials
- Efficiencies will play an important role in decarbonisation
  - → Material (innovation and recycling)
  - → Energy efficiency
- Electrification of end-use applications shows promise throughout many subsectors
- Other fuel switching plays an important role too
  - → Available now: coal-to-gas or biomass and biomethane
  - → New uncertain production modalities: hydrogen (and fuel ammonia) applications
- For those applications most difficult to switch away from fossil fuels → CCS
- The 9th Outlook will show the relative importance of different decarbonisation options

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