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Renewable Energy for Industry

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Nordic Pavillion, COP23, Fidji - Bonn, 15 November 2017

IEA

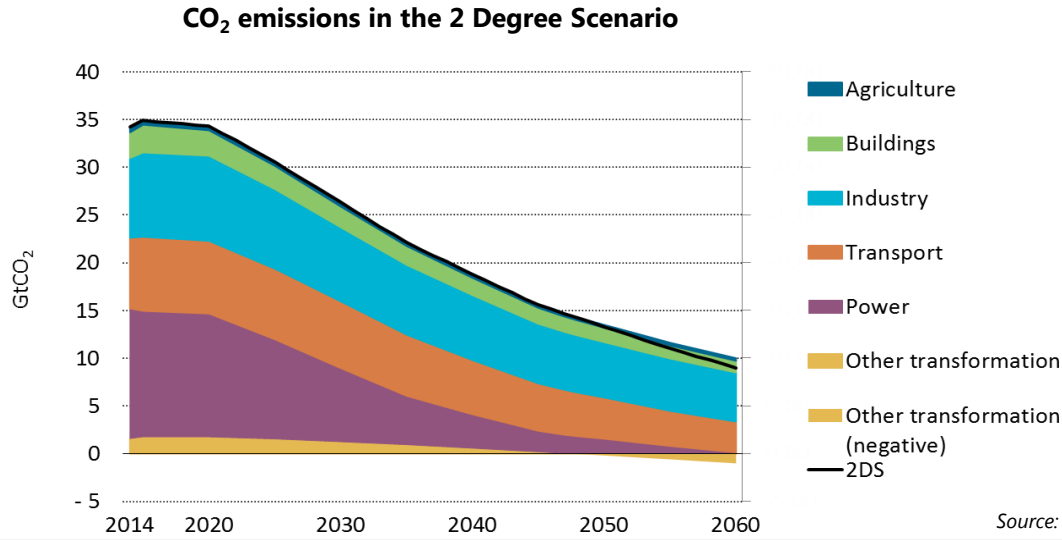
Thank you Minister……

Following the mandate from the 2015 ministerial, the IEA has made great progress in becoming a global clean energy hub, for instance, creating a new Energy Efficiency Division and a new Systems Integration of Renewables Unit; strengthening our Technology Collaboration Programmes; and building Association Partnerships with key countries like China, India, and Indonesia.

The IEA has also been proud of our long and extensive history of partnership with the CEM and its various initiatives since its formation, including the more recent decision by CEM countries to house the CEM Secretariat at IEA.

During this new phase of the CEM going forward focussed on ensuring strong and enduring multilateral leadership, the IEA looks forward to continuing to strengthen its ability to help the CEM and its Members. We eagerly look forward to further conversations on how we can strengthen our support for various initiatives, campaigns, and, more broadly, all CEM governments in their efforts to efficiently and securely transition to clean energy economies.

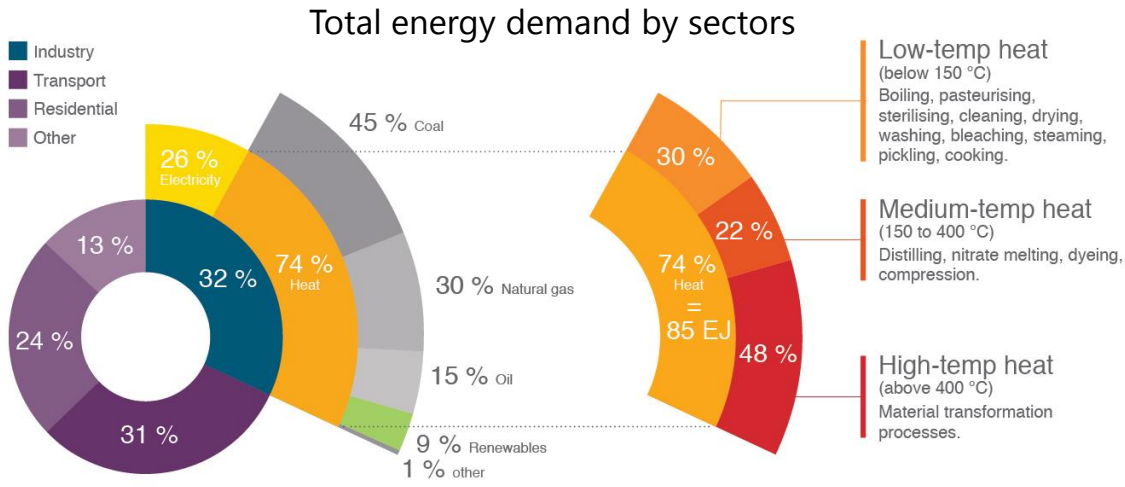
Industry represents a major issue for climate change



Source: ETP 2017

Cement, iron and steel, and chemicals responsible for the bulk of remaining industrial emissions in 2050.

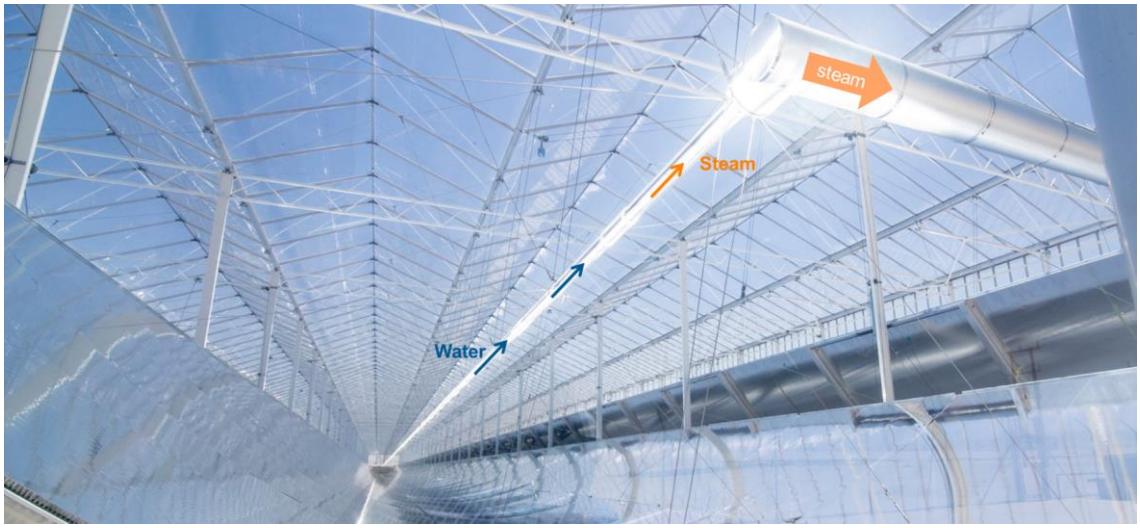
Industry remains dependent on fuel combustion for process heat



Source: Solrico, 2017

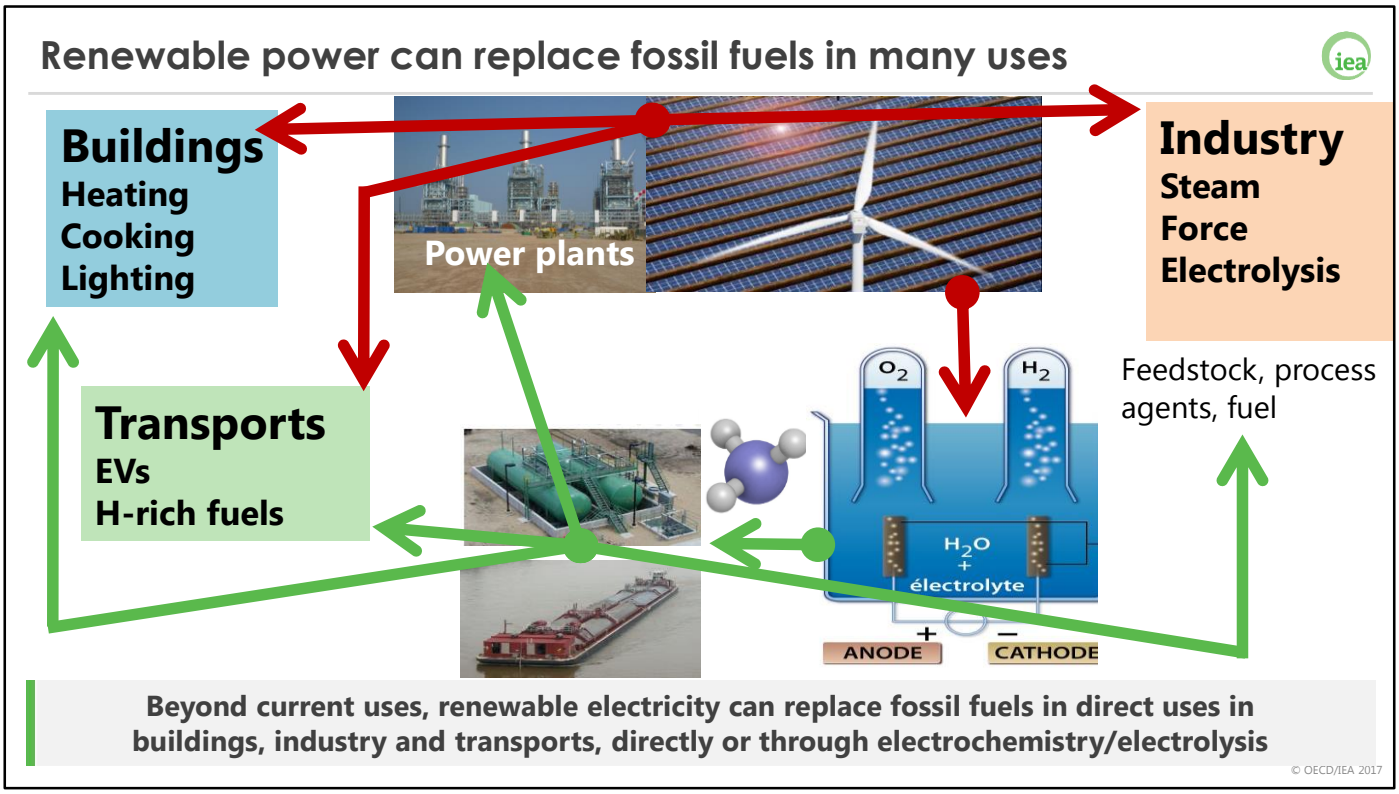
Heat represents three quarters of the energy demand of industries world-wide, and half of it is low to medium temperature heat, more easily supplied by direct renewable heat

Direct renewable heat is improving on various fronts



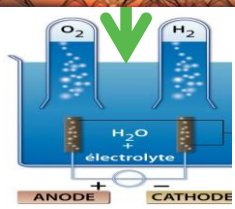
Source: Glasspoint, 2017

Enclosed troughs technology delivers significant improvements and cost reductions to solar heat, opening new applications such as enhanced oil recovery in Oman

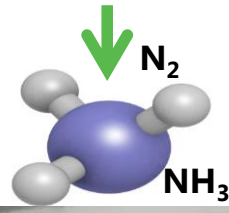


Red lines show electricity flows; green lines show flows of H-rich chemicals (with or without carbon extracted from air)

Ammonia precursor of fertilisers: a low-hanging fruit



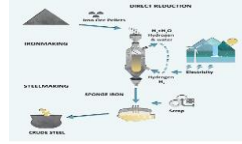
H_2



Precursor fertilizers industry

Process agent steel industry

Fuel



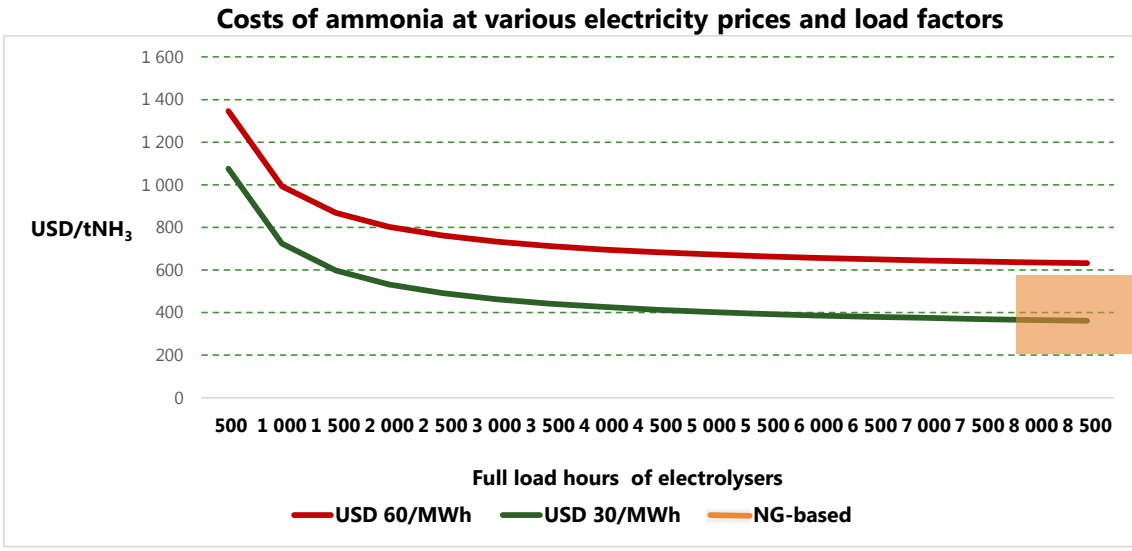
Ammonia may have multiple uses in industry as feedstock, process agent and fuel

Renewables-based electrolysis of water delivers oxygen and hydrogen, which can then be combined with nitrogen from the air to give ammonia (Haber-Bosch process).

Ammonia is one of the most wide-spread chemicals, easy to ship and store. It is a precursor for nitrogen fertilisers, a refrigerant, etc. But it could also be used in industry as a process agent or as a hydrogen-rich fuel.

Currently the world produces 180 t/y ammonia from natural gas reforming or coal gasification, entailing the emission of 420 Mt CO2/y.

Producing ammonia from cheap solar and wind

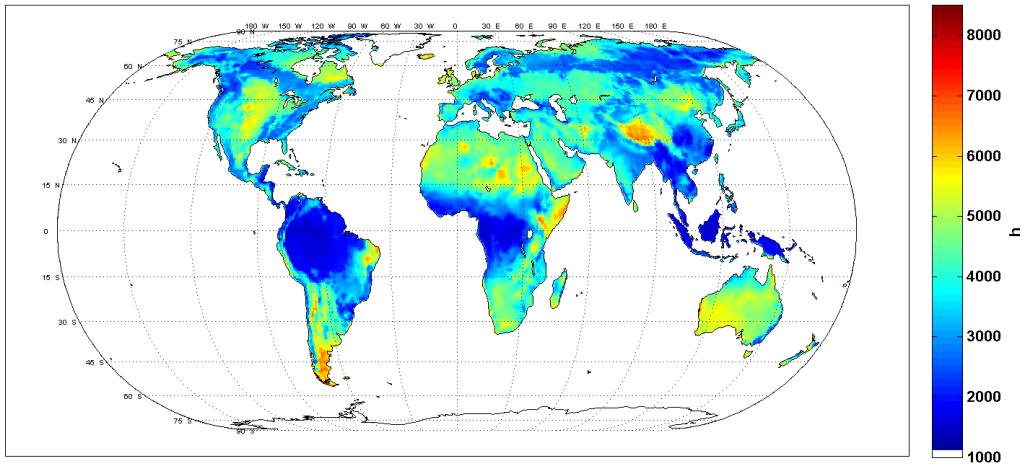


Assumptions: Capex electrolysers USD 450/kW; Capex, NH_3 plant USD 382 million 500,000 t/y; efficiency electrolysers 70%; WACC 7%, lifetime 30 years, Opex USD 14 to 37/tNH_3 (plus electricity).

At USD 30/MWh or less, and with high capacity factors, solar and wind power in best resources areas can now run all-electric ammonia plants at competitive costs.

The emergence of low-cost renewable power is a game-changer

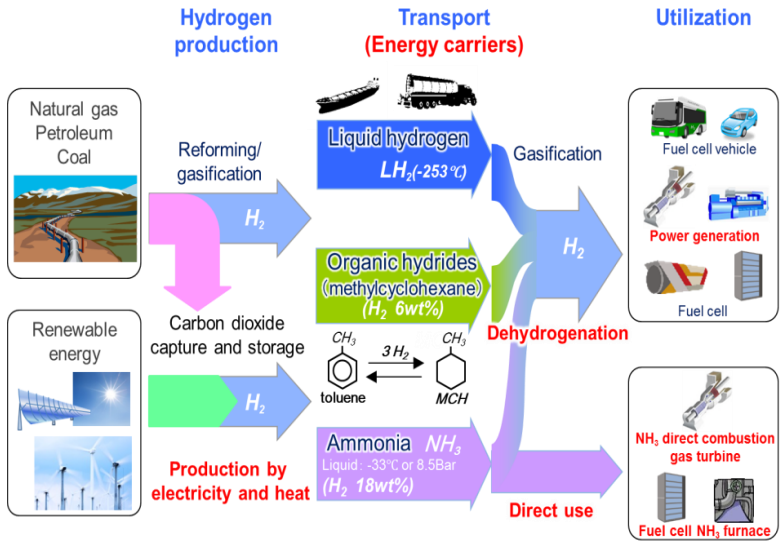
Hybrid solar and wind full load hours adjusted for overlap



Source: Fasihi & Breyer, 2017

Capacity factors of combined wind and power exceeds 50% in vast areas, often remote from large consumption centers, potentially delivering huge amounts of power at less than $30/MWh

Exploiting cheap RE will require massive trade



Source: Japan's Energy Carriers Program, 2017

Ammonia is rich in hydrogen, easy to store and ship, and may prove the most versatile carrier of renewable energy

Ammonia is also a fuel

- Works in combustion engines, turbines, fuel cells, directly/cracked
- 100-y safe handling in industry
- Stationary applications in power and industry sectors
- A possible fuel for boats, long-haul trucks, even lighter vehicles
- Power-to-power efficiency better than other fuels for long-term storage
  - Pumped-storage hydropower and batteries more efficient short-term storage options

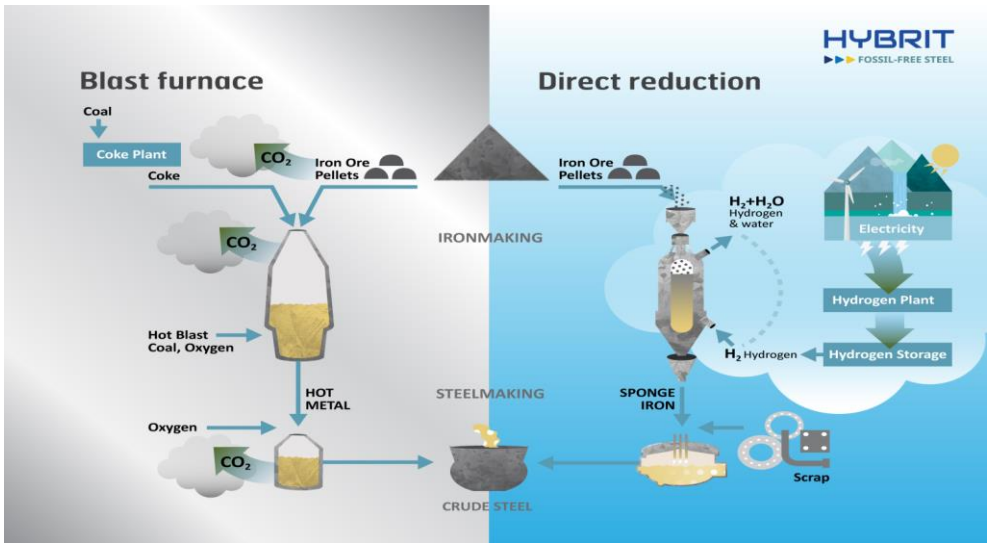
Power to power efficiency

Fuel	PtP efficiency CO_2 from air	PtP efficiency CO_2 from fumes
CH_4	27%	31%
MeOH	27%	32%
DME	23%	28%
NH_3	35%	
NH3 PEM	*29%*	
NH3 SOEC	*39%*	

Sources: Grinberg Dana et al, 2017

Ammonia can be used as a carbon-free fuel in various ways, which must be further developed

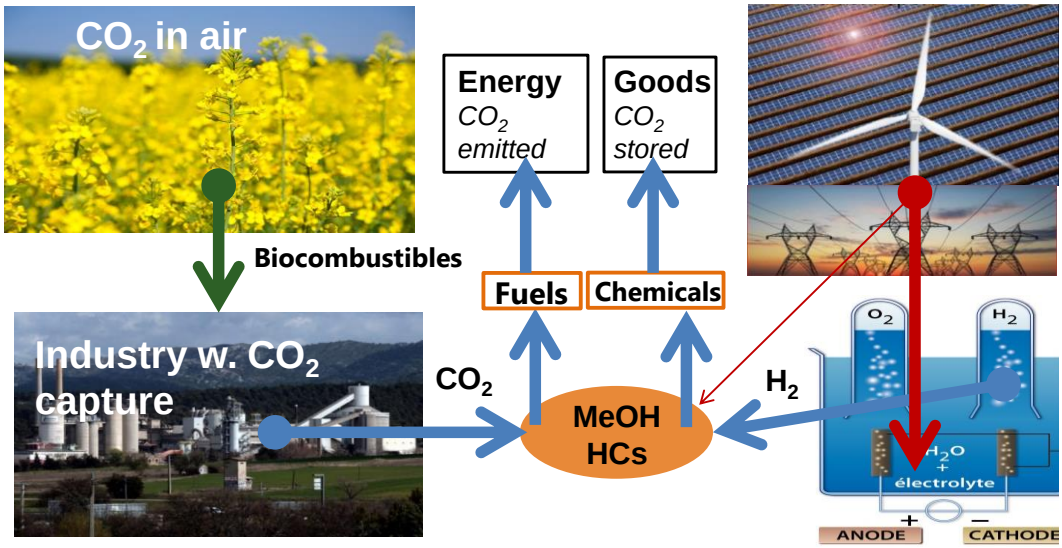
Renewable power can make CO_2-free iron and steel



Sources: Hybrit Projekt, 2017

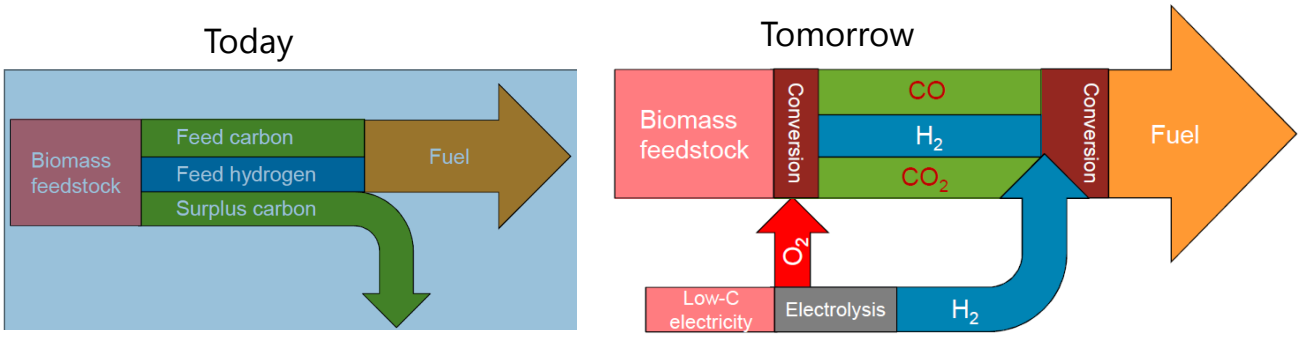
Substituting natural gas with renewable-based hydrogen for direct iron reduction may be phased in gradually and lead ultimately to CO_2-free iron and steelmaking

Renewable hydrogen can be combined with recycled CO_2



Manufacturing methanol from renewables-based water electrolysis and recycled CO_2 would strongly reduce life-cycle CO_2 emissions and could drive negative emissions

Multiplying the use of constrained biomass feedstock

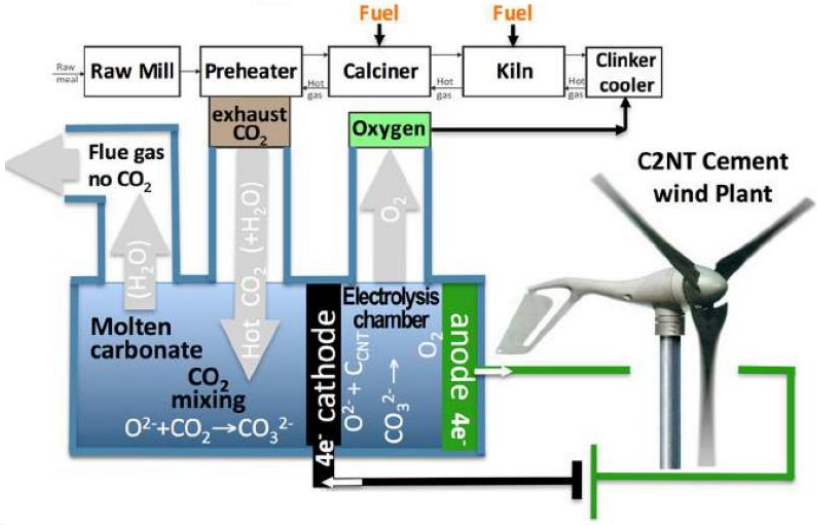


Source: Hannula, 2016

Using hydrogen and oxygen from renewable electricity can augment the potential of biomass in converting CO_2 into fuel

Electrolysis might allow for CO_2-free cement manufacturing

Concept scheme of co-production of cement and carbon nanotubes



Source: Stuart Licht, Journal of CO_2 utilization, 2017

Still at lab-scale, molten carbonate electrolysis run on solar and wind could be coupled with an oxyfuel cement factory and produce high-value carbon nanotubes instead of CO_2

Policy options

- De-risking investment is key – as always
- Carbon pricing would improve competitiveness
- Risks of carbon leakage for heavily-traded commodities
  - Global sectoral agreements?
  - Border carbon adjustments? Standards?
  - Reconsidering the carbon leakage issue and identifying win-win strategies will help fostering RE deployment in most favourable areas - and vice-versa
- Procurement of green materials could help jump-start deployment
  - Private procurement by Business-to-Consumer companies, public procurement for infrastructures

A new era of international collaboration is required to foster global decarbonisation of industry

Concluding remarks

- Industrial air pollutants and CO_2 emissions must be addressed
  - Renewable heat can increase its contribution but faces obstacles
- The recent rapid cost reduction of solar PV and wind power opens new possibilities for greening the industry
  - Directly with electricity
  - With hydrogen-rich chemicals, including ammonia, as feedstocks, process agents and fuels
- Electrification of industry can help integrate variable renewables.
- RE for industry creates new Terawatt-scale market opportunities for PV and wind
  - International collaboration should facilitate new forms of international energy trade

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Let me highlight a few concluding points.

- Renewables are going to dominate global electricity growth, accounting for two thirds of total net additions in the global power mix by 2022.
We see renewables growing by about 1,000 GW by 2022. That equals around half of the current total global capacity in coal power, which took 80 years to build.

- By 2022, renewable electricity generation will surpass 8000 TWh, i.e equal to current total electricity consumption of China, India, and Germany combined. The growth in renewable generation will be twice as large as that of gas and coal combined.

- **What we are witnessing is the birth of a new era in solar PV**. We expect solar PV capacity growth to be higher than onshore wind and hydro combined in the next six years. This trend is determined by China, which dominates both global cell manufacturing and demand. But India is also entering in the center stage.

- Renewables also contribute to a cleaner transport sector, supplying 30% of consumption of electric vehicles by 2022. But despite surging EVs and growing biofuels, the overall share of renewables in road transport energy consumption will only expand marginally up to 5%. The decarbonisation of transport remains a major challenge and will require a complementary role of both EVs (mainly in cities) and biofuels in long haul transport and aviation.

- The IEA envisages that advanced biofuels (based on non-edible feedstocks to avoid the food-vs-fuel dilemma) will play a significant role to achieve long-term decarbonisation of transport.
  This will however require more policy focus, including specific incentives to bolster their deployment and cost reductions

- For now, the success of renewables remains limited to wind and solar, which together represent more than 80% of total capacity expansion. In many countries market design and policy frameworks will need to evolve to address the challenge of system integration of variable renewables.

- Much more needs to done beyond the power sector. Today, electricity accounts for just a fifth of total world final energy demand. The next chapter in the rise of renewables will require multiplying their uses in the building, industry and transport sectors.

- The IEA continues working in all these areas to provide data, analysis and guidance for best policy practice.
  Good policies have been and will remain the basis for renewables deployment in the years to come.