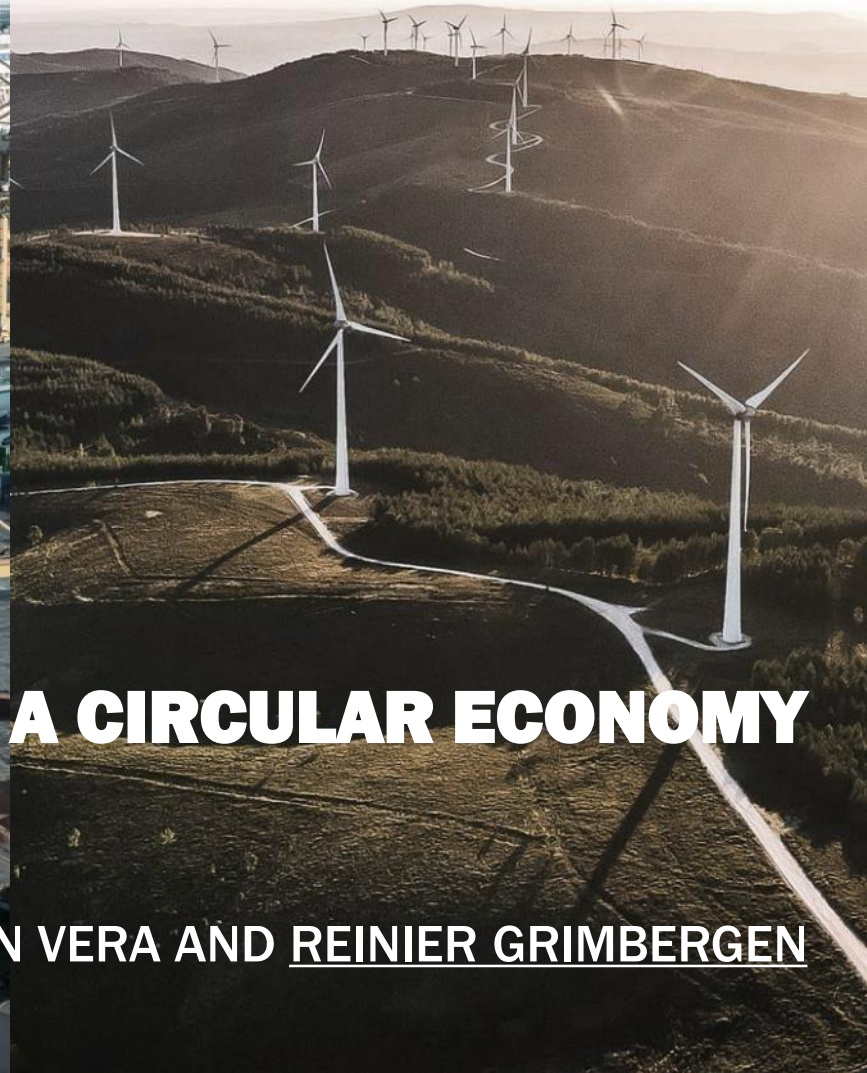




TNO innovation
for life



ANDI | MÁS PAÍS
12ª Colombia Genera 2023
Sector Minero-energético
El camino hacia la transición energética



› **HOW THE ENERGY TRANSITION WILL ENABLE A CIRCULAR ECONOMY**

IVAN VERA AND REINIER GRIMBERGEN

INTRODUCTION TO TNO

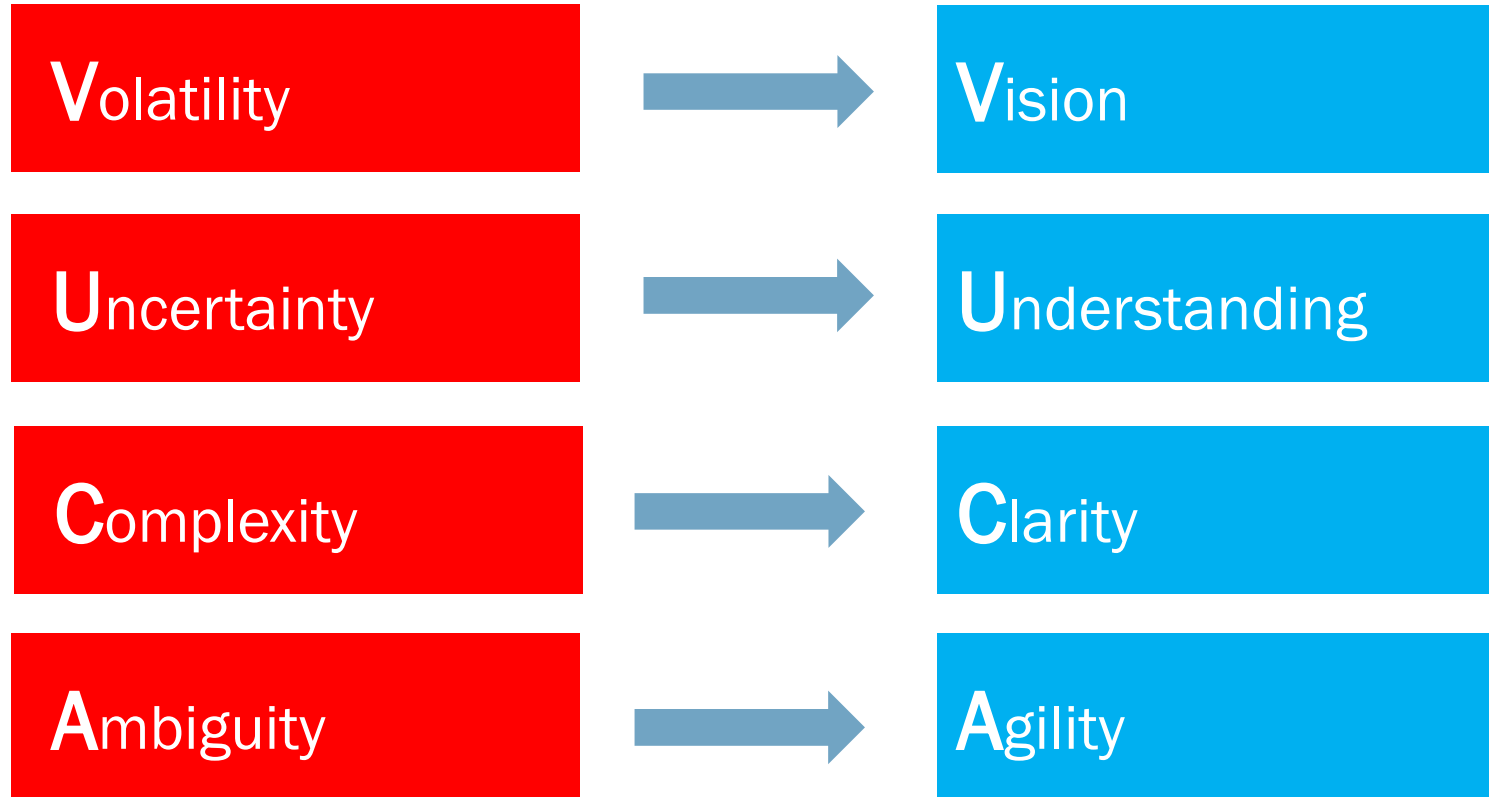
AN INDEPENDENT NON-PROFIT APPLIED TECHNOLOGY AND RESEARCH ORGANISATION

We are TNO. Since 1932, it has been our mission to give the right answers – and to ask the right questions. This is how we work for welfare and prosperity. For the world of today and tomorrow. By combining disciplines and domains, we can tackle the most complex questions. On the road to a better life and a brighter future.



WE LIVE IN VUCA TIMES...

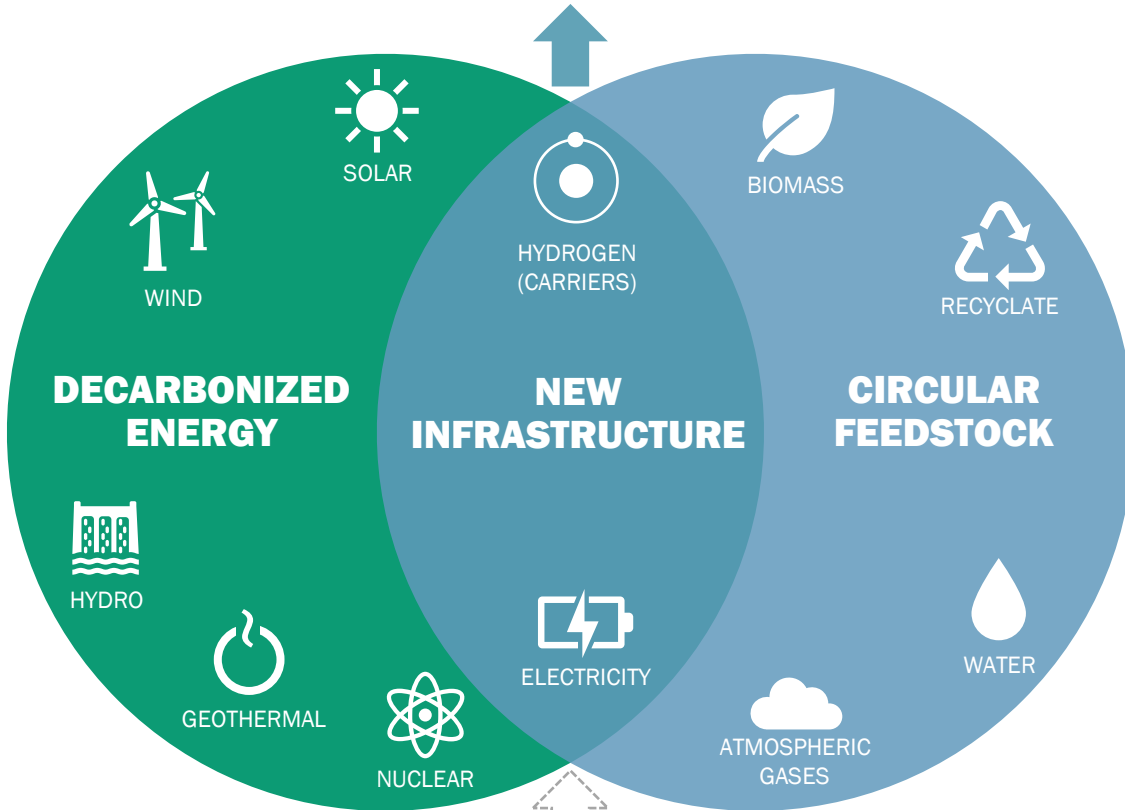
OUR AMBITION FOR TODAY



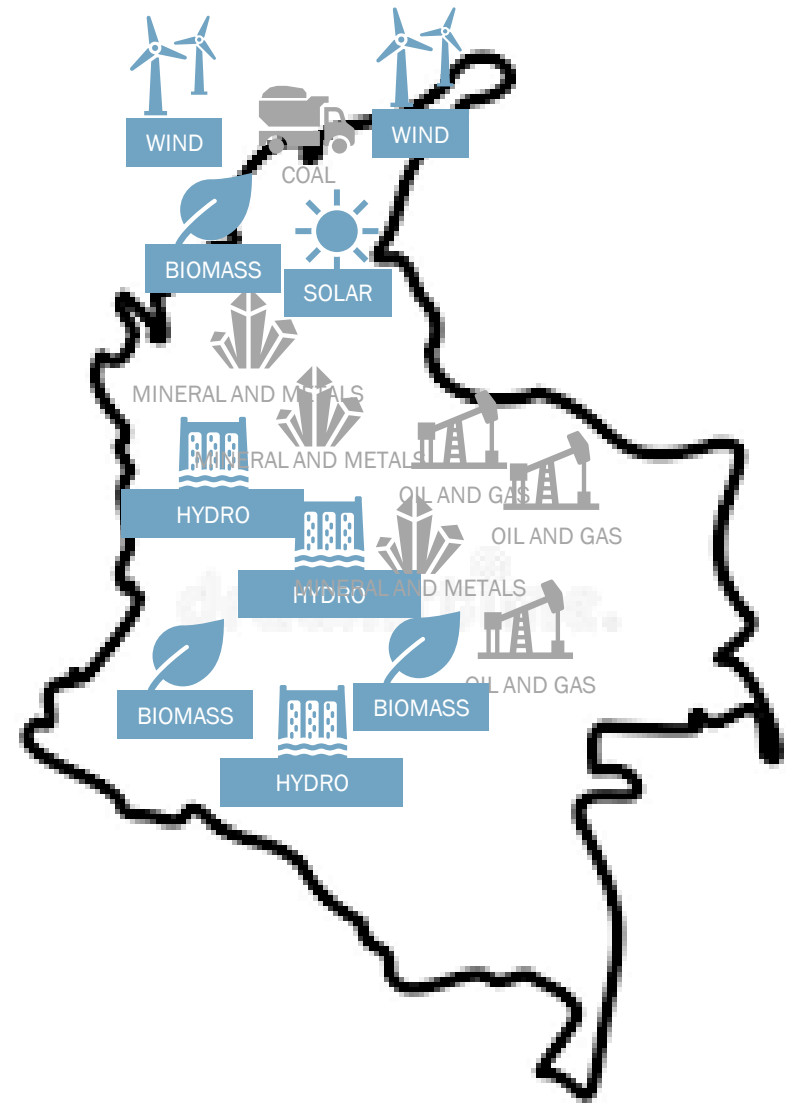
THE ENERGY- AND FEEDSTOCK TRANSITION

A SYSTEMIC INDUSTRIAL TRANSFORMATION IN COLOMBIA

- MEDICINE
- BUILDING
- ELECTRONICS
- AGRICULTURE
- TRANSPORT
- PACKAGING



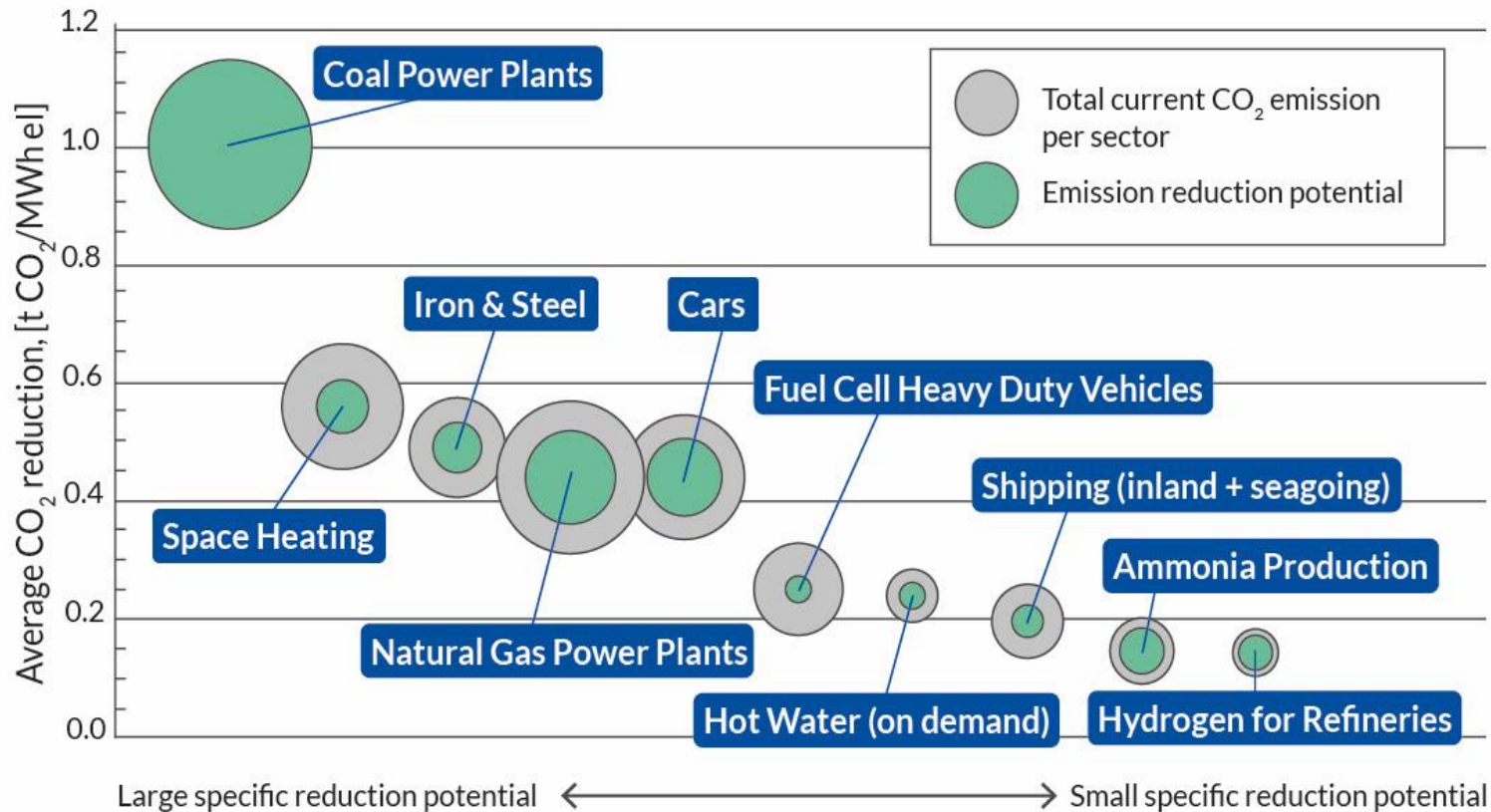
- COAL
- OIL AND GAS
- MINERAL AND METALS



LOW EMISSION ELECTRICITY AND DECARBONIZATION

DIRECT ELECTRIFICATION YIELDS THE HIGHEST EMISSION REDUCTION POTENTIAL

EMISSION REDUCTION BY GREEN ELECTRICITY IN THE NETHERLANDS



MERIT ORDER OF ELECTRIFICATION

- 1 FOSSIL POWER GENERATION**
- 2 SPACE HEATING (HEAT PUMPS)**
- 3 IRON & STEEL (H-DRI)**
- 4 PASSENGER VEHICLES (BEV)**

48% reduction emission in 2030 requires **135 TWh/yr (15.5 GW)** green electricity.

GREEN HYDROGEN WILL START TO CONTRIBUTE SUBSTANTIALLY BEYOND 2030

NEW INFRASTRUCTURE : HYDROGEN IN COLOMBIA BY 2030

WILL A TOP-DOWN APPROACH SUFFICE AND IS H₂ EVERYWHERE THE BEST DECARBONIZATION OPTION?

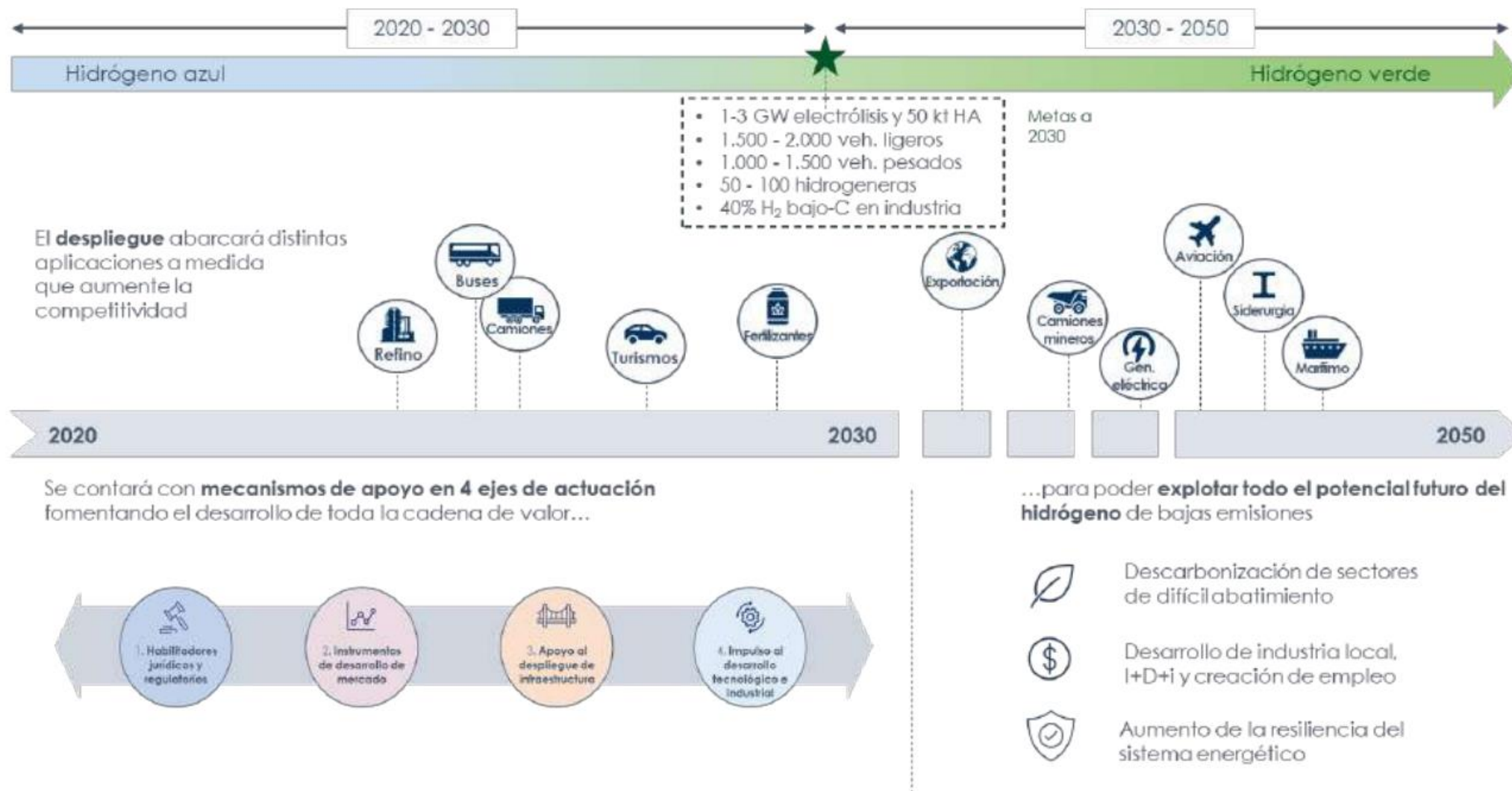
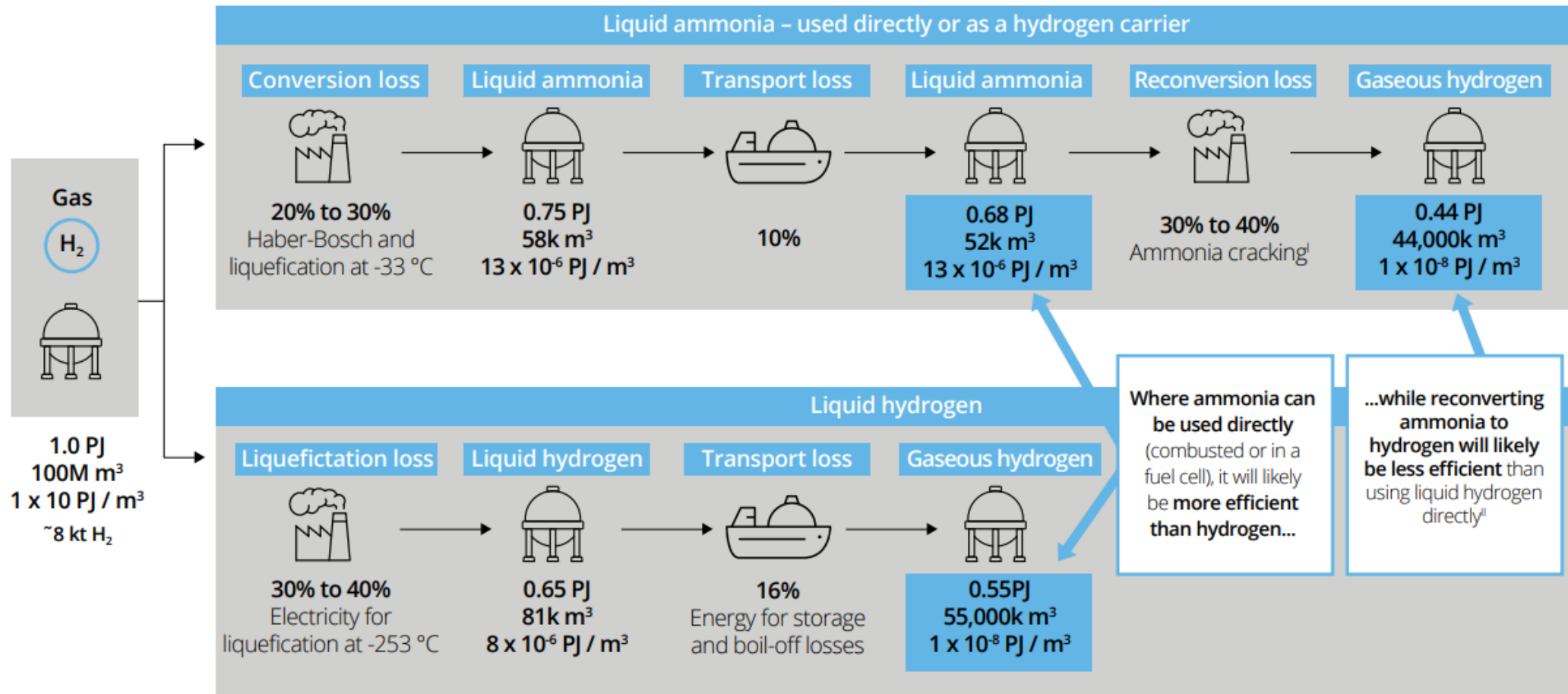


Figura 16: Estrategia nacional a 2050 en materia de hidrógeno de bajas emisiones

CIRCULAR FEEDSTOCKS AND HYDROGEN - AMMONIA

LOW EMISSION AMMONIA IS A NO-REGRET OPTION FOR LOCAL FERTILIZER PRODUCTION AND H2 EXPORT



LOW EMISSION AMMONIA IS A RELATIVELY EFFICIENT HYDROGEN CARRIER FOR EXPORT

CIRCULAR FEEDSTOCKS AND HYDROGEN - AMMONIA

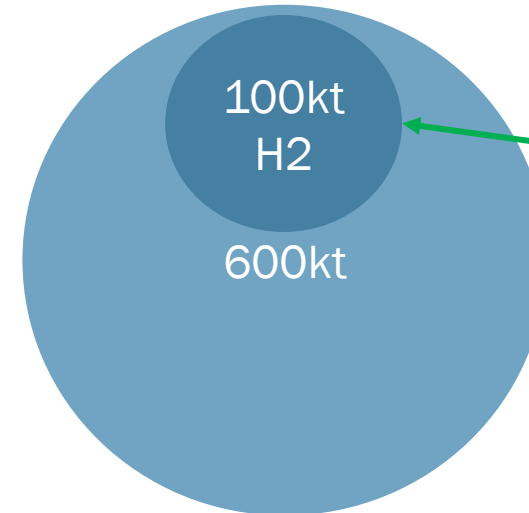
NO-REGRET OPTION TO ENABLE LOCAL FERTILIZER PRODUCTION AND START A H₂ EXPORT BUSINESS

Colombia urea imports



- Dependence on import
- low costs

“Industrial ammonia plantsize”



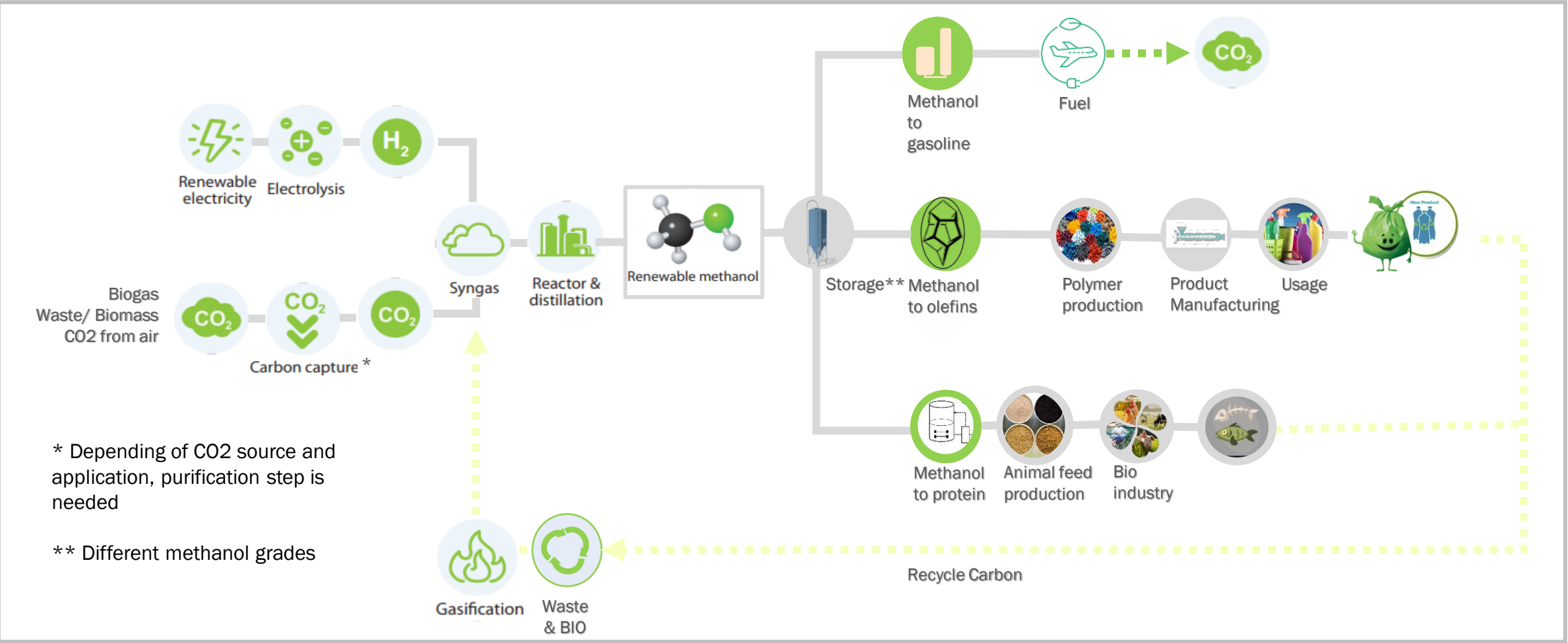
5 TWh Green electricity
= 1.1 GW installed
offshore Wind

- More resilience
- Export business opportunity
- Lower systemic emissions
- Higher costs
- Blue ammonia (from blue hydrogen)
economically viable at the short term

GLOBAL MARKET IS 185 MTON (0.36 GTON CO₂), MID-LONG TERM MARKET POTENTIAL >1000MTON

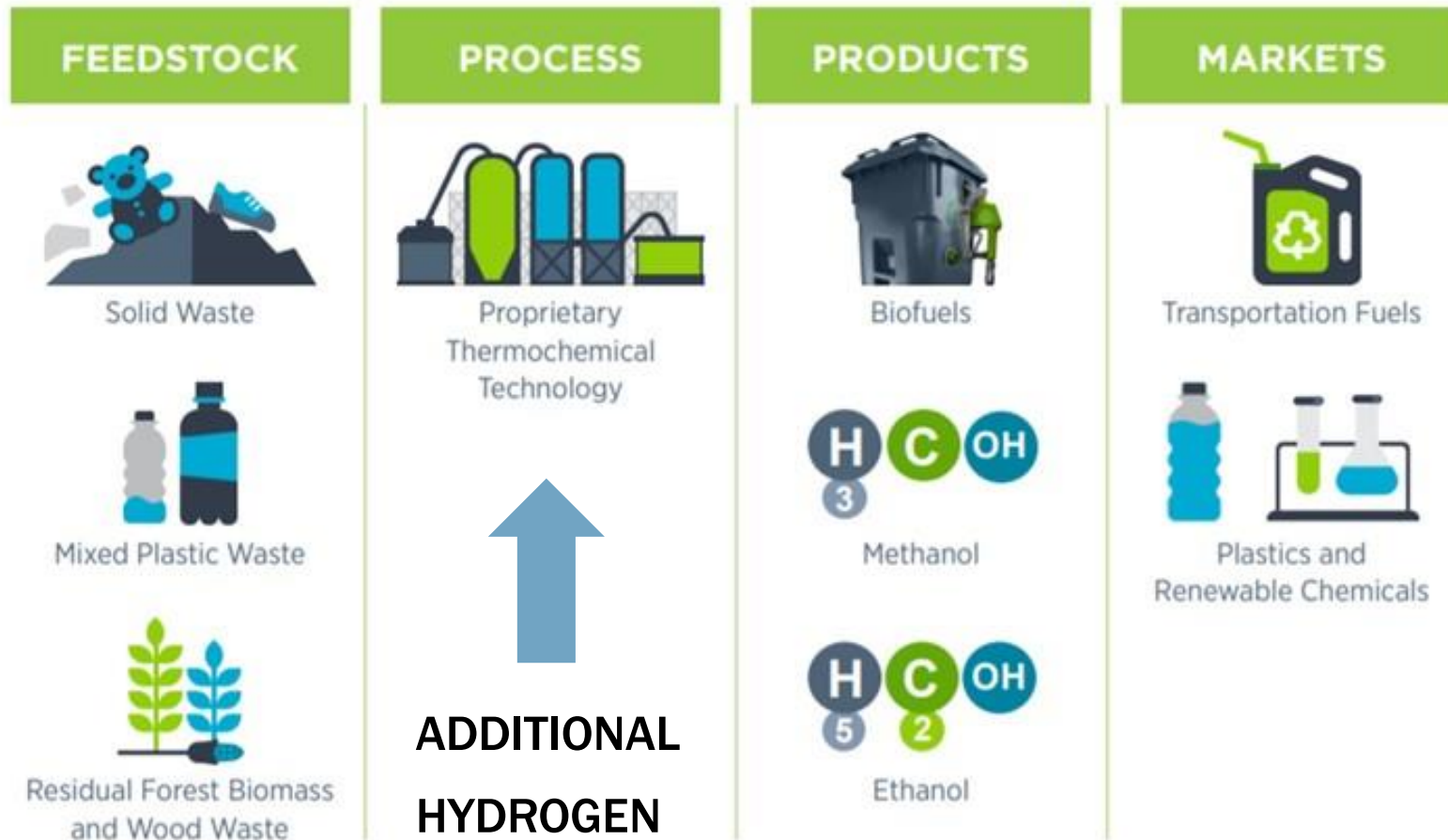
CIRCULAR FEEDSTOCKS AND HYDROGEN - METHANOL

LOW EMISSION METHANOL IS A NO-REGRET OPTION FOR THE CHEMICALS, FUELS AND FOOD INDUSTRY



CIRCULAR FEEDSTOCKS AND HYDROGEN - METHANOL

BIO-METHANOL AS AN OPPORTUNITY FOR COLOMBIA – HYDROGEN ADDITION INCREASES THE YIELD



Indicative figures for a biomass gasification plant + electrolyzer:

- *Feed 400 kton biomass*
- *250MW electrolyzer*
- *Product: 400kton Methanol*
- *CAPEX 1 Bn US\$*

GLOBAL MARKET IS 100 MTON, MID-LONG TERM MARKET POTENTIAL >400MTON

THE ELEPHANT IN THE ROOM



WITHOUT REGULATIONS AND INCENTIVES BUSINESS CASES ARE NOT POSITIVE (YET)

KEY TAKE-AWAYS

FOR THE ENERGY TRANSITION IN COLOMBIA



The energy transition can enable the development of a circular economy



Risks and opportunities for the Colombian Industry:

Decarbonized energy (Energy Transition):

- Electrify as many processes as possible
- Secure access to decarbonized electricity and energy
- Secure local production of low emission (Blue and Green) hydrogen

New infrastructure:

- Blue and green hydrogen production and conversion to methanol and ammonia
- Electricity transport and storage

Circular feedstock (Circular Economy):

- Transition from a fossil to circular carbon feedstocks such as plastic recylate, biomass or CO₂
- Renewable methanol and ammonia will have to become the new oil and gas



The Colombian Industry can deliver low carbon products both for local consumption (to reduce imports and increase resilience) and for export when supported by regulatory framework and incentives to compensate for the (yet) unviable business case to invest.

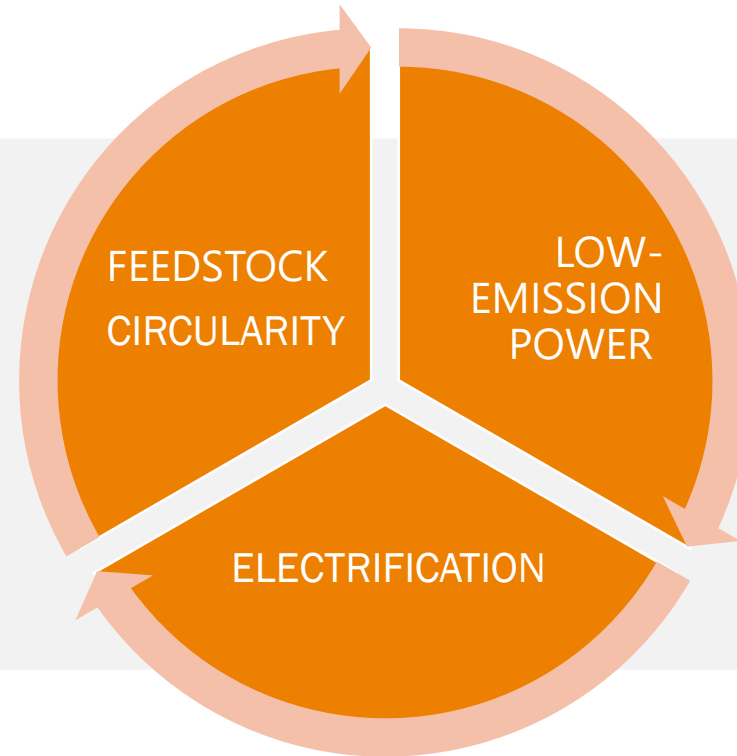
WHERE CAN TNO SUPPORT?

WE FACILITATE TRANSITIONS IN COLLABORATION WITH OUR CLIENTS

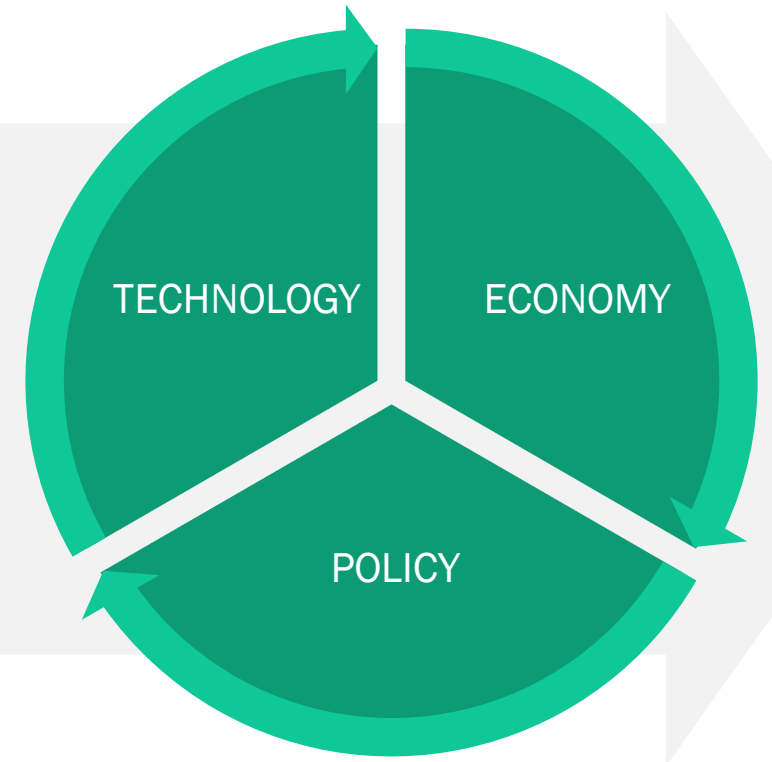
WHY



HOW



WHAT



WHERE CAN TNO SUPPORT?

WE ALREADY STARTED THIS WEEK IN COLOMBIA...A BIG THANKS TO (IN ORDER OF APPEARANCE):



- ANDI
- THE DUTCH EMBASSY
- THE MINISTRY OF BUSINESS DEVELOPMENT

- THE MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION
- PROMIGAS



› **THANKS FOR YOUR ATTENTION**

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