Is Renewable Energy Sustainable? Potential relationships between renewable energy production and the Sustainable Development Goals

Presenter: Jing Tian

Supervisors:

Professor Holger Maier

Dr Sam Culley

Dr Aaron Zecchin

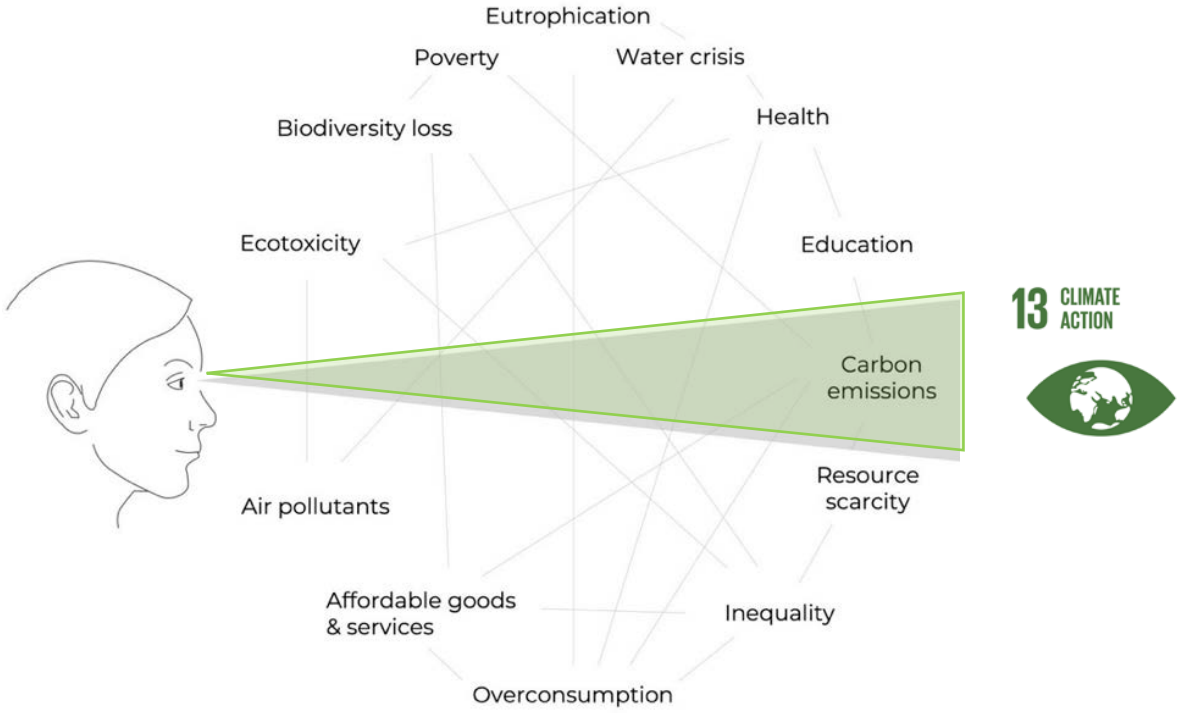
The use of renewables is critical for achieving net zero carbon emissions

Image source: Google Earth

400MW Solar Power Plant, Bhadla

- Clean Energy Generation: Utilizes solar power to feed the national grid.
- Annual Production: Estimated at 732,874 MWh.
- Environmental Impact: Reduces ~694,471 tCO2e emissions annually.

By focusing on net zero, we are at risk of ignoring broader sustainability outcomes



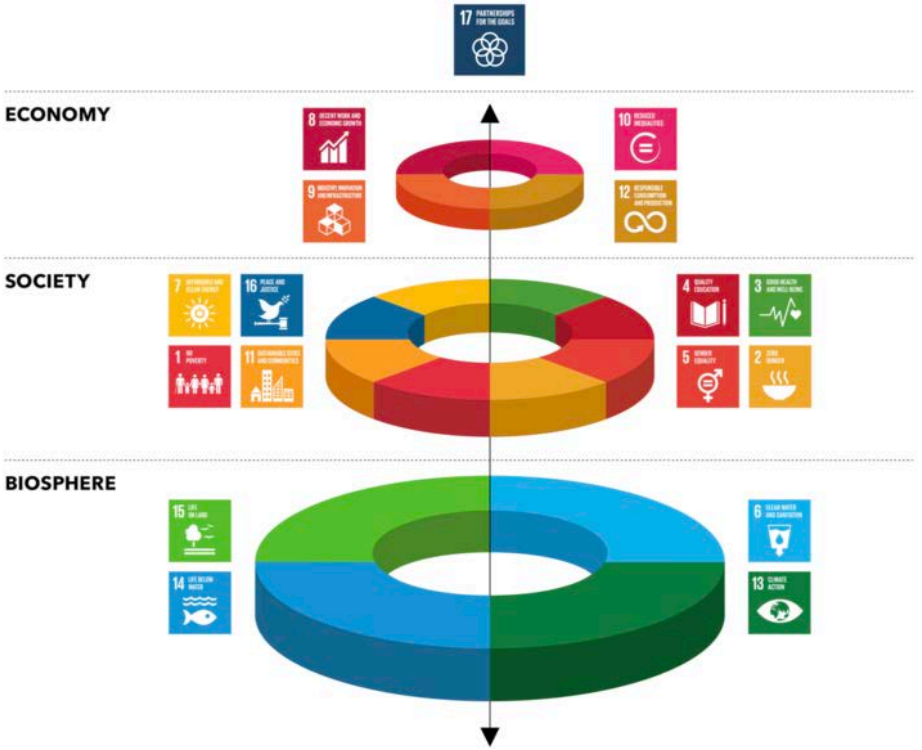
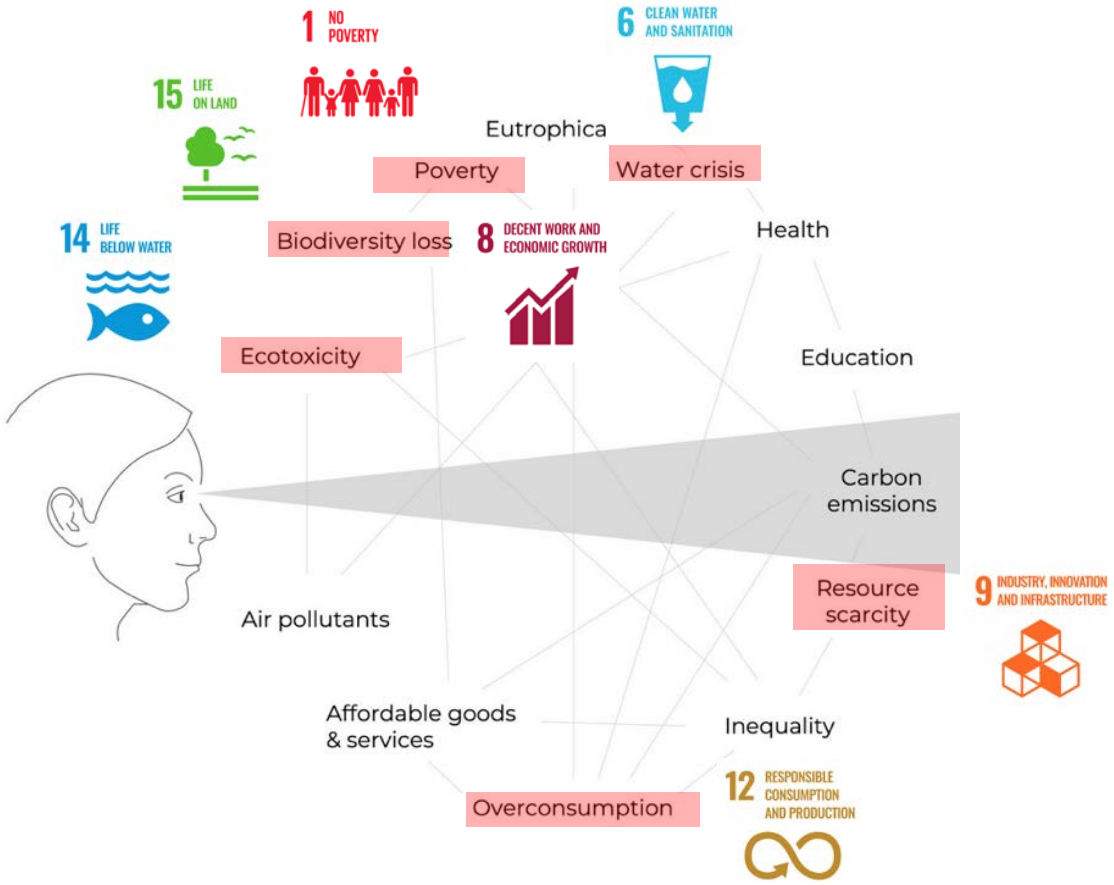


Image source: Pelc, R. & Fujita, R. M. Renewable energy from the ocean. Marine Policy 26, 471-479 (2002).

Source: Stockholm Resilience Centre (2016)

By focusing on net zero, we are at risk of ignoring broader sustainability outcomes



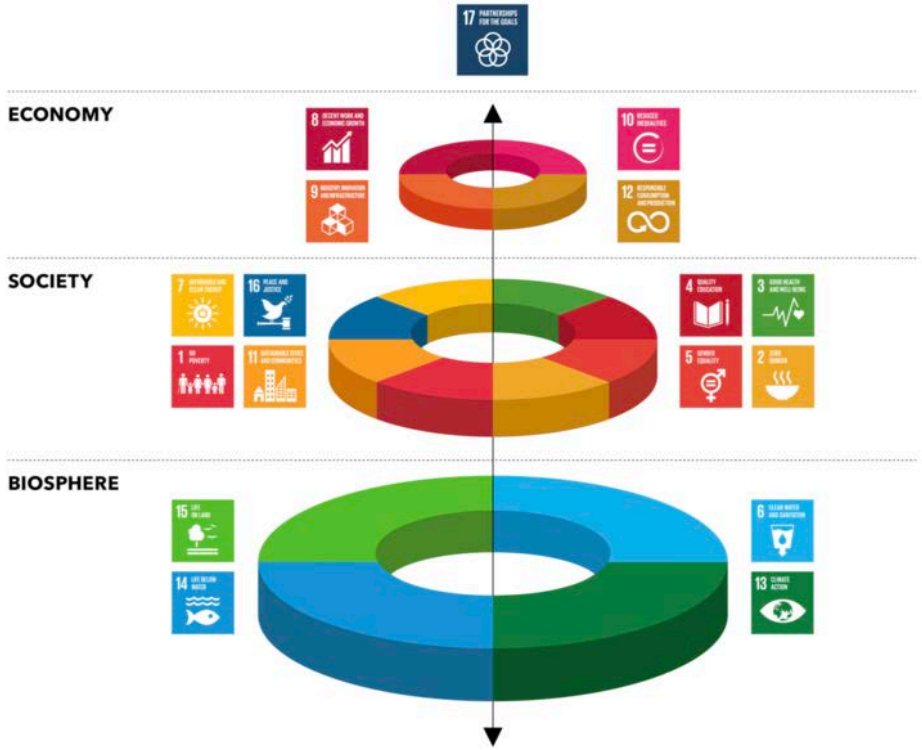


Image source: Pelc, R. & Fujita, R. M. Renewable energy from the ocean. Marine Policy 26, 471-479 (2002).

Source: Stockholm Resilience Centre (2016)

By focusing on net zero, we are at risk of ignoring broader sustainability outcomes

Net zero ≠? Sustainability

To assess the sustainability of renewables, we need to look at the entire renewable energy production process

Input → **Process** → **Output**

Storage

- Biomass: Tanks/Fuel cell
- Geothermal: Battery/ Fluid
- Solar: Battery/ Fuel cell
- Wind: Battery / Fuel cell
- Hydropower: Pumped hydro
- Wave & Tidal: Battery / Flywheel energy storage

S T

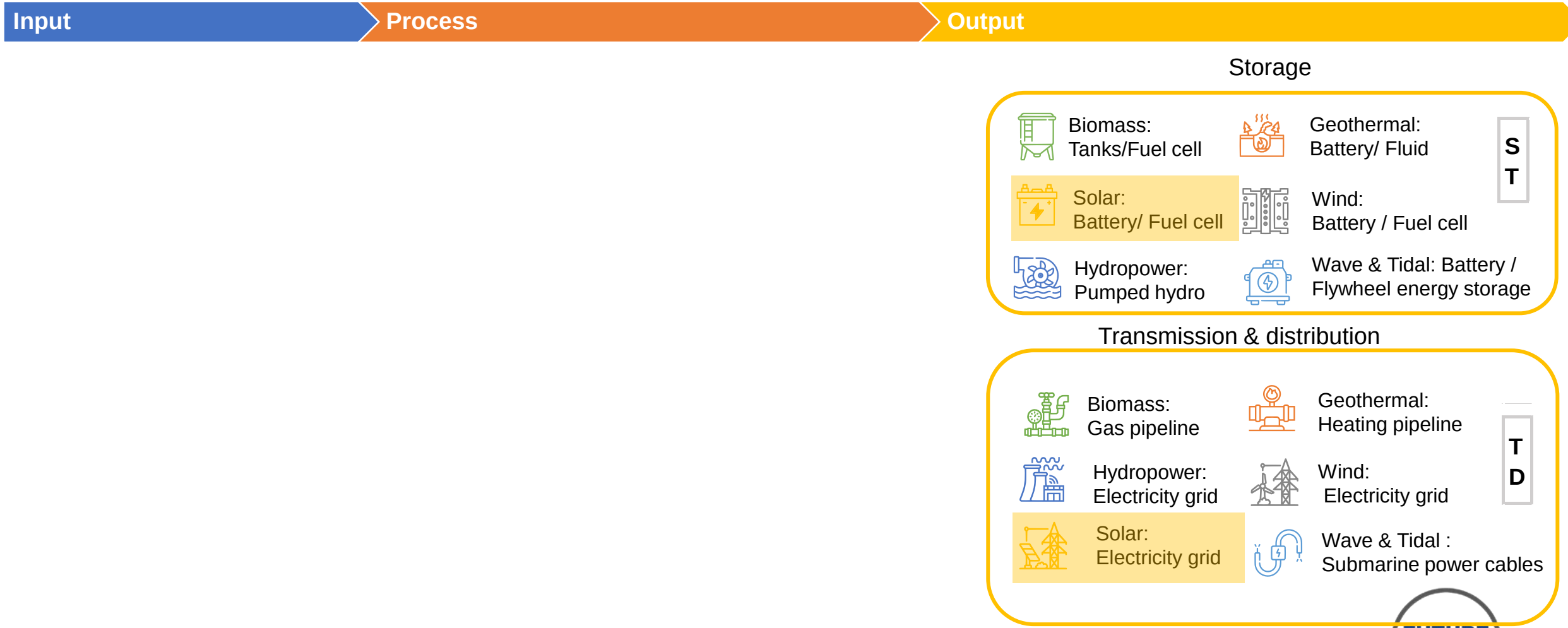
Transmission & distribution

- Biomass: Gas pipeline
- Geothermal: Heating pipeline
- Hydropower: Electricity grid
- Wind: Electricity grid
- Solar: Electricity grid
- Wave & Tidal : Submarine power cables

T D

FUTURE FUELS CRC

To assess the sustainability of renewables, we need to look at the entire renewable energy production process



To assess the sustainability of renewables, we need to look at the entire renewable energy production process

Input | **Process** | **Output**

Operational requirements

OP

- All: Labour
- All: Raw materials
- All: Utilities

Re-use

RU

- Biomass: Fertilizer, CO2
- Geothermal: Water, heat,CO2

Storage

ST

- Biomass: Tanks/Fuel cell
- Geothermal: Battery/ Fluid
- Solar: Battery/ Fuel cell
- Wind: Battery / Fuel cell
- Hydropower: Pumped hydro
- Wave & Tidal: Battery / Flywheel energy storage

Conversion process

CP

- All: Infrastructu
- All: Land Impact
- All: Maintenance

Waste production

WA

- Biomass: Chemical residues
- Geothermal: Polluted water

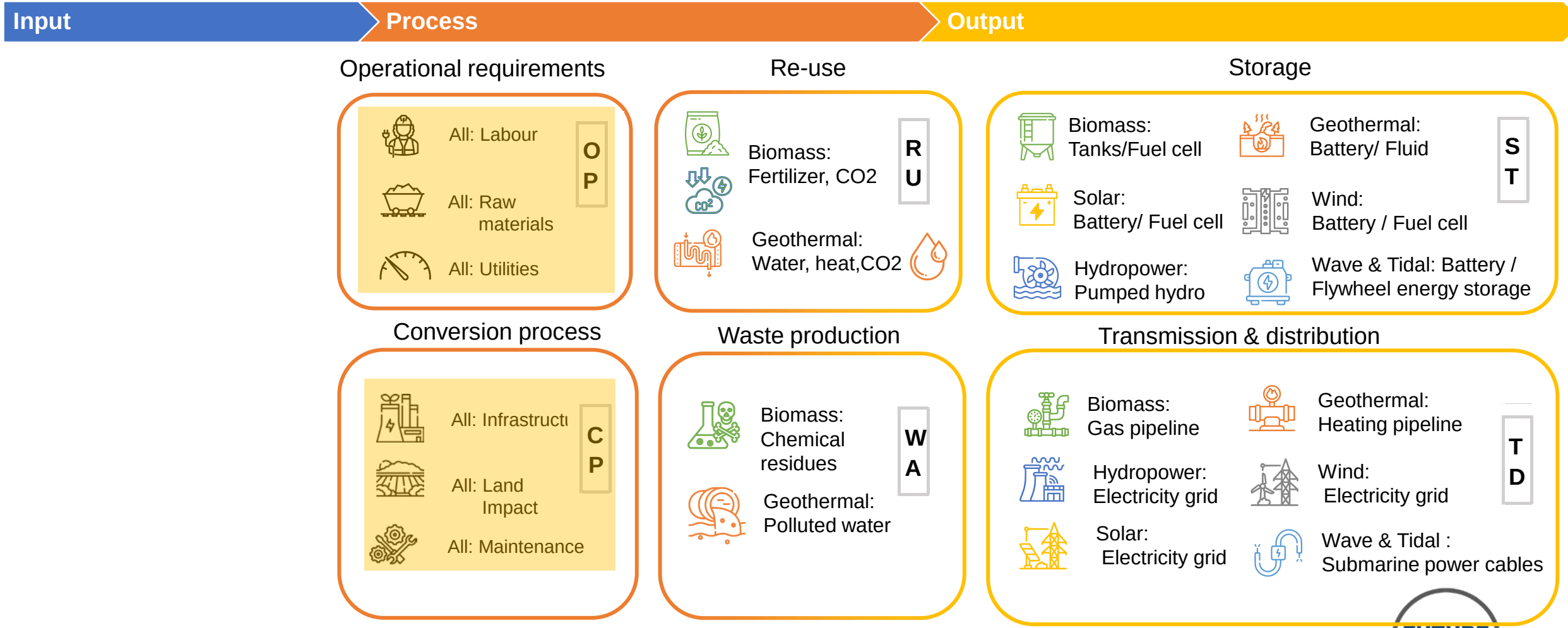
Transmission & distribution

TD

- Biomass: Gas pipeline
- Geothermal: Heating pipeline
- Hydropower: Electricity grid
- Wind: Electricity grid
- Solar: Electricity grid
- Wave & Tidal : Submarine power cables

FUTURE FUELS CRC

To assess the sustainability of renewables, we need to look at the entire renewable energy production process



To assess the sustainability of renewables, we need to look at the entire renewable energy production process

Input | **Process** | **Output**

Source selection

Stored (potential) Energy

- Chemical energy: Biomass
- Gravitation energy: Hydropower

Working (kinetic) Energy

- Radiant: Solar
- Thermal: Geothermal
- Motion: Wind
- Motion: Wave & Tidal

SO

Operational requirements

- All: Labour
- All: Raw materials
- All: Utilities

OP

Re-use

- Biomass: Fertilizer, CO2
- Geothermal: Water, heat,CO2

RU

Storage

- Biomass: Tanks/Fuel cell
- Geothermal: Battery/ Fluid
- Solar: Battery/ Fuel cell
- Wind: Battery / Fuel cell
- Hydropower: Pumped hydro
- Wave & Tidal: Battery / Flywheel energy storage

ST

Conversion process

- All: Infrastructu
- All: Land Impact
- All: Maintenance

CP

Waste production

- Biomass: Chemical residues
- Geothermal: Polluted water

WA

Transmission & distribution

- Biomass: Gas pipeline
- Geothermal: Heating pipeline
- Hydropower: Electricity grid
- Wind: Electricity grid
- Solar: Electricity grid
- Wave & Tidal : Submarine power cables

TD

FUTURE FUELS CRC

To assess the sustainability of renewables, we need to look at the entire renewable energy production process

Input | **Process** | **Output**

Source selection

Stored (potential) Energy

- Chemical energy: Biomass
- Gravitation energy: Hydropower

Working (kinetic) Energy

- Radiant: Solar
- Thermal: Geothermal
- Motion: Wind
- Motion: Wave & Tidal

SO

Operational requirements

- All: Labour
- All: Raw materials
- All: Utilities

OP

Re-use

- Biomass: Fertilizer, CO2
- Geothermal: Water, heat,CO2

RU

Storage

- Biomass: Tanks/Fuel cell
- Geothermal: Battery/ Fluid
- Solar: Battery/ Fuel cell
- Wind: Battery / Fuel cell
- Hydropower: Pumped hydro
- Wave & Tidal: Battery / Flywheel energy storage

ST

Conversion process

- All: Infrastructu
- All: Land Impact
- All: Maintenance

CP

Waste production

- Biomass: Chemical residues
- Geothermal: Polluted water

WA

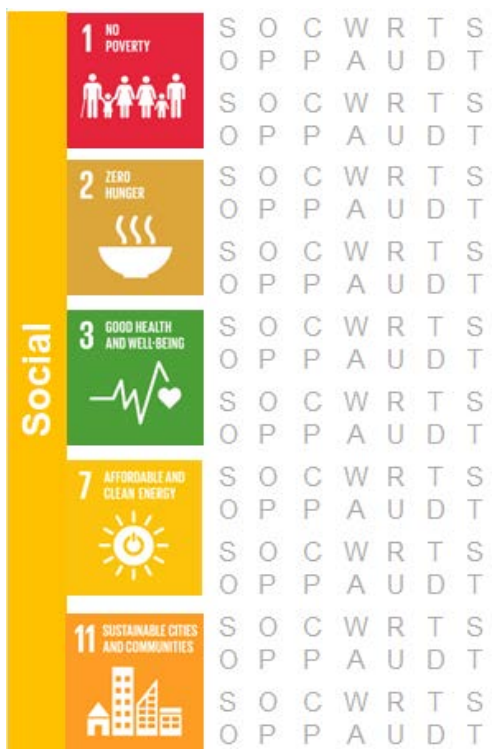
Transmission & distribution

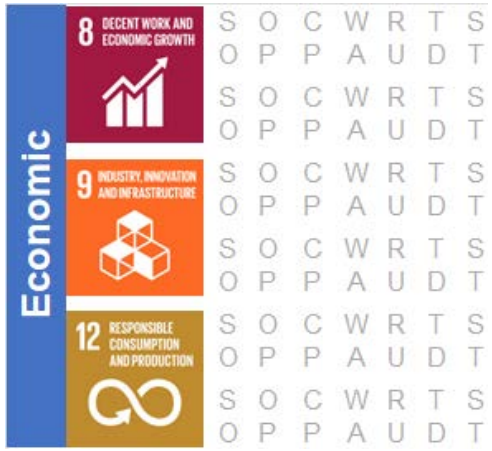
- Biomass: Gas pipeline
- Geothermal: Heating pipeline
- Hydropower: Electricity grid
- Wind: Electricity grid
- Solar: Electricity grid
- Wave & Tidal : Submarine power cables

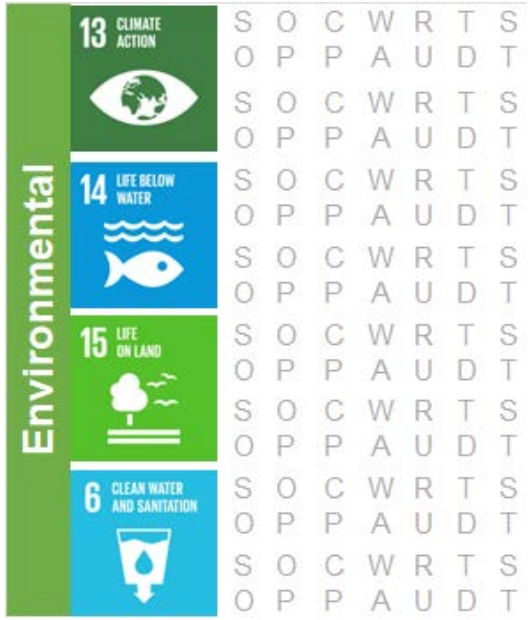
TD

FUTURE FUELS CRC

Renewables can have wide ranging impacts on sustainability – both positive and negative



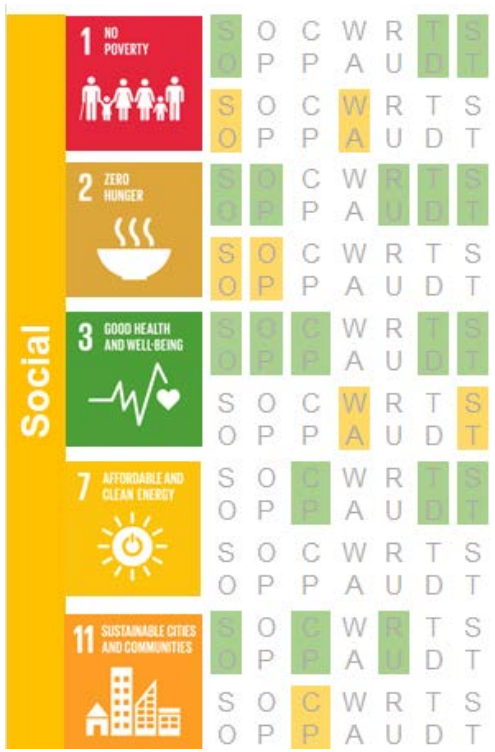


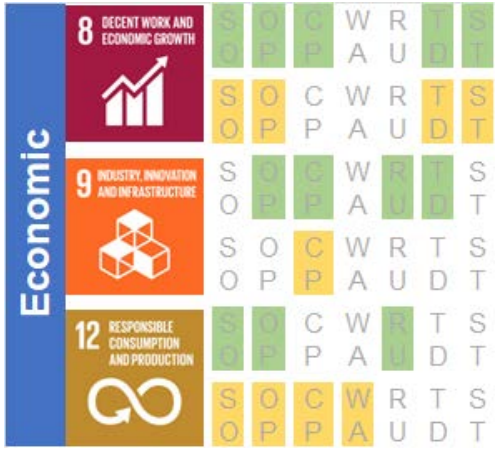


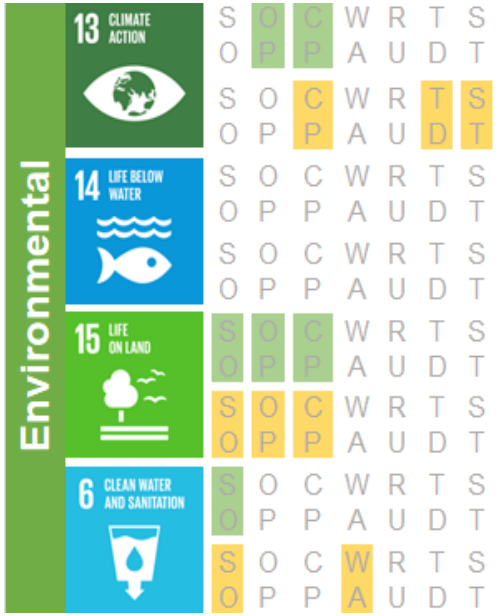
ENABLER **INHIBITOR**

SO	Source selection	OP	Operational requirements	RU	Re-use	ST	Storage
CP	Conversion process	WA	Waste production	TD	Transmission & distribution		

Renewables can have wide ranging impacts on sustainability – both positive and negative



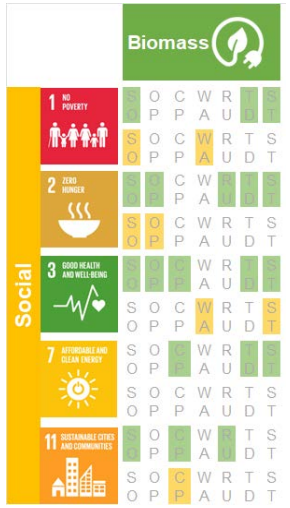


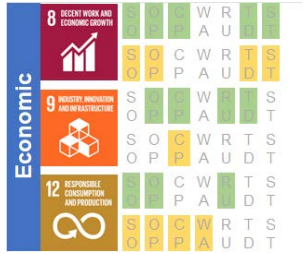


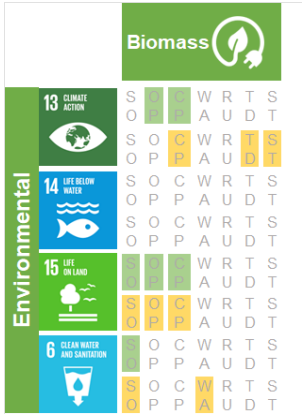
ENABLER **INHIBITOR**

SO	Source selection	OP	Operational requirements	RU	Re-use	ST	Storage
CP	Conversion process	WA	Waste production	TD	Transmission & distribution		

Renewables can have wide ranging impacts on sustainability – both positive and negative



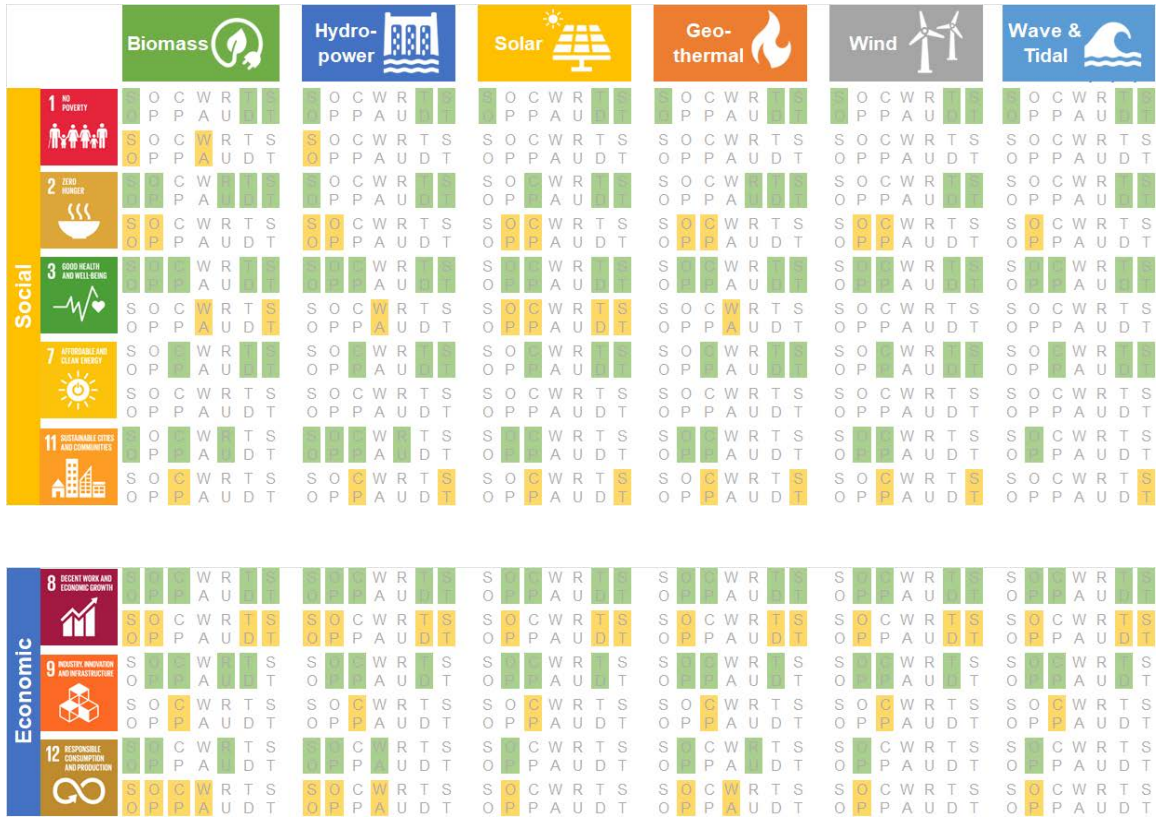




ENABLER **INHIBITOR**

SO	Source selection	OP	Operational requirements	RU	Re-use	ST	Storage
CP	Conversion process	WA	Waste production	TD	Transmission & distribution		

Renewables can have wide ranging impacts on sustainability – both positive and negative

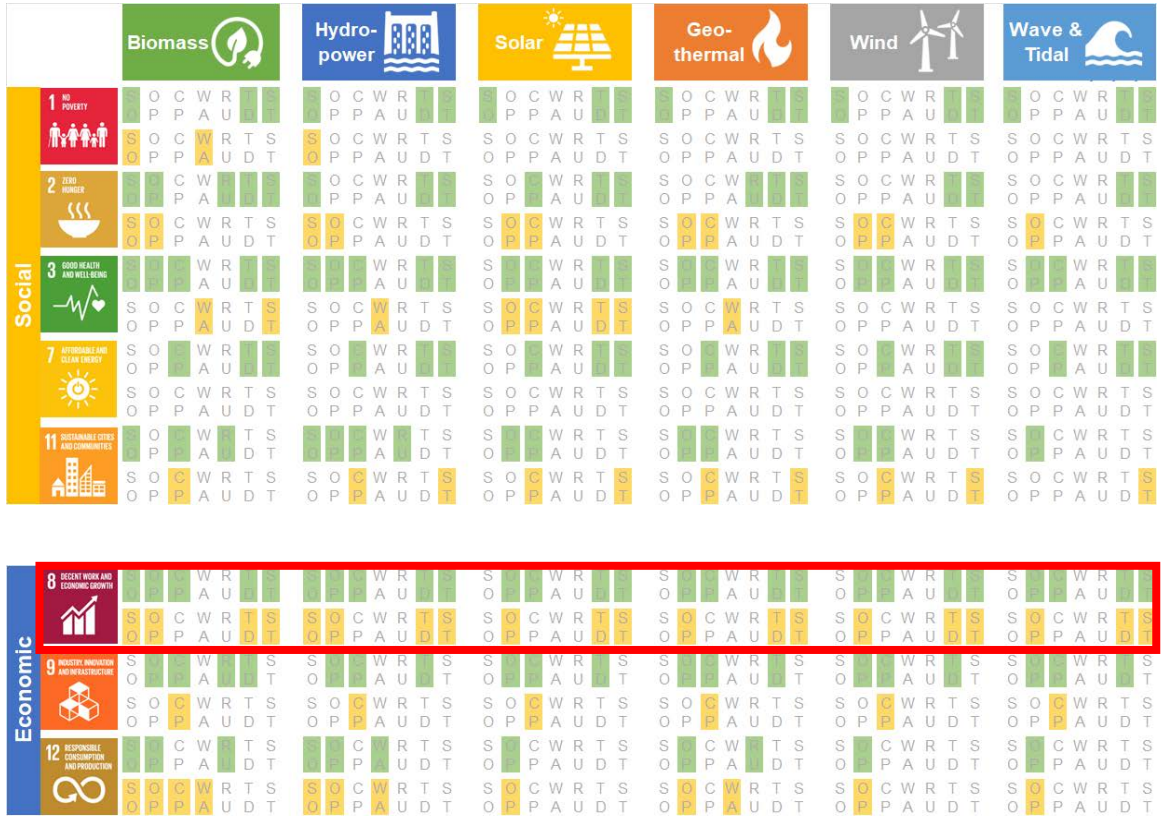


ENABLER **INHIBITOR**

SO	Source selection	OP	Operational requirements	RU	Re-use	ST	Storage
		CP	Conversion process	WA	Waste production	TD	Transmission & distribution

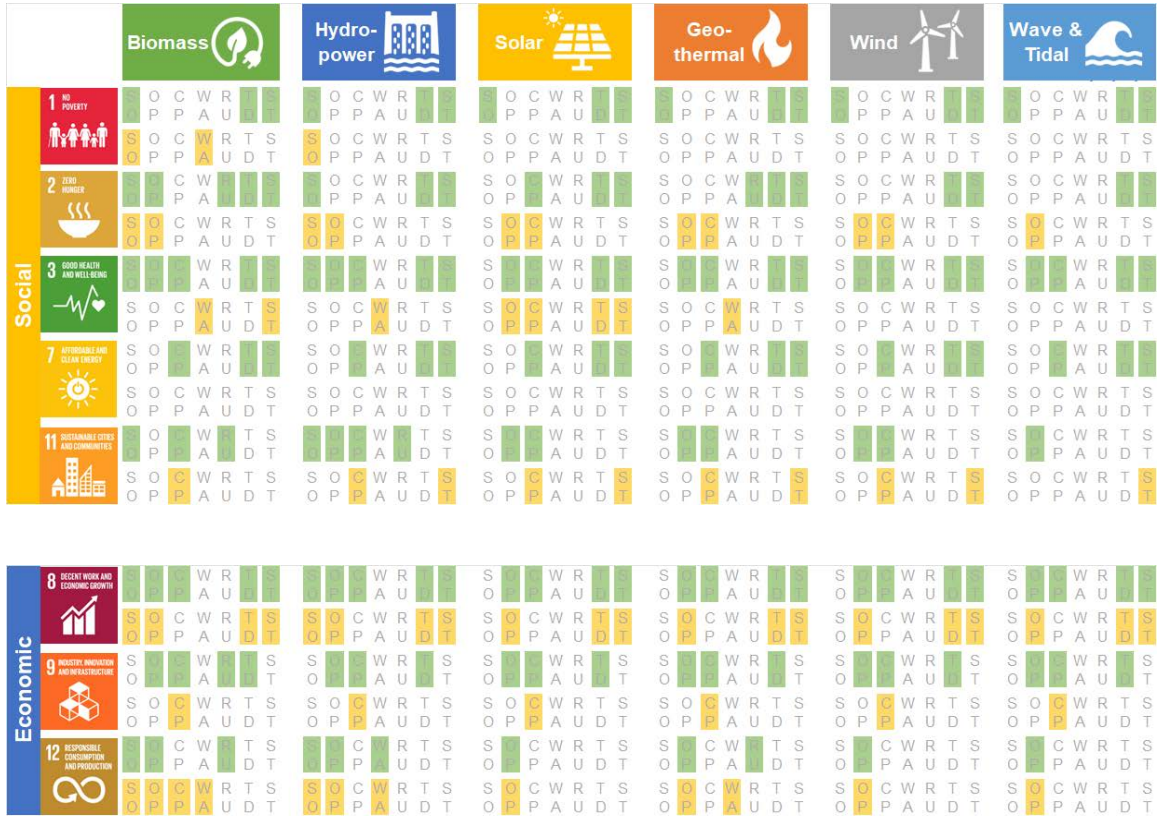
Renewables can have wide ranging impacts on sustainability – both positive and negative

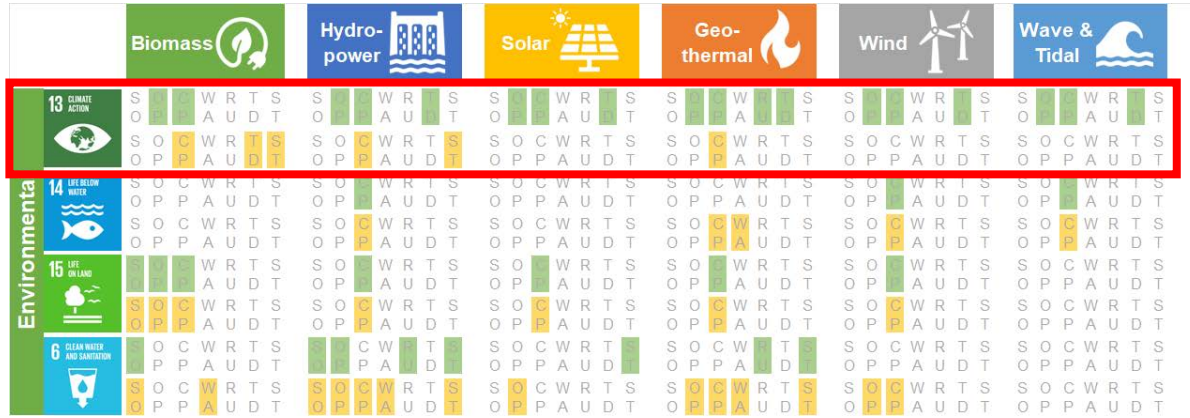
- Underestimation of negative sustainability impacts



Renewables can have wide ranging impacts on sustainability – both positive and negative

- Underestimation of negative sustainability impacts



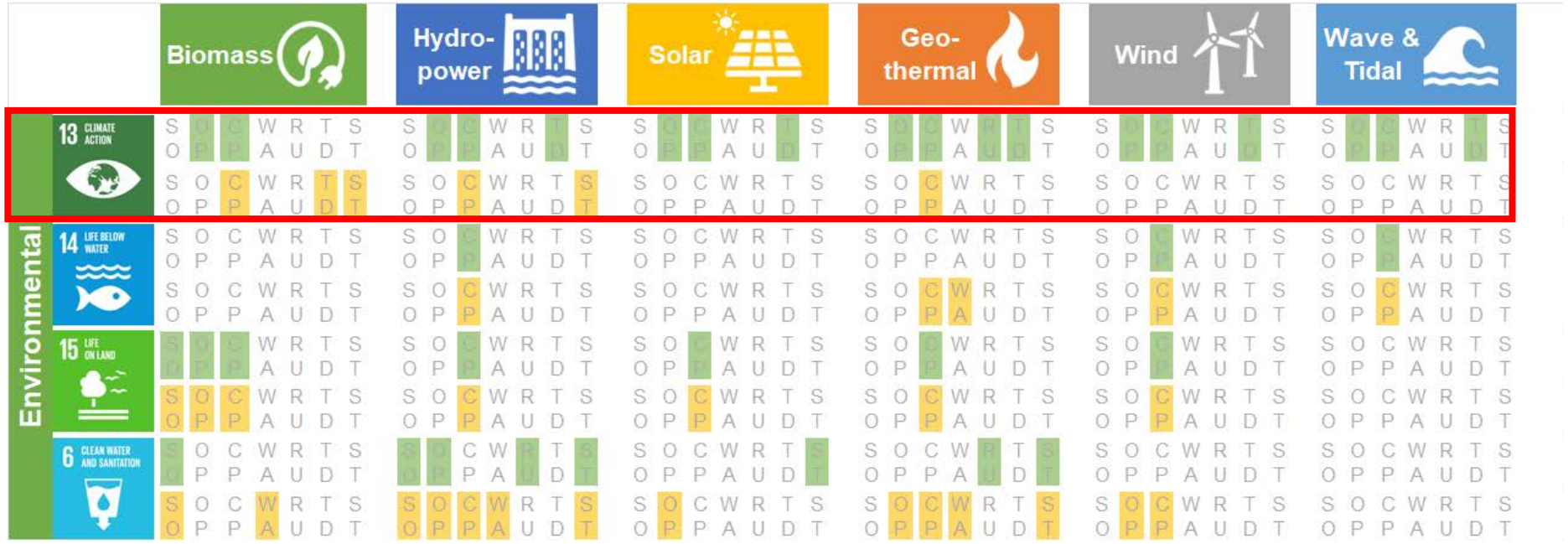


ENABLER **INHIBITOR**

SO	Source selection	OP	Operational requirements	RU	Re-use	ST	Storage
		CP	Conversion process	WA	Waste production	TD	Transmission & distribution

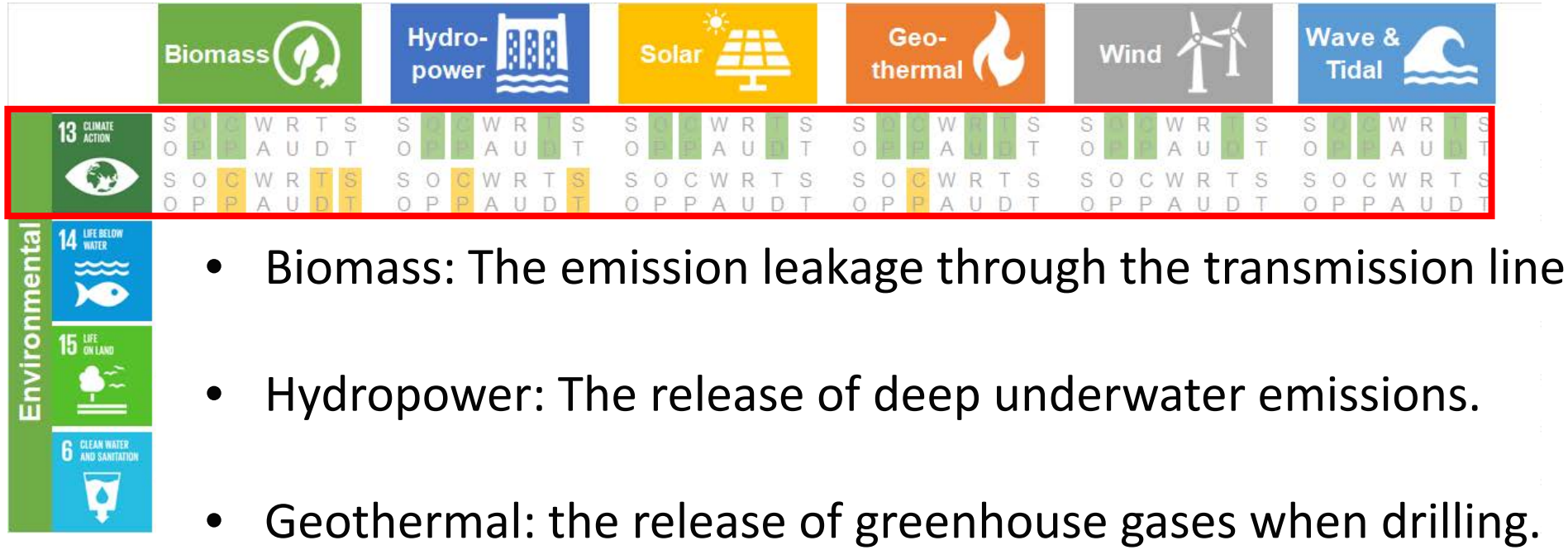
Renewables can have wide ranging impacts on sustainability – both positive and negative

- Underestimation of negative sustainability impacts



Renewables can have wide ranging impacts on sustainability – both positive and negative

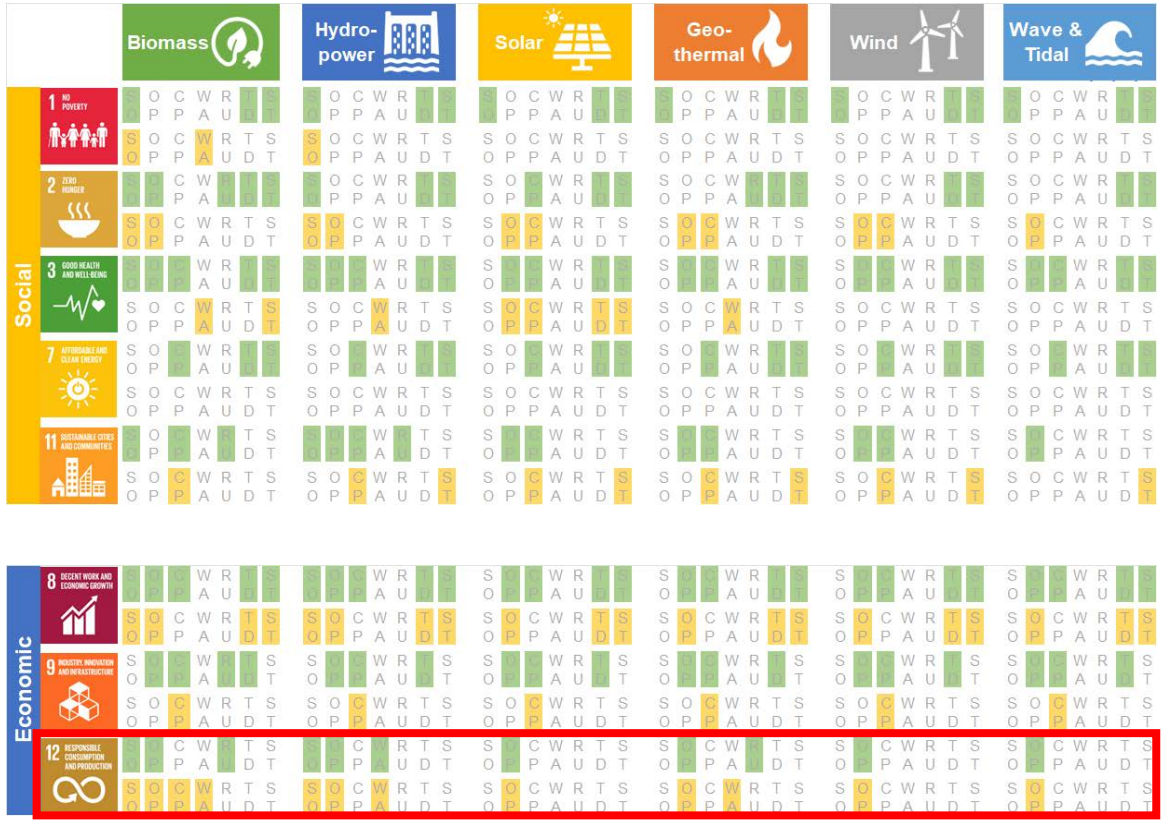
- Underestimation of negative sustainability impacts

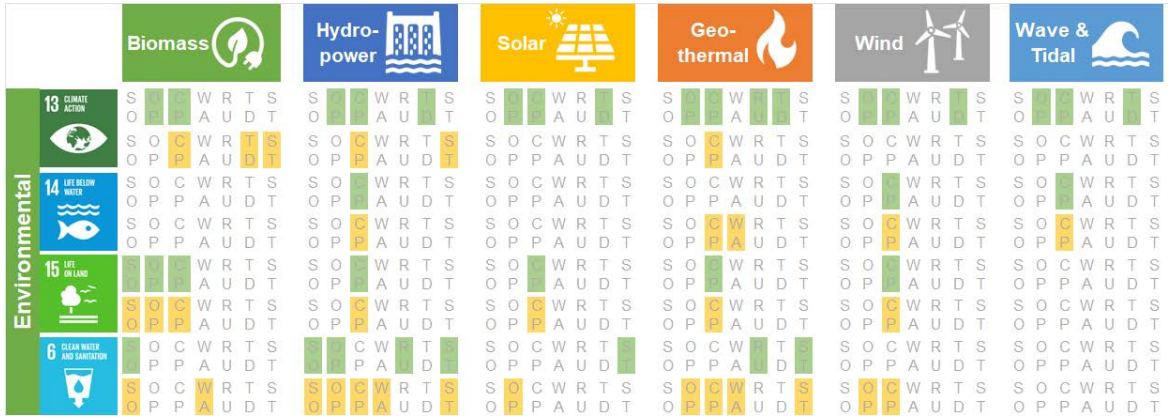


- Biomass: The emission leakage through the transmission line.
- Hydropower: The release of deep underwater emissions.
- Geothermal: the release of greenhouse gases when drilling.

Renewables can have wide ranging impacts on sustainability – both positive and negative

- Underestimation of negative sustainability impacts





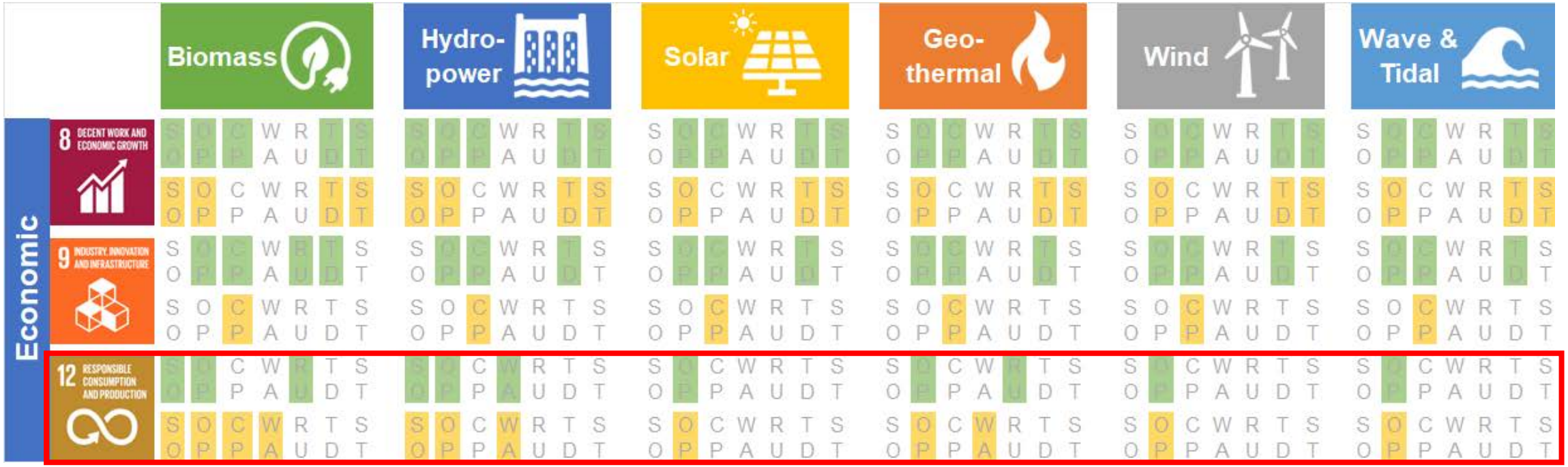
ENABLER **INHIBITOR**

SO	Source selection	OP	Operational requirements	RU	Re-use	ST	Storage
		CP	Conversion process	WA	Waste production	TD	Transmission & distribution

FUTURE FUELS CRC

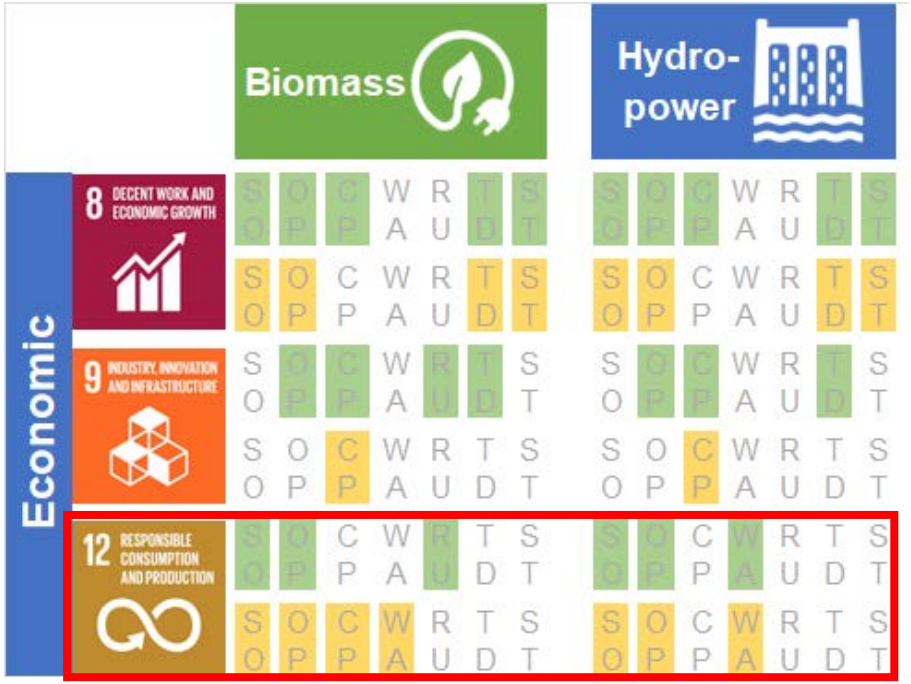
Renewables can have wide ranging impacts on sustainability – both positive and negative

- Underestimation of negative sustainability impacts



Renewables can have wide ranging impacts on sustainability – both positive and negative

- Underestimation of negative sustainability impacts



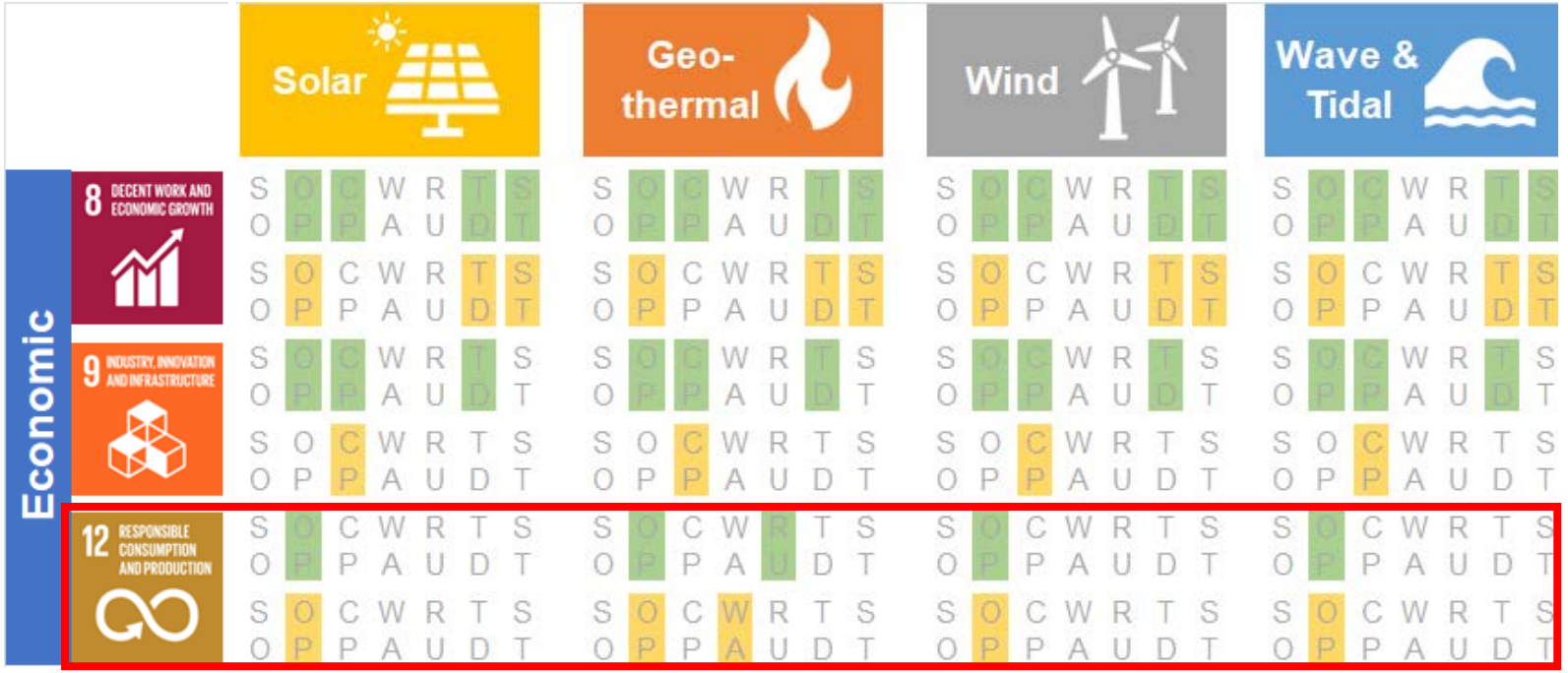
For Biomass and Hydropower: There is a big impact on SDG 12.

This is because these energy types require transmission, storage, and pre-processing of raw materials before energy is generated.

Renewables can have wide ranging impacts on sustainability – both positive and negative

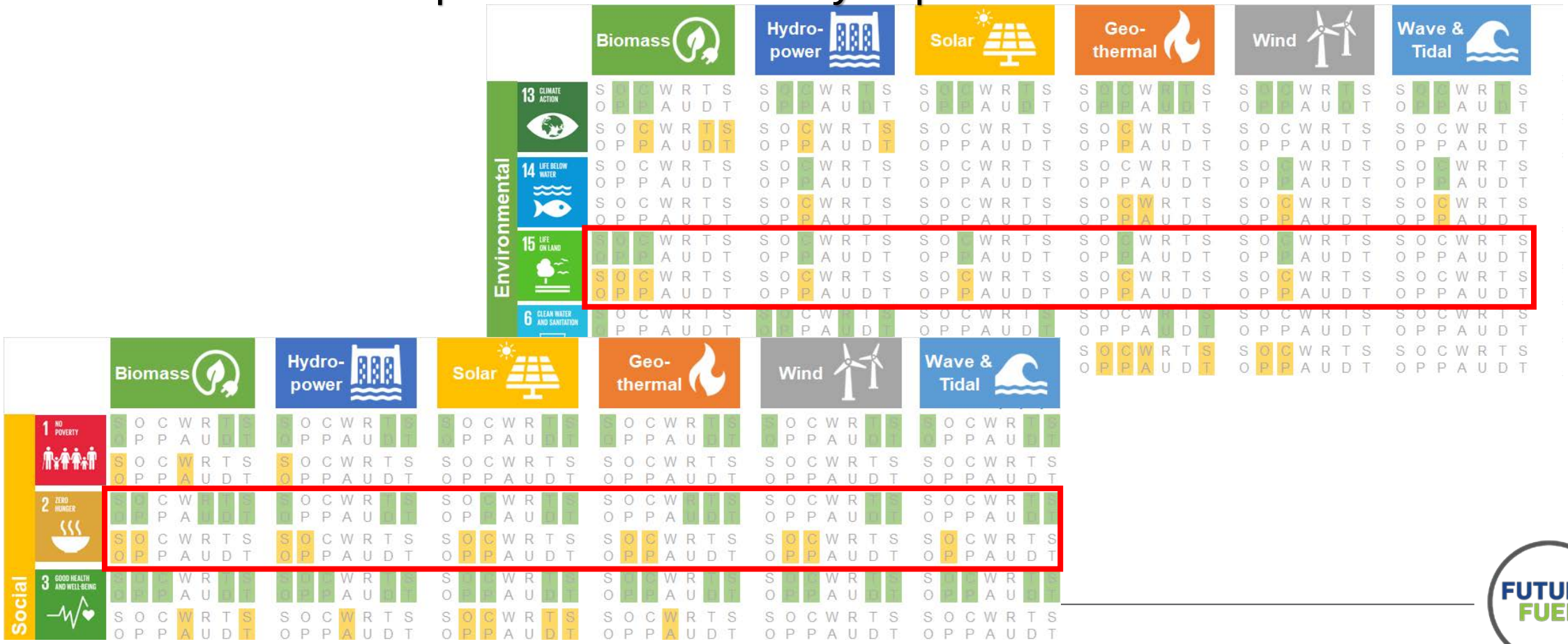
- Underestimation of negative sustainability impacts

For Solar, Geothermal, Wind and Wave/tidal, there is minimal impact on SDG 12.



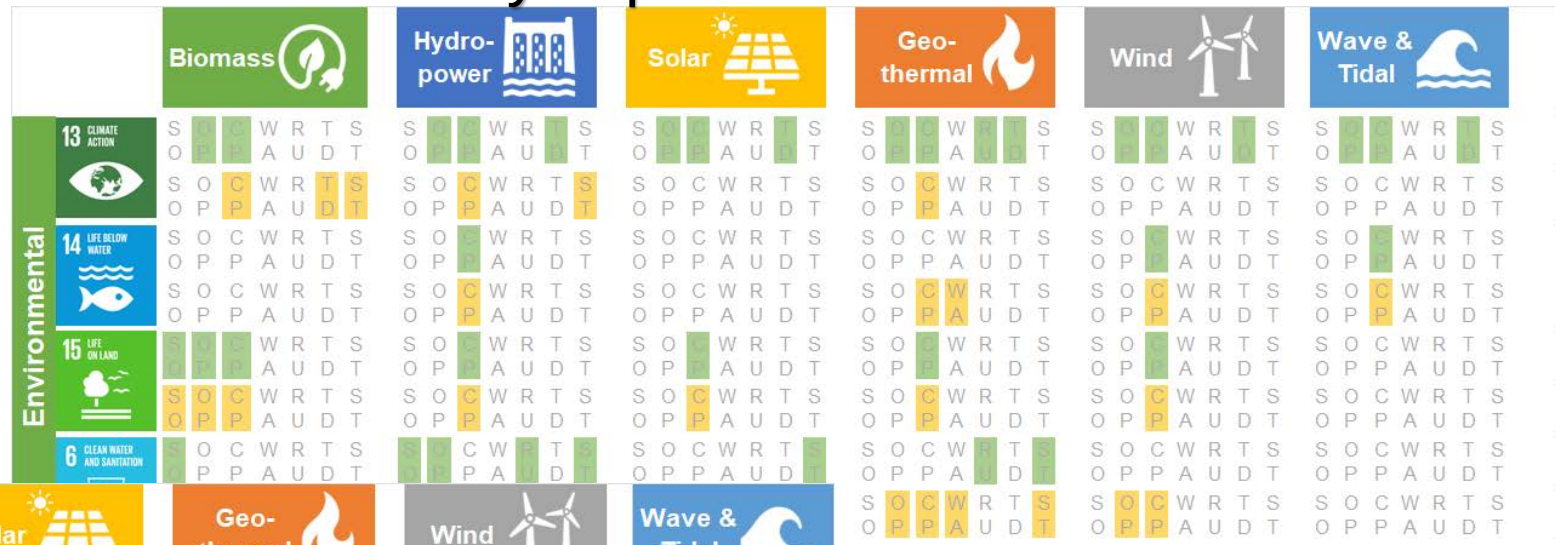
Renewables can have wide ranging impacts on sustainability – both positive and negative

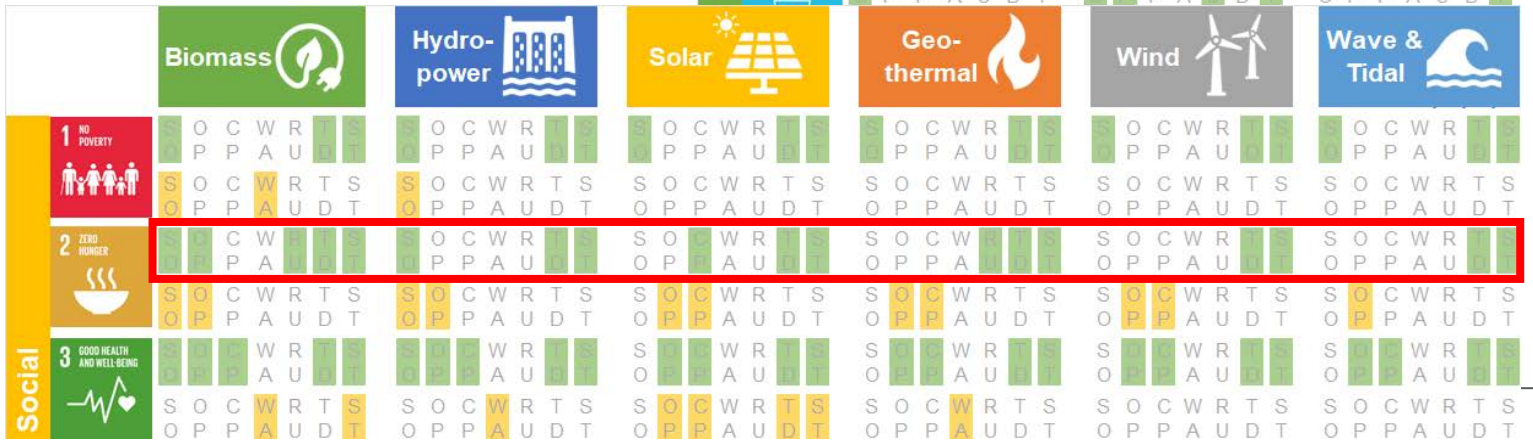
- Underestimation of positive sustainability impacts



Renewables can have wide ranging impacts on sustainability – both positive and negative

- Underestimation of positive sustainability impacts



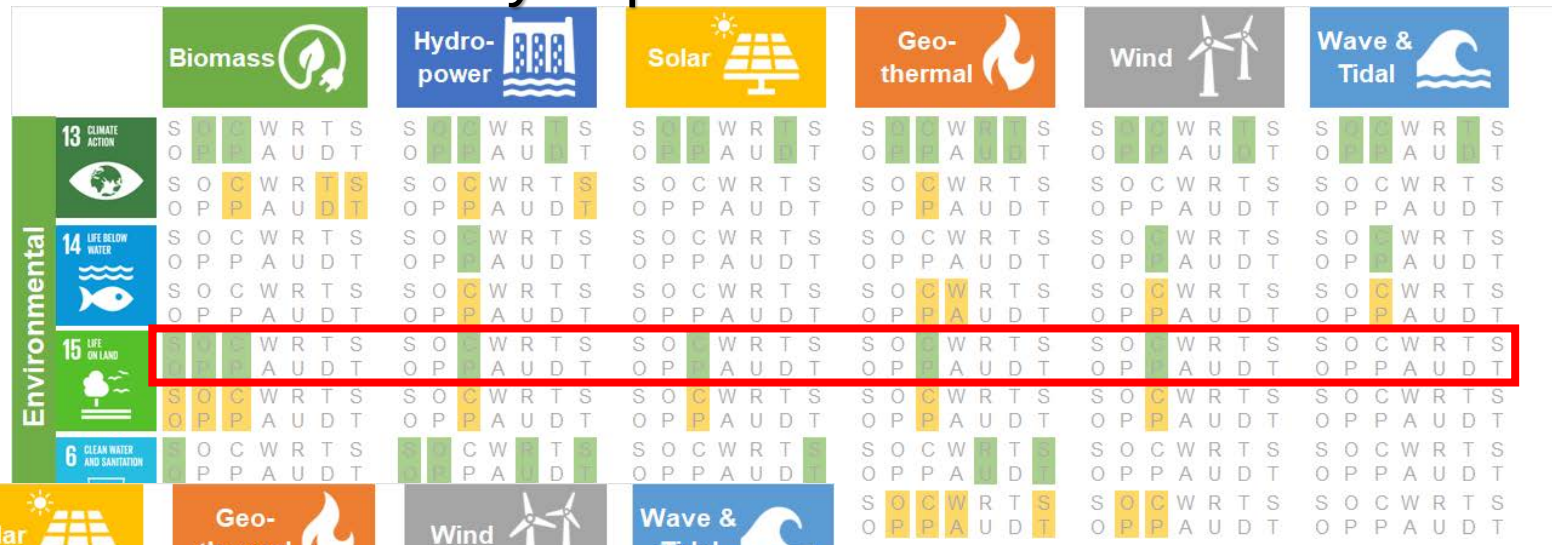


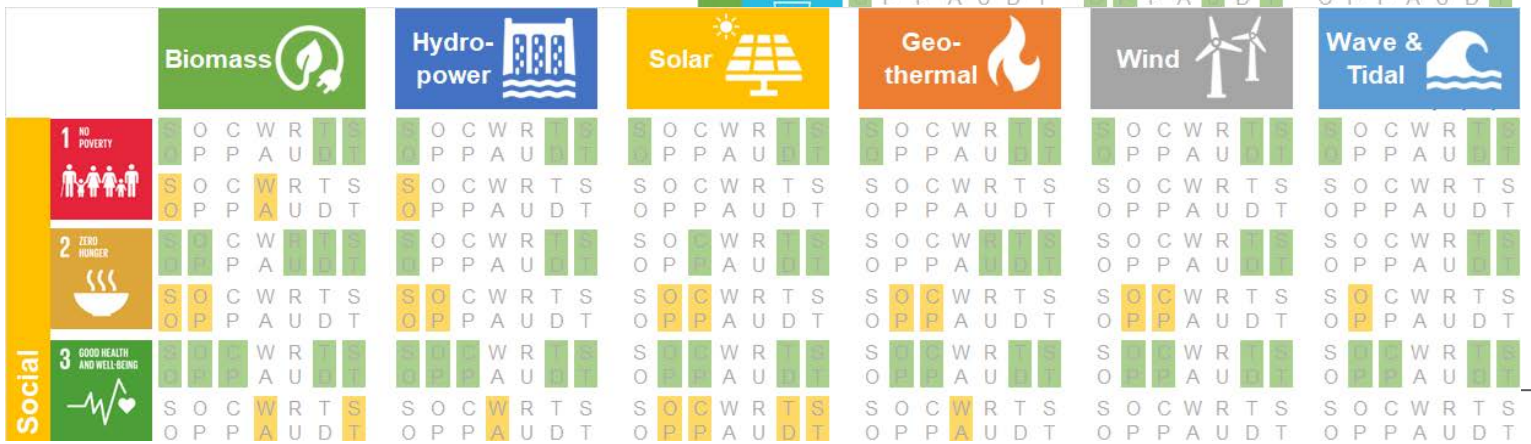
For agriculture use: Shading from solar panels can improve production.

FUTURE FUELS CRC

Renewables can have wide ranging impacts on sustainability – both positive and negative

- Underestimation of positive sustainability impacts





For territorial use:
Repurpose the degraded land.

The full range of potential sustainability impacts needs to be considered when developing renewables

Net zero ≠ Sustainability

Thank you for your attention


@Jing_Dreamer


Jing (Jean) Tian


Jing.tian@adelaide.edu.au

Enabling the decarbonisation of Australia's energy networks

@futurefuelscrc

futurefuelscrc

futurefuelscrc.com

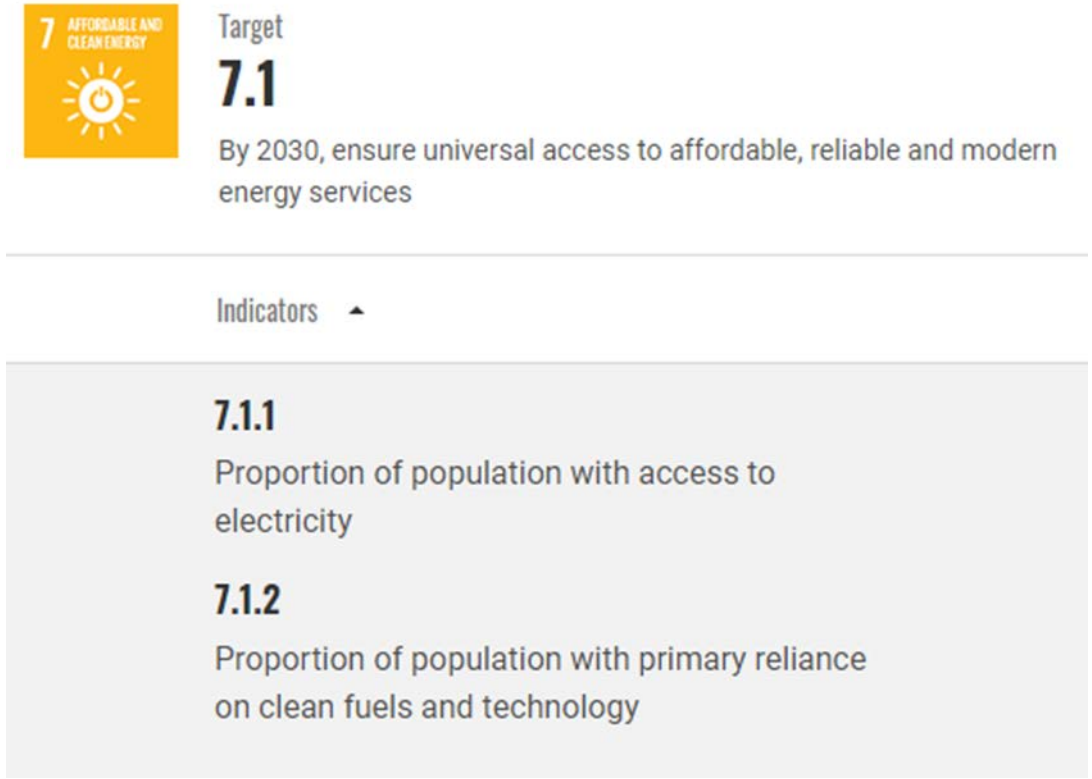
Future Fuels CRC is supported through the Australian Government's Cooperative Research Centres Program. We gratefully acknowledge the cash and in-kind support from all our research, government and industry participants.

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program

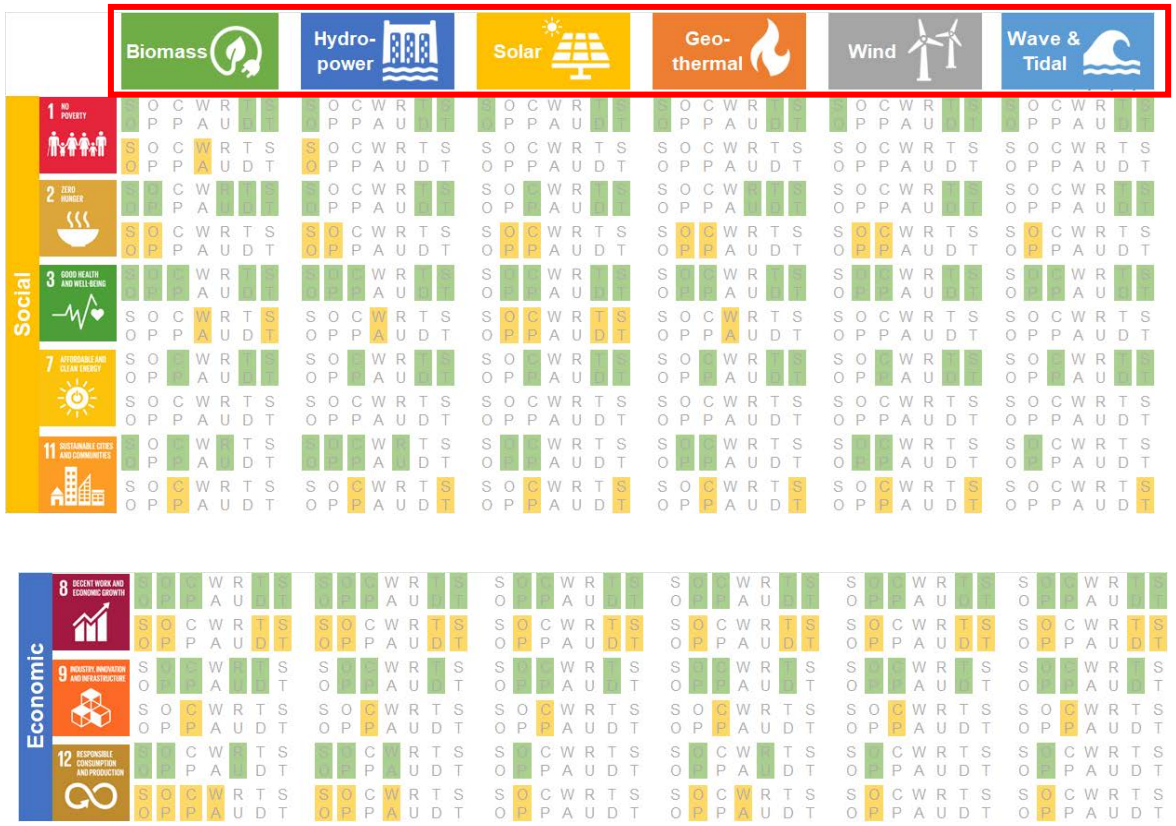
Methodology

Translating broad goals into specific targets/indicators and defined the direct and indirect connections.



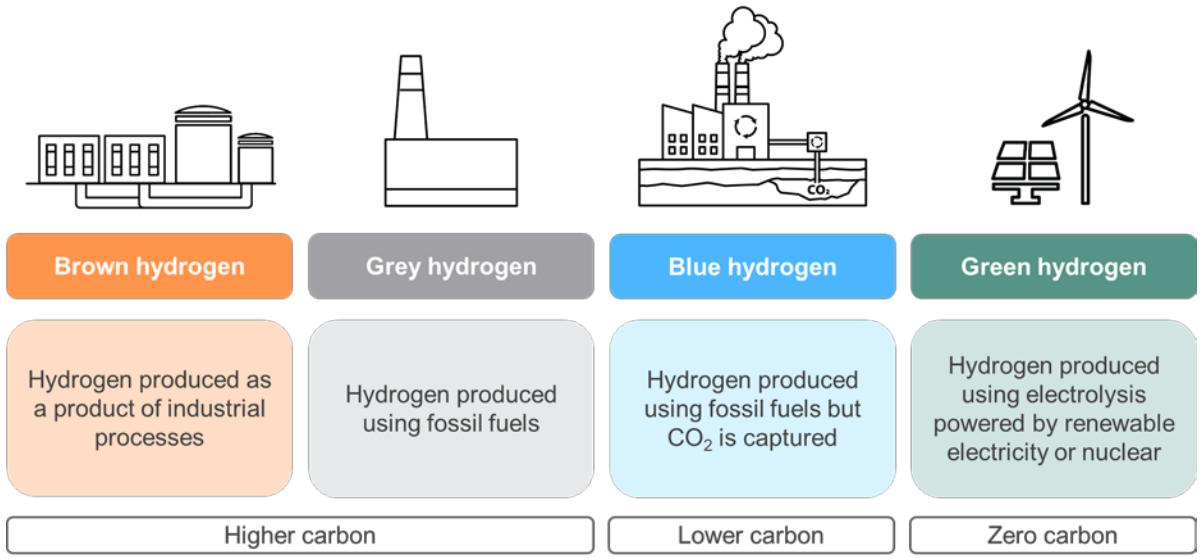
- Indirect effect: a connection to SDG 7 or 13, but not any other SDGs.
- No connections: The existing literature does not show contributions to the targets/indicators.
- Note that SDGs 4, 5, and 10 are excluded from this study since no direct relationships with quantitative indicators could be identified in literature.

Apply to all energy types



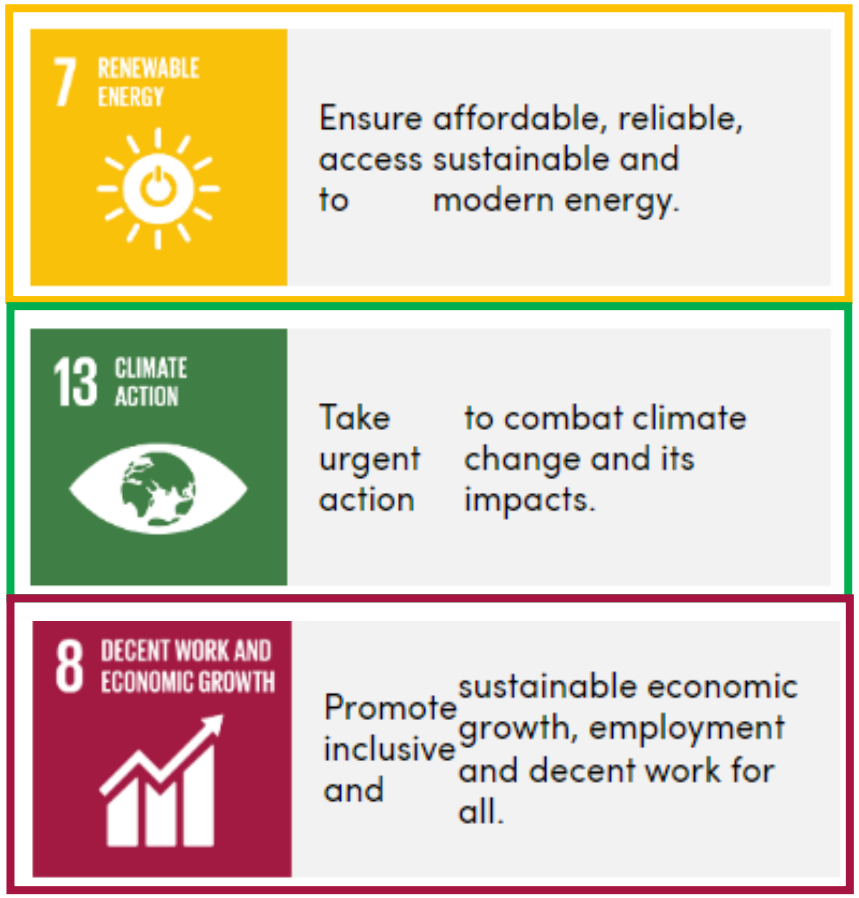
Why not include hydrogen?

Hydrogen is an energy carrier, and renewable energy sources are used in its generation process..



Preliminary links to the SDGs

The 400 MW Solar power project of Bhadla, Rajasthan' project aligns with the following UN Sustainable Development Goals:



- Replacing 732,874 MWh/year amount of electricity with renewable energy.
- Reduces emissions of greenhouse gases estimated to be approximately 694,471 tCO2e per year
- No. of employment opportunities created: 10

Data source: https://marketplace.goldstandard.org/products/eki-energy-services-gold-standard-foundation-400-mw-solar-power-project-at-bhadla-rajasthan-india