Hydrogen (and ammonia) at scale

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AHC members

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As of August 2022

AHC has 103 members

- All are companies
- Range of sizes and locations
- Highest industry representation is from the energy sector, with other main categories of technology, transport and consulting

Policy settings to create the industry

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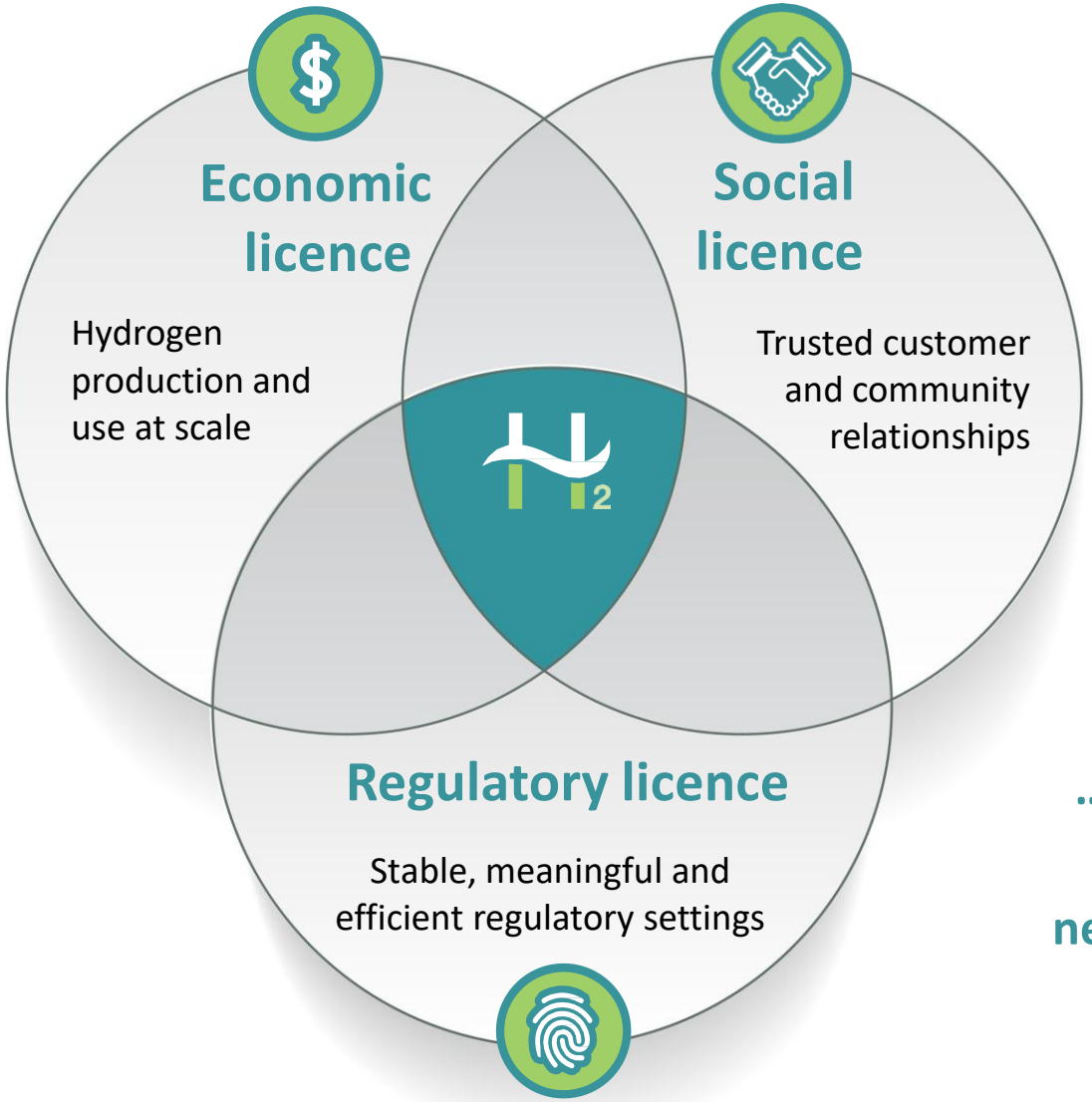
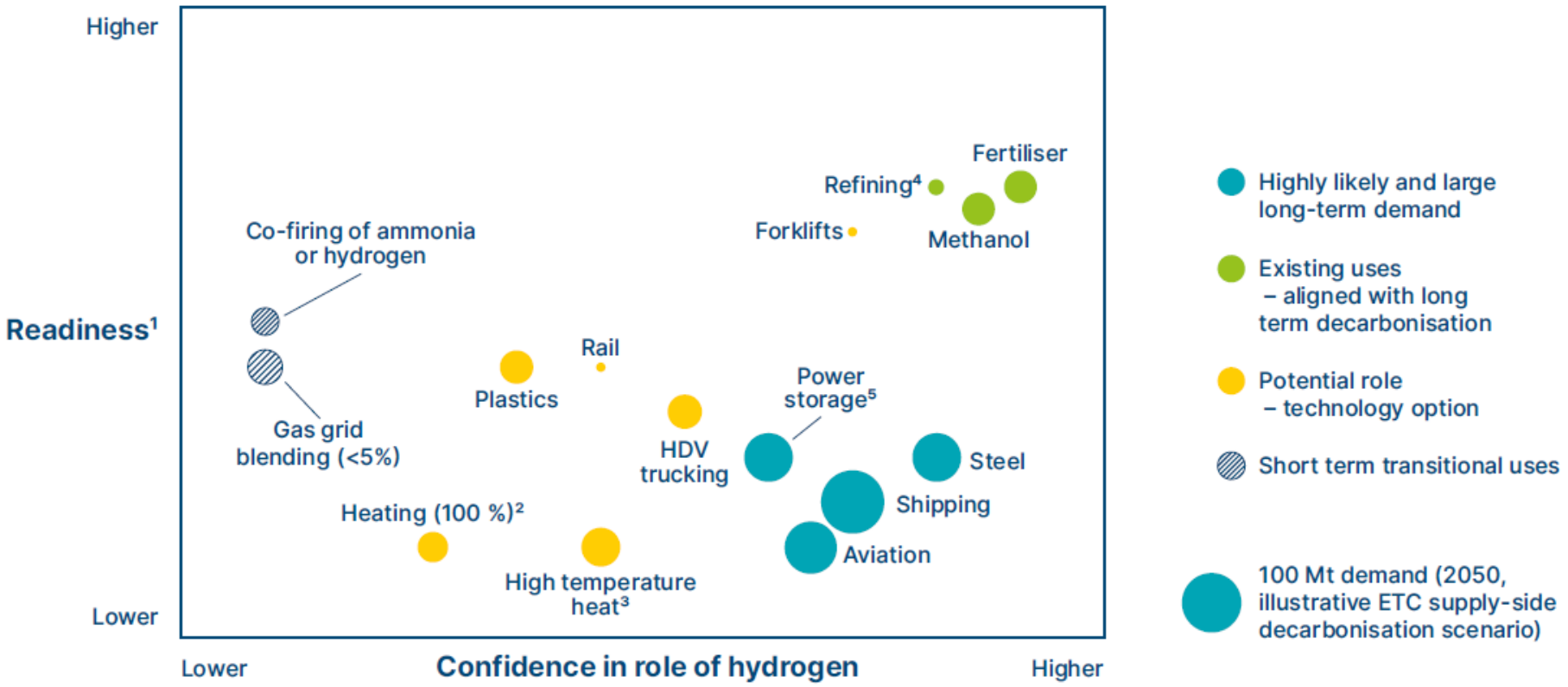
Framing with the three licences to operate for a sustainable hydrogen industry…



…and prioritising demand side policy to then bring the necessary investment in supply

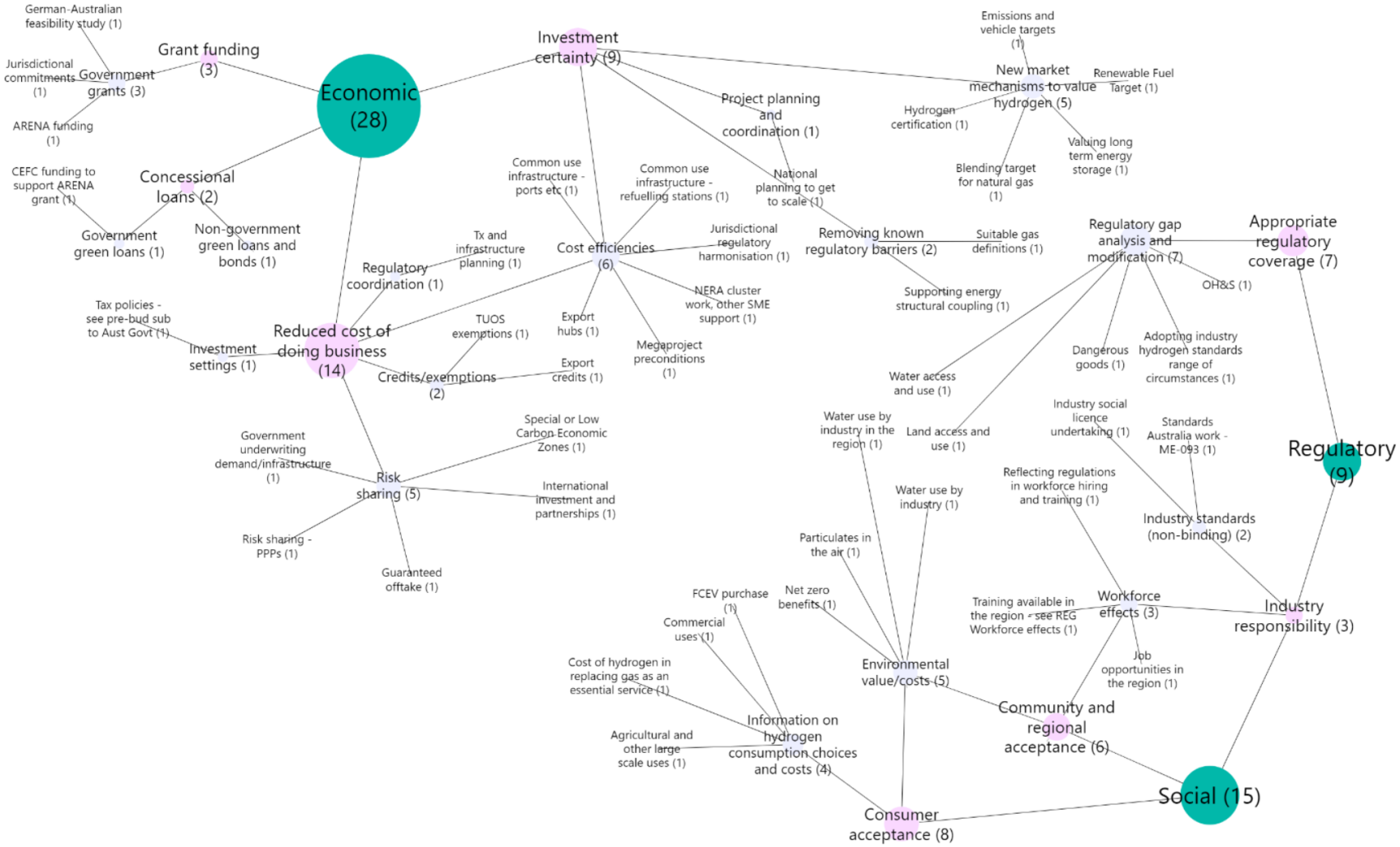
Potential uses



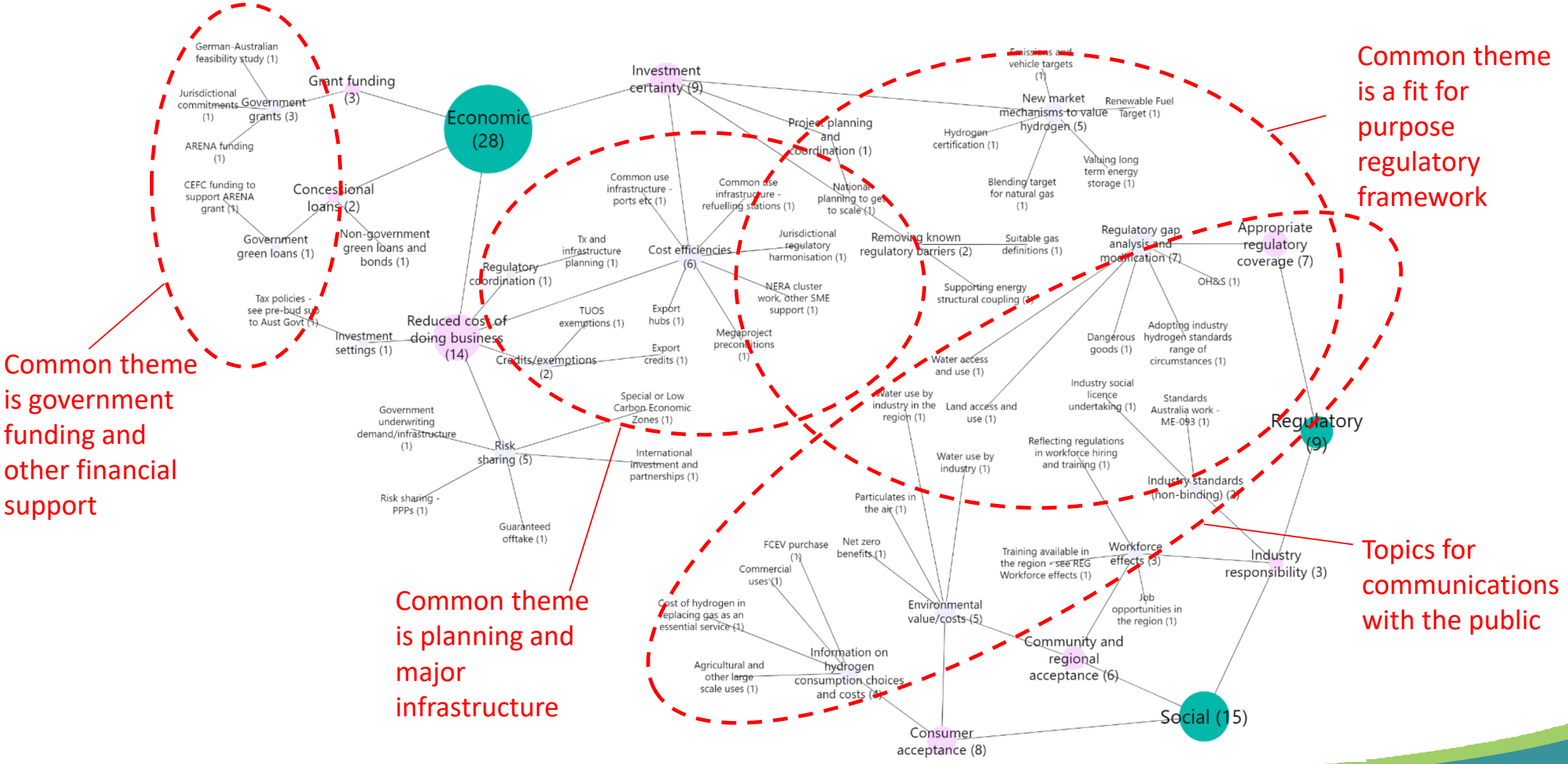
NOTES: [1] Readiness refers to a combined metric of technical readiness for clean hydrogen use, economic competitiveness and ease of sector to use clean hydrogen. [2] 'Heating (100%)' refers to building heating with hydrogen boilers via hydrogen distribution grid, [3] 'High temperature heat' refers to industrial heat processes above ca. 800°C [4] Current hydrogen use in refining industry is higher due to greater oil consumption. [5] Long-term energy storage for the power system.

Multiple potential uses of hydrogen in a low carbon economy, some of which can provide early 'off take' for clean hydrogen. SOURCE: Energy Transitions Commission (2021), page 17.

Policy issues and relationships



Policy issues and relationships



The cleaner version

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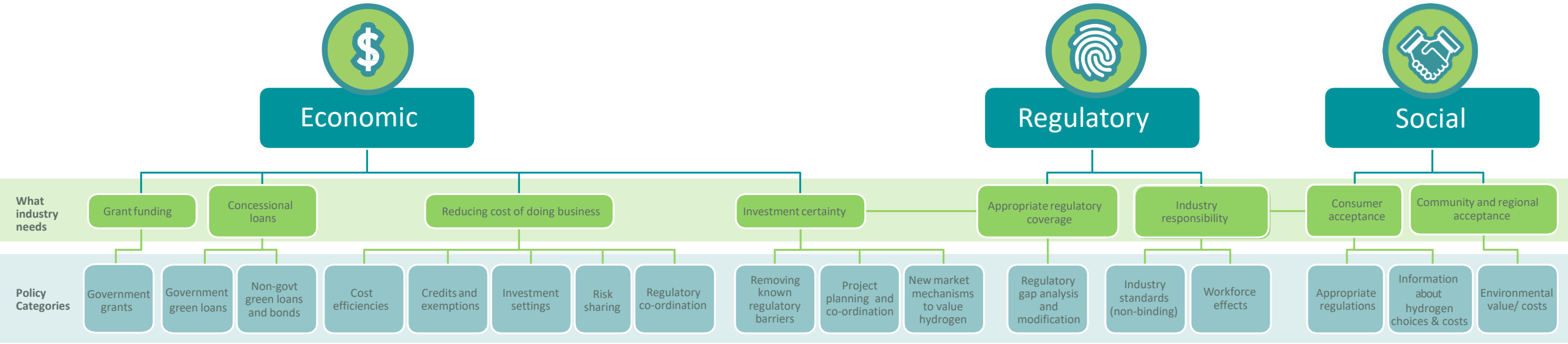
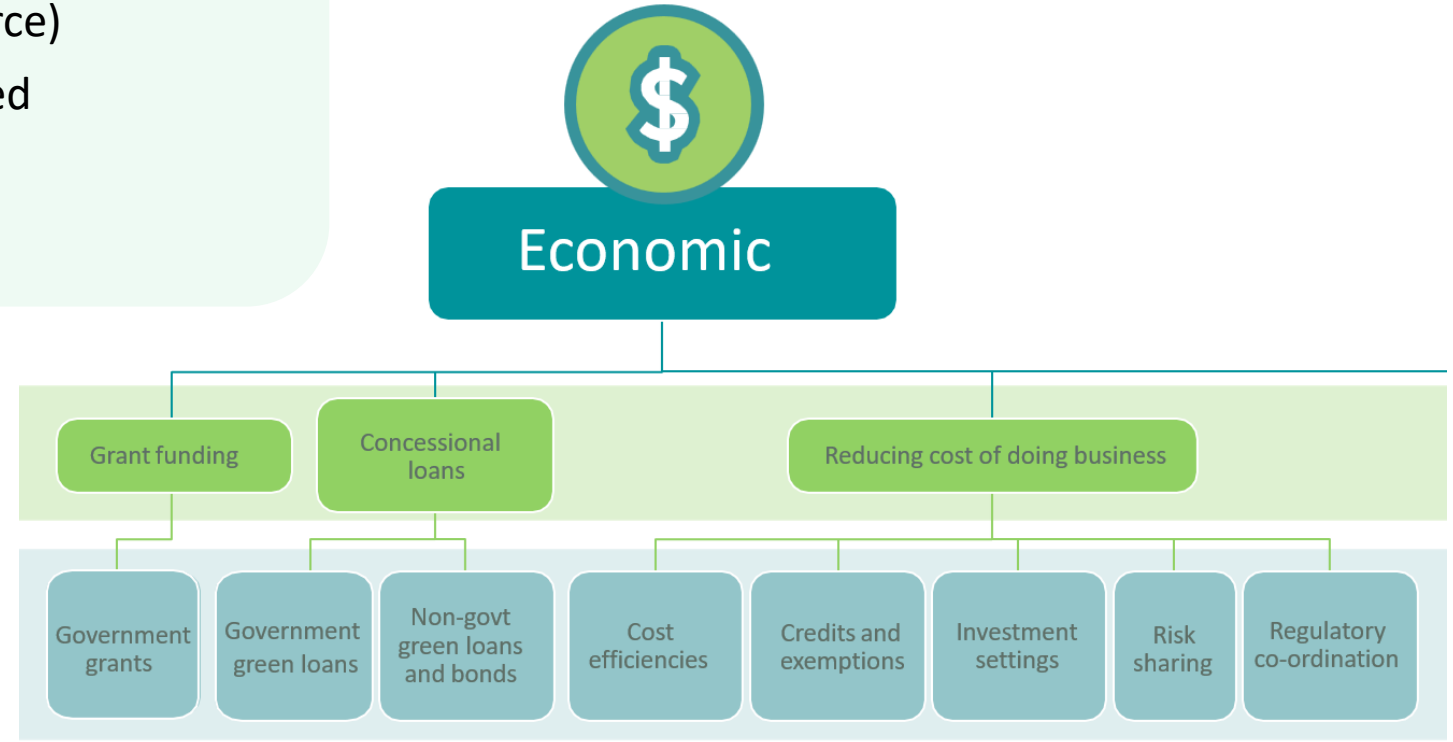


Economic matters

Current state

- ✓ >$1.6 bn in government funding
- ✓ >100 projects in Australia (see HyResource)
- ✓ 7 hubs in the process of being announced
- ✓ International agreements in place
- ✓ Increasing industry and port MoUs



Regulatory coverage

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Regulated sector

Electricity
- Security
- Access
- RAPSs
- Demand response

Land
- Refuelling stations
- Export terminals
- Access

Gas
- Pipe materials
- Access
- Appliances
- Storage

Water
- Quality
- Volumes
- Access
- Use
- Treatment

Transport
- Buses
- Trucks
- Roads
- Trains
- Maritime
- Aviation
- Cars
- Forklifts

Industry
- Ammonia
- Chemicals
- Explosives
- Steel
- Feedstock

Type of regulation

Environment
- Water
- Pollutants
- Carbon emissions
- Land use

Safety
- Handling
- Use
- Storage
- Delivery
- Emergency response

Consumers
- Warranties
- Markets
- Awareness
- Green vs other

Jurisdiction

Local/Council
- By-laws
- Approvals

State/Territory
- Laws
- Codes
- Standards
- Regulations

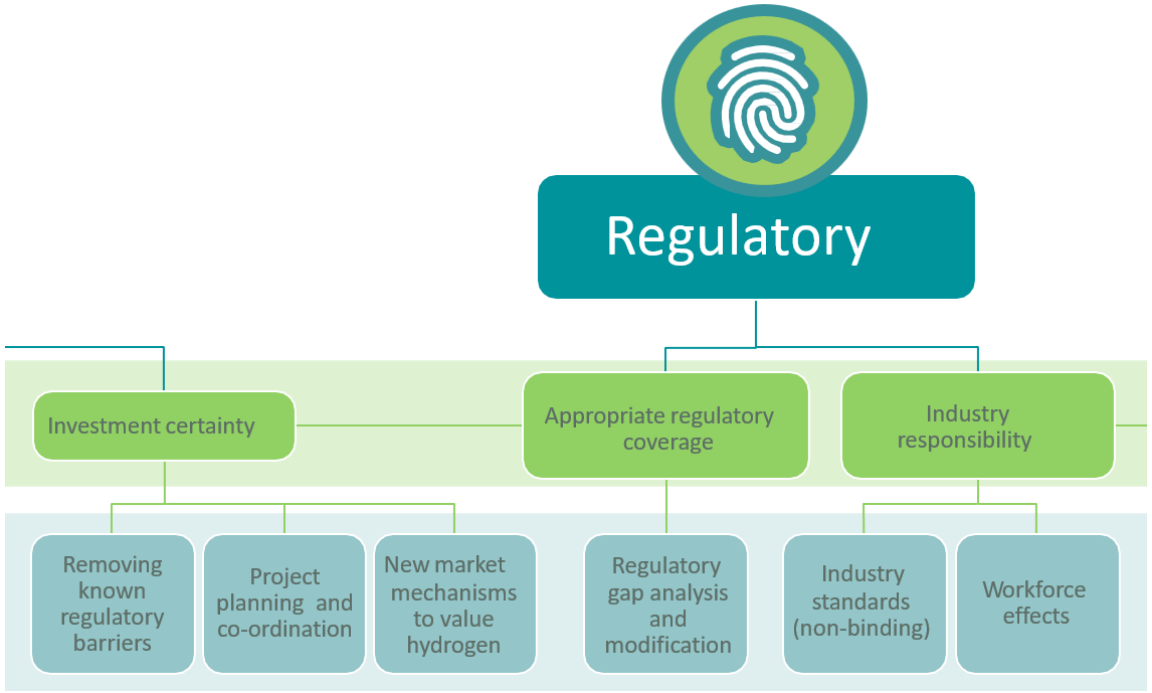
Federal
- Laws
- Codes
- Standards
- Regulations

International
- Laws
- Agreements
- Standards

Regulatory matters

Current state

- ✓ Federal and state processes underway
- ✓ Standards Australia leading technical work
- ✓ International progress in some areas



Existing social licence issues that can impact hydrogen

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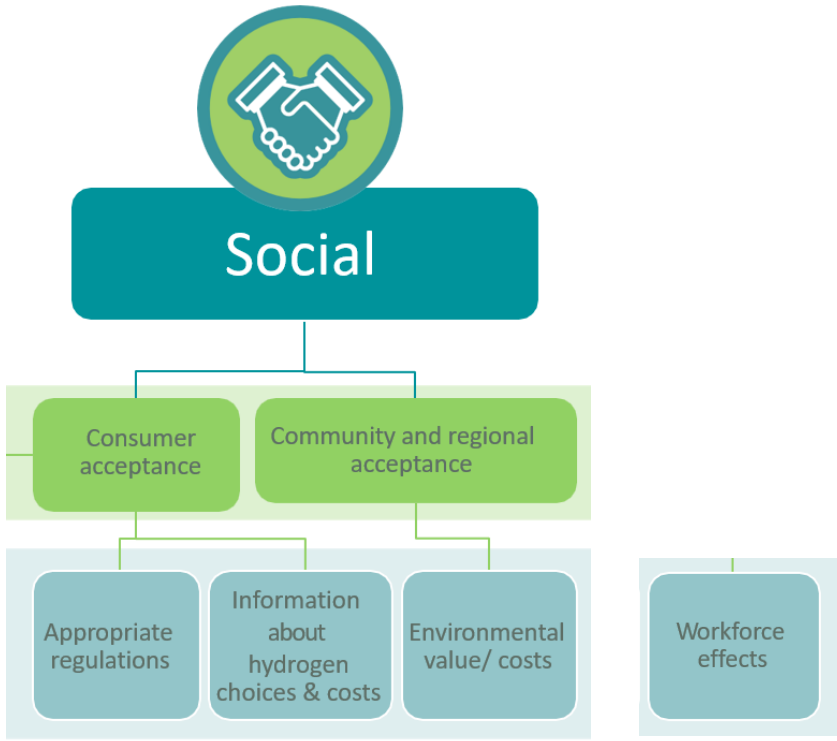
Issue	Existing/past social licence issues
Making hydrogen	*Electricity transmission infrastructure*: visual impacts, land access and use, health, biodiversity, bushfire risk and community compensation.
	Solar farms: land, past developer behaviours, decommissioning and waste management.
	Wind farms: onshore (land, noise, birdlife, visual impacts, past developer behaviours) and offshore (animals, birdlife, fishing, visual amenity); also decommissioning and waste management.
	CSG production: land, 'fracking' and effects on water, including waste management, procedural fairness.
	Raw water use: stakeholder concern about water allocation and the effectiveness of water markets.
	Seawater use: brine waste from desalination and effect on sea life, economic cost of desalination plants for communities.
	CCS/CCUS: existing scepticism about fossil fuel interests and success rates, international concerns about land value (e.g. Barendrecht) and safety.
	Mining: coal and iron ore for jobs, and hydrogen production.
Export	*LNG export*: local economy boom and bust, lack of coordination for proponents, and domestic reserve policy.
	Ports: workforce concerns and consultation.
Storage	*Hazardous goods*: e.g. 2020 Beirut port explosion from ammonium nitrate; CCS – see safety above.
End user experience	*Natural gas*: access to supply/contracts.
	Energy retail prices: concerns about affordability and energy company price gouging for smaller consumers.

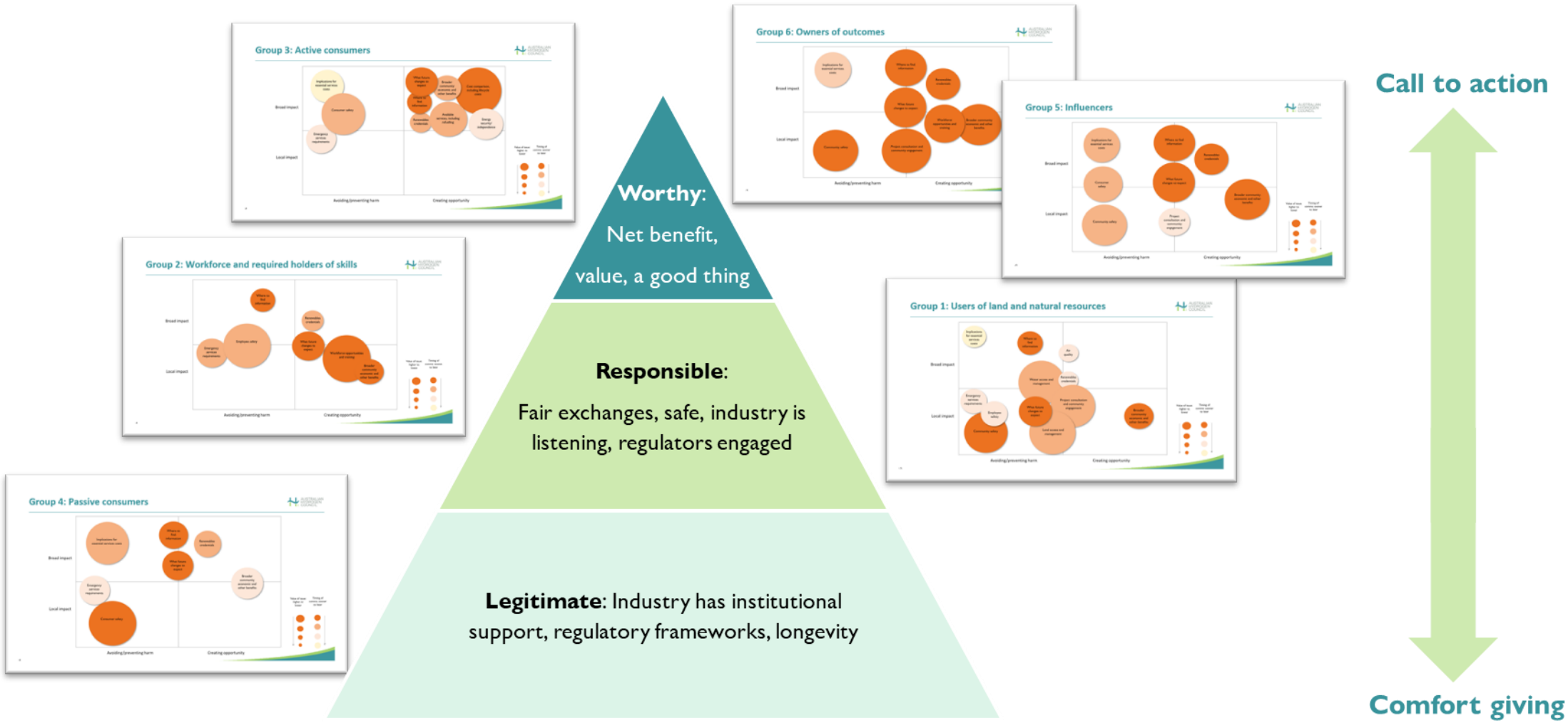
Social matters

Current state

- ✓ Surveys
- ✓ Regular discussion
- ✓ AHC work on public comms



Orienting groups to hierarchy of messaging



The issue of scale

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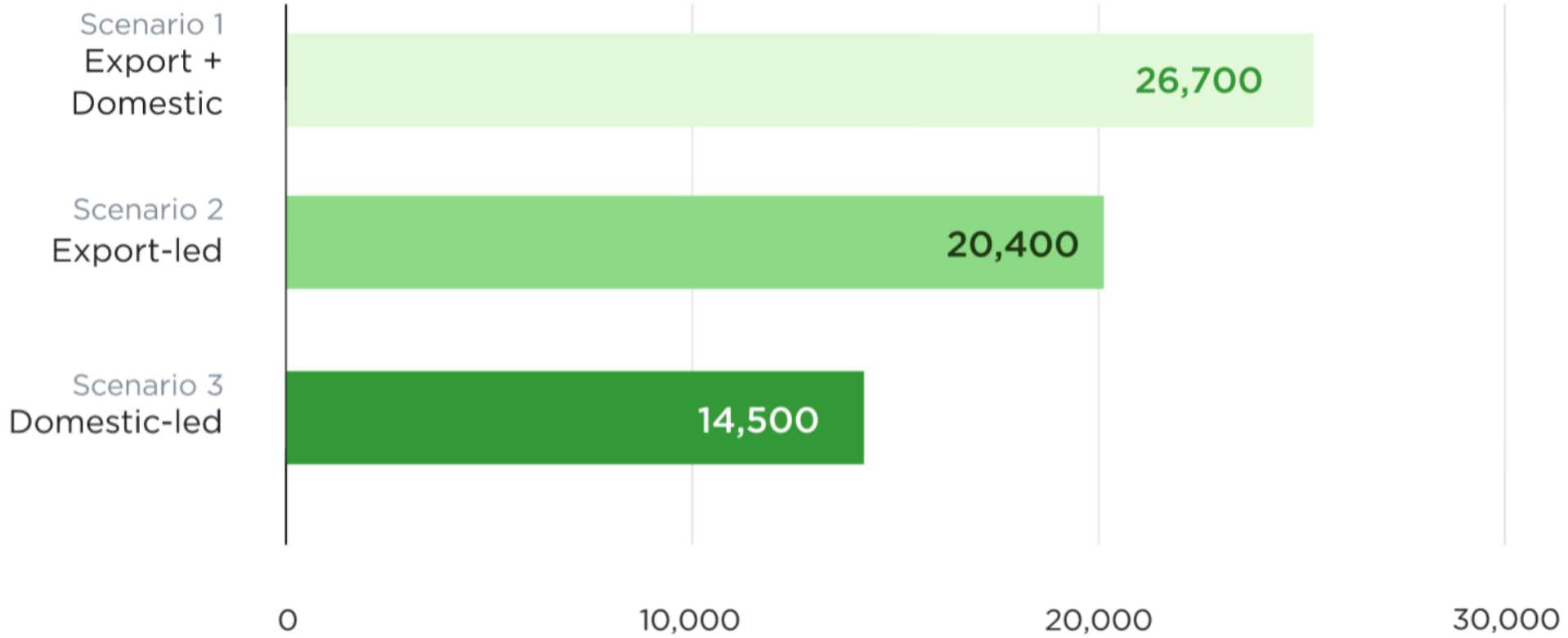
The issue of scale

Figure 7 Scenario input assumptions

	Slow Change		Progressive Change		Step Change		Hydrogen Superpower	
DEMAND								
Electrification	**2030**	**2050**	**2030**	**2050**	**2030**	**2050**	**2030**	**2050**
- Road transport that is EV (%)	2	36	5	84	12	99	18	94
- Residential EVs still relying on convenience charging (%)	82	58	75	44	70	31	66	22
- Industrial Electrification (TWh)	-24	-21	4	92	27	54	37	64
- Residential Electrification (TWh)	0	0	0.2	15	4	13	2	4
- Energy efficiency savings (TWh)	8	19	14	40	22	55	22	56
Underlying Consumption								
- NEM Underlying Consumption (TWh)	163	213	201	394	222	336	243	330
- Hydrogen consumption - domestic (TWh)	0	0	0	32	0.1	58	2	132
- Hydrogen consumption - export, incl. green steel (TWh)	0	0	0	0	0	0	49	816
- Total underlying consumption (TWh)	**163**	**213**	**201**	**425**	**223**	**394**	**294**	**1,278**
SUPPLY								
Distributed PV Generation (TWh)	39	58	39	80	45	93	51	112
Household daily consumption potential stored in batteries (%)	3	5	5	22	12	38	13	39
Underlying consumption met by DER (%)	24	27	20	19	20	24	17	9
Coal generation (% of total electricity production)	32	5	38	2	21	0	6	0
NEM emissions (MT CO_2-e)	53.3	13.0	77.2	22.4	48.1	6.8	20.6	6.6
2020 NEM emissions (% of)	38	9	54	16	34	5	15	5

The issue of scale

Renewables-related construction labour demand, Queensland (average, 2021-2050)



Source: CSIRO (2022) for Construction Skills Queensland.

The issue of scale

What are the cost/practical differences in treatment for each water type?

What are the efficiency losses and are those volumes gone or reused?

What's most likely to drive hydrogen production and how might it vary per state?

Ground water | Rivers | Lakes | Storm water | Dams | Creeks | Waste water | Sea water

Pre-treatment

Primary treatment

Secondary treatment

Final polishing

Waste/by-products

How should we address the issue of competing uses and community acceptance for these?

How do we account for actual or perceived water scarcity?

What waste are we talking about?

What are the issues we need to understand?

Hydrogen via electrolysis

Electrolyser feed water + Process plant cooling water	L/kg H2? L/kg H2?

Hydrogen via SMR, plus CCS

Boiler feed water for steam methane reformation + Process plant cooling water + Water for carbon capture and storage (CCS)	L/kg H2? L/kg H2? L/kg H2?

What is the answer to this, so that we can back solve with the above to estimate total volumes from the different sources?

In answering this publicly, how should we think about the production volume only vs the broader lifecycle?

How much more water is required for different conversions, say to ammonia?

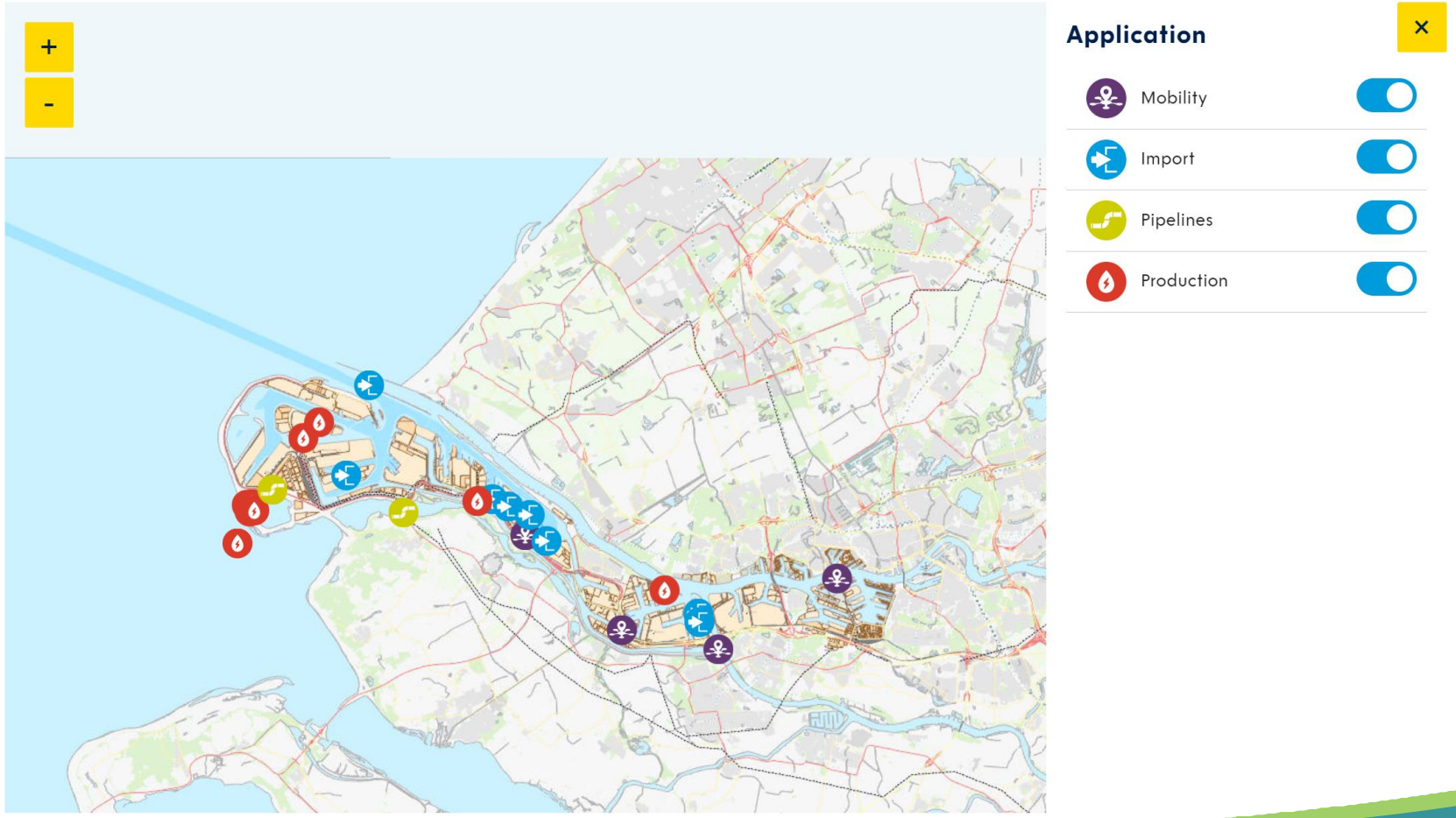
What is the answer to this, so that we can back solve with the above to estimate total volumes?

What further recycling is possible?

The issue of scale

Hydrogen projects in Rotterdam

Together with partners, we are building a hydrogen based economy in the port of Rotterdam. Find the current hydrogen projects below:



The issue of scale

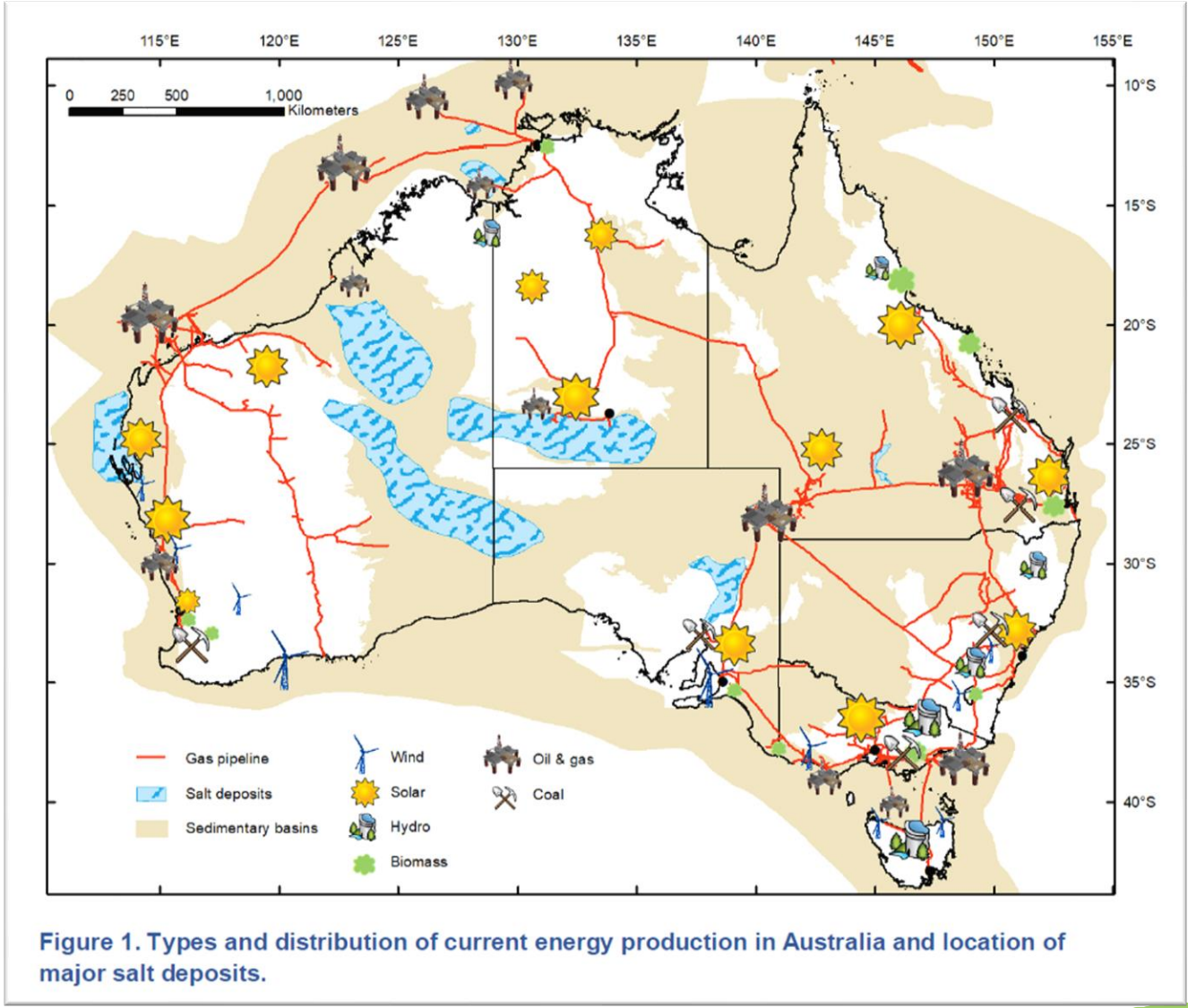


Figure 1. Types and distribution of current energy production in Australia and location of major salt deposits.

SOURCE: Future Fuels CRC (2021), RP1-1.04 Underground Storage of Hydrogen, July, page 12.

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Thank you

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