

Green Electrification

How Finland positions itself on a global level


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A woman wearing a bright yellow hooded jacket and a grey beanie stands on the deck of a boat, holding a vertical pole. The boat is moving across a dark sea, leaving a white wake. In the background, a sailboat with a dark sail is visible on the horizon. The sky is a dramatic mix of orange, red, and dark blue, suggesting a sunset or sunrise. The overall mood is adventurous and determined.

” We have the **courage** to succeed,
passion for innovation through science
and **will** to build well-being.

LUT UNIVERSITY STRATEGY 2030

TRAILBLAZERS

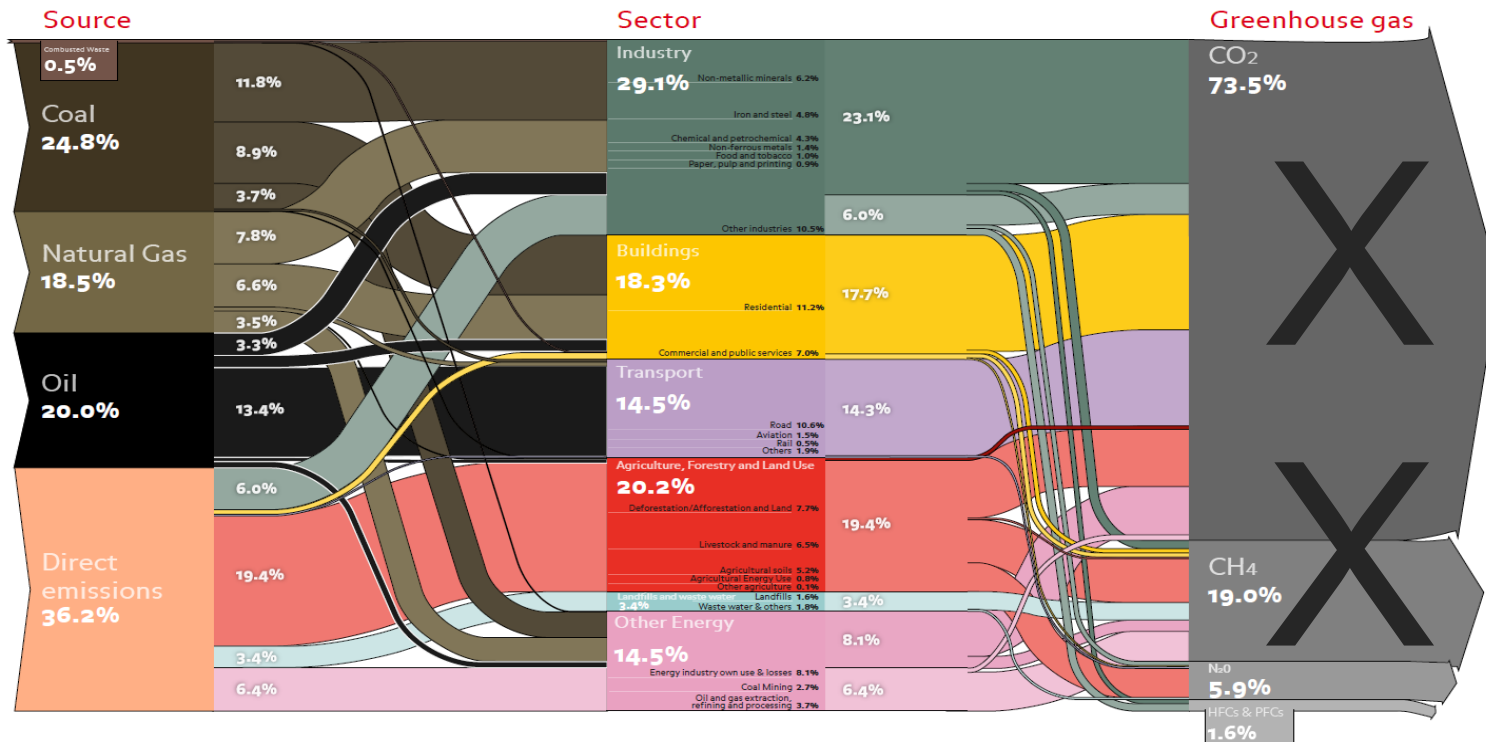
Science with a Purpose

“Need”

WORLD GHG EMISSIONS FLOW CHART

Total emissions worldwide (2012)

51,840
MtCO₂ EQ



Electrification - Basis

ELECTRICITY

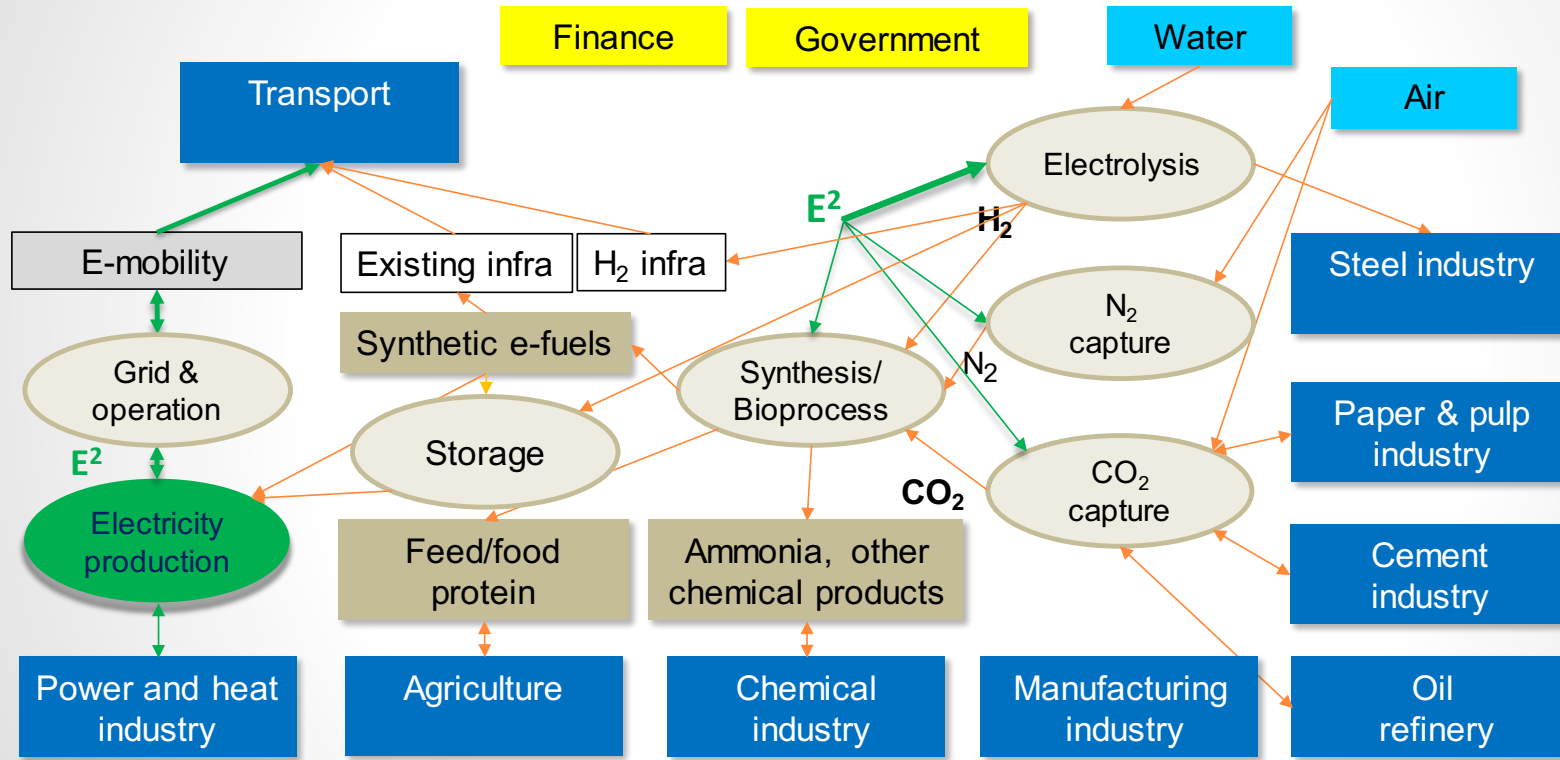
□ Storable, **unlimited !**, clean, low cost,

--> The primary energy source

→ Second wave of electrification;

□ Chemical *industry*, steel industry, cement industry, energy sector, *transportation, agriculture*, ... (target of COP21)

Green electrification E² – system level interactions and impacts



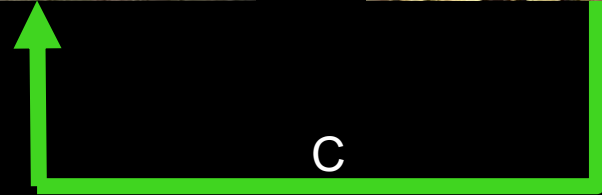
CO₂



CO₂



C_xH_x



C

C



C



CO₂

CO₂



C_xH_x

CO₂

C



H₂



~~C~~

Potential of resources in Finland; Bio based CO₂



Bio CO ₂ lähteet		CO ₂ sivuvirrat		Sähkön tarve		
Nr	Maakunta	MCO ₂ ton	kumul.	TWh	kumul.	kumul. %
1	Etelä-Karjala	5,0	5,0	43	43	21%
2	Keski-Suomi	3,6	8,6	31	73	35%
3	Kymenlaakso	3,2	11,8	27	101	49%
4	Lappi	2,6	14,4	22	123	59%
5	Pohjanmaa	2,4	16,8	21	143	69%
6	Pohjois-Karjala	1,9	18,7	16	159	77%
7	Pohjois-Pohjanmaa	1,5	20,2	13	172	83%
8	Satakunta	1,5	21,7	13	184	89%
9	Pohjois-Savo	0,7	22,4	6	191	92%
10	Uusimaa	0,6	23,0	5	195	94%
Muut maakunnat		1,4	24,4	12	207	100%
Yhteensä		24,4		207		



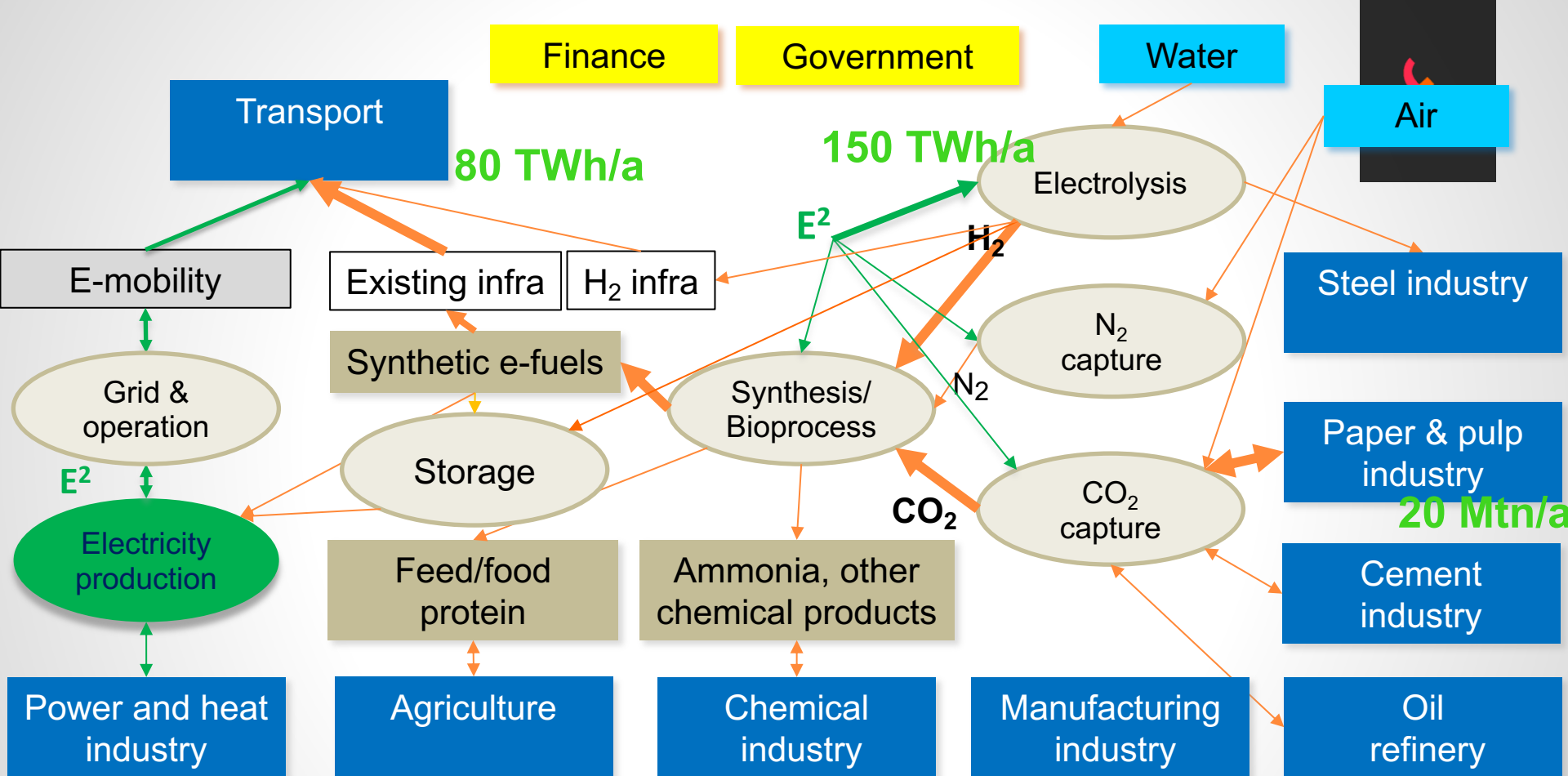
Potential of resources in Finland; All sources of CO₂

Kaikki CO ₂ lähteet		CO ₂ sivuvirrat		Sähkön tarve		
Nr	Maakunta	MCO ₂ ton	kumul.	TWh	kumul.	kumul. %
1	Uusimaa	9,0	9,0	76	76	18%
2	Pohjois-Pohjanmaa	6,6	15,5	56	132	32%
3	Etelä-Karjala	5,5	21,1	47	179	43%
4	Lappi	4,7	25,8	40	219	53%
5	Keski-Suomi	4,3	30,1	37	256	62%
6	Kymenlaakso	3,8	34,0	33	289	70%
7	Pohjanmaa	3,6	37,6	31	320	77%
8	Satakunta	2,4	40,0	21	340	82%
9	Pohjois-Karjala	2,0	42,0	17	357	86%
10	Varsinais-Suomi	1,9	43,9	16	373	90%
	Muut maakunnat	4,8	48,7	41	414	100%
	Yhteensä	48,7		414		



Potential of resources in Finland; Need of electricity for H₂ production, TWh/a

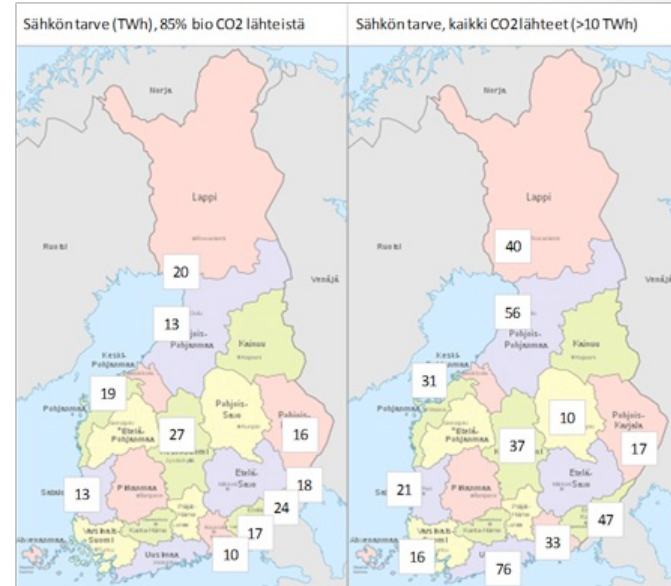
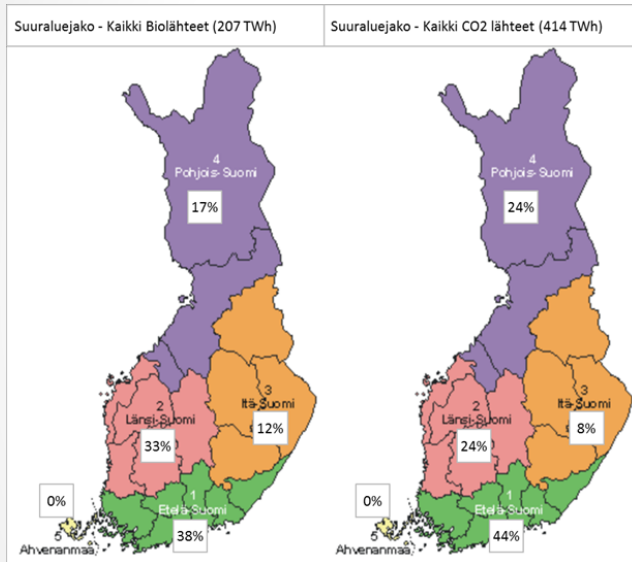
Bio CO ₂ lähteet		CO ₂ sivuvirrat		Sähkön tarve		
Nr	Maakunta	MCO ₂ ton	kumul.	TWh	kumul.	kumul. %
1	Etelä-Karjala	5,0	5,0	43	43	21%
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	Muut maakunnat	1,4	24,4	12	207	100%
	Yhteensä	24,4		207		



Production of electricity was about 70 TWh/a in 2019



Need of additional clean, cheap electricity is +200-400 TWh/a



Mission impossible?



Wind power potential in Finland

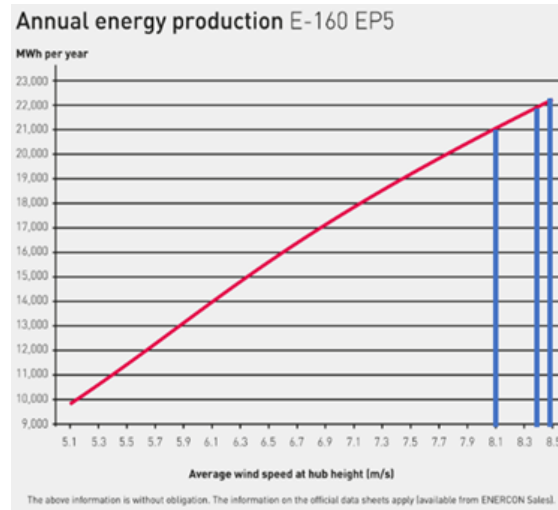
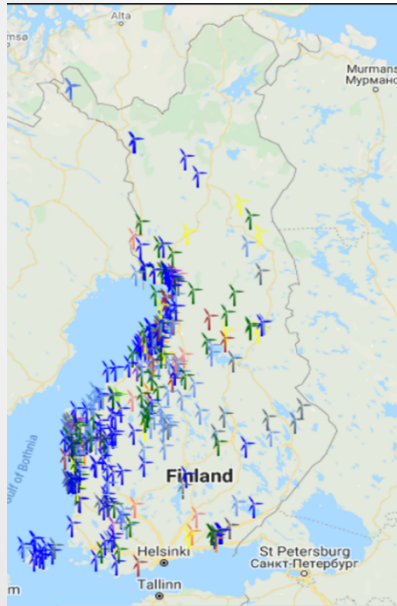
Existing production of wind power is about 12 TWh/a

In planning phase there are capacities of 37 TWh/a

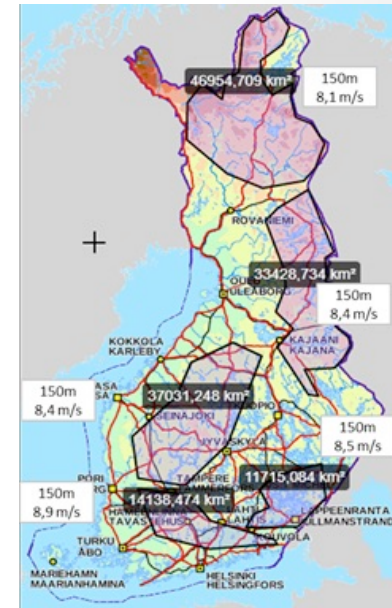
Existing 50 TWh/a



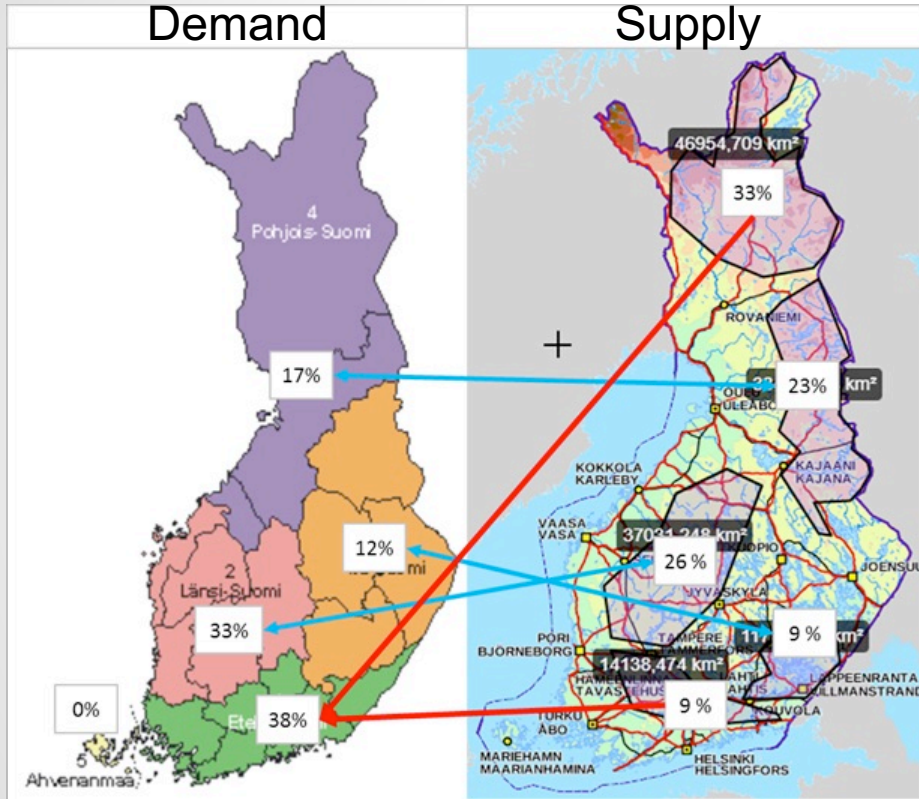
Potential 250 TWh/a



Mission possible!



Areal balance between demand and supply



New transmission lines and flexibility markets are inevitable

What is the best way to transfer energy –

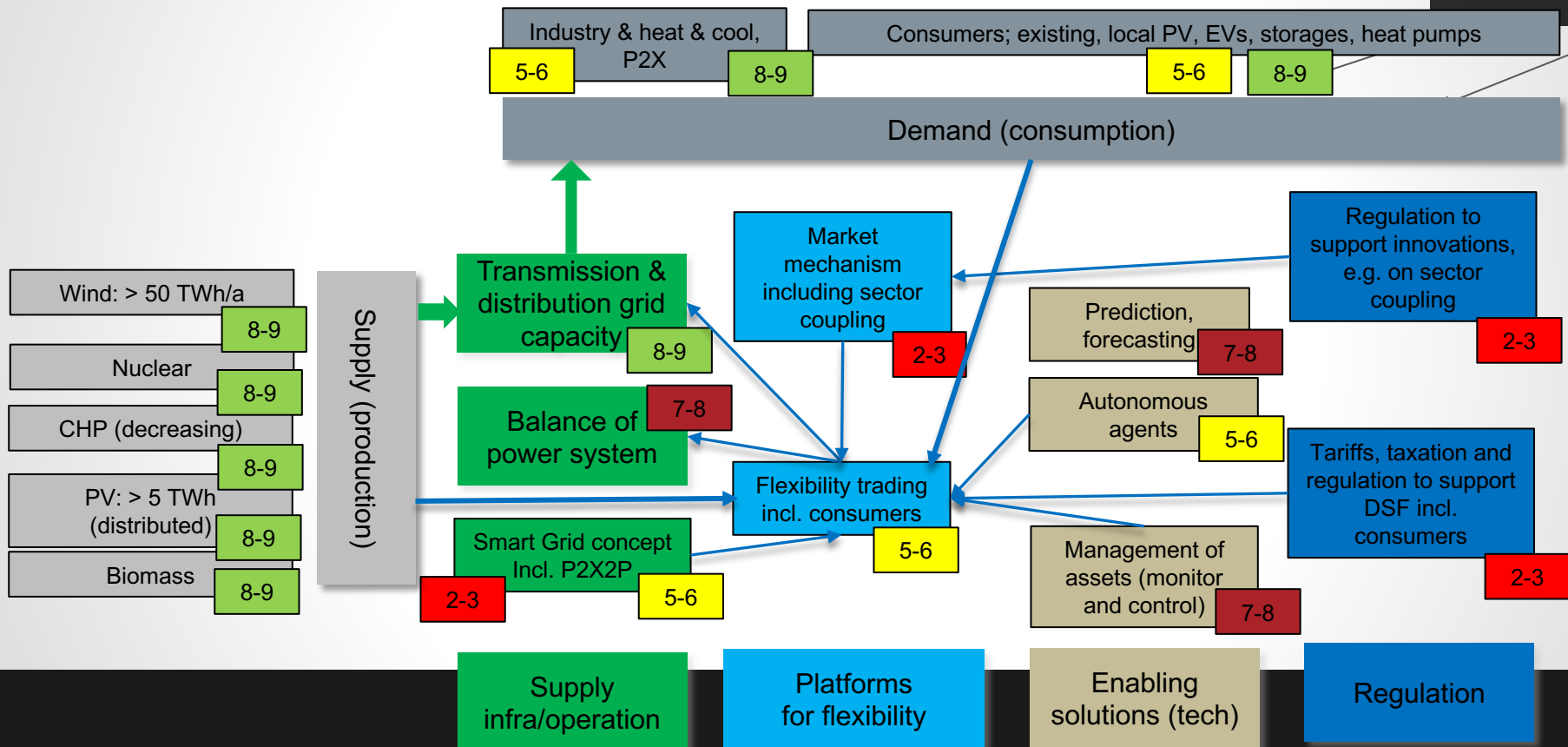
Transfer of electricity or hydrogen.

Is there a need to transfer CO₂ ?

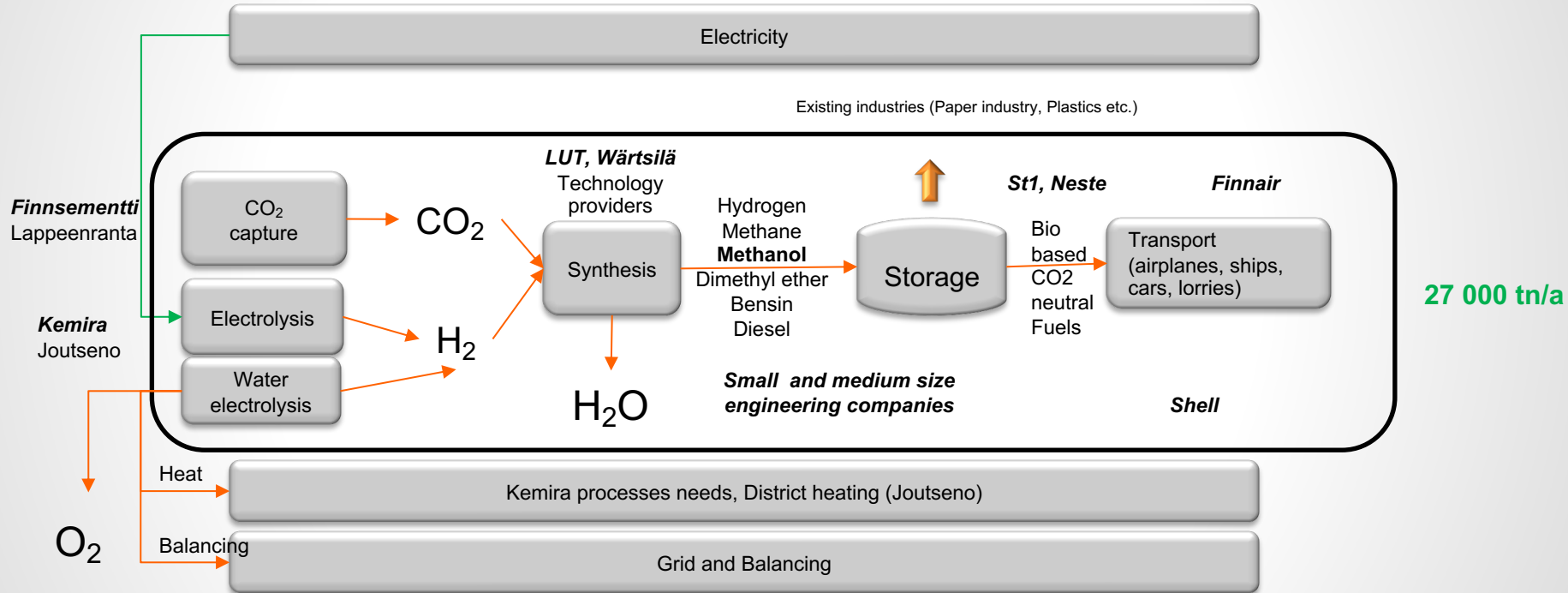
Operation of System of Systems



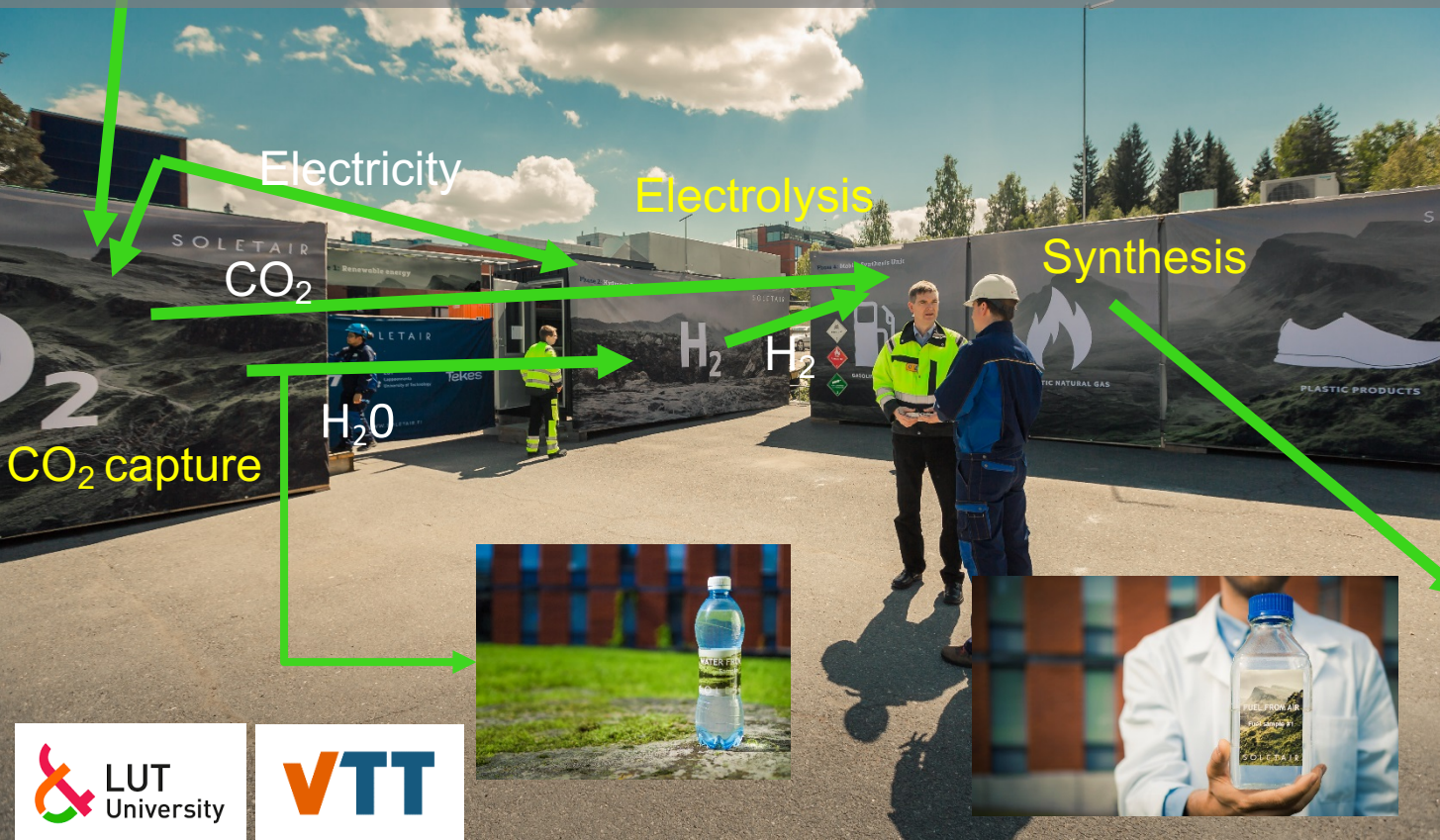
Innovation needs, resources and technology readiness levels



Feasibility study on industrial sized production pilot of carbon neutral fuels at Joutseno



SOLETAIR - Fuel from the air



Hydrocarbon from air and sunlight



Electricity from solar power plant



Production of hydrogen from water using electrolysis



Carbon dioxide recovery from air



Hydrocarbon formed from synthesis



Hydrocarbons refined into fuels and chemicals



End products – gasoline, diesel, plastics, etc.

Source: Soletair-project

Yle Uutisgrafikka