SYSTEM EARTH

FUTURE ENERGY SOLUTIONS, LAPPEENRANTA 8.11.2022

SOUTH - EAST FINLAND HYDROGEN VALLEY

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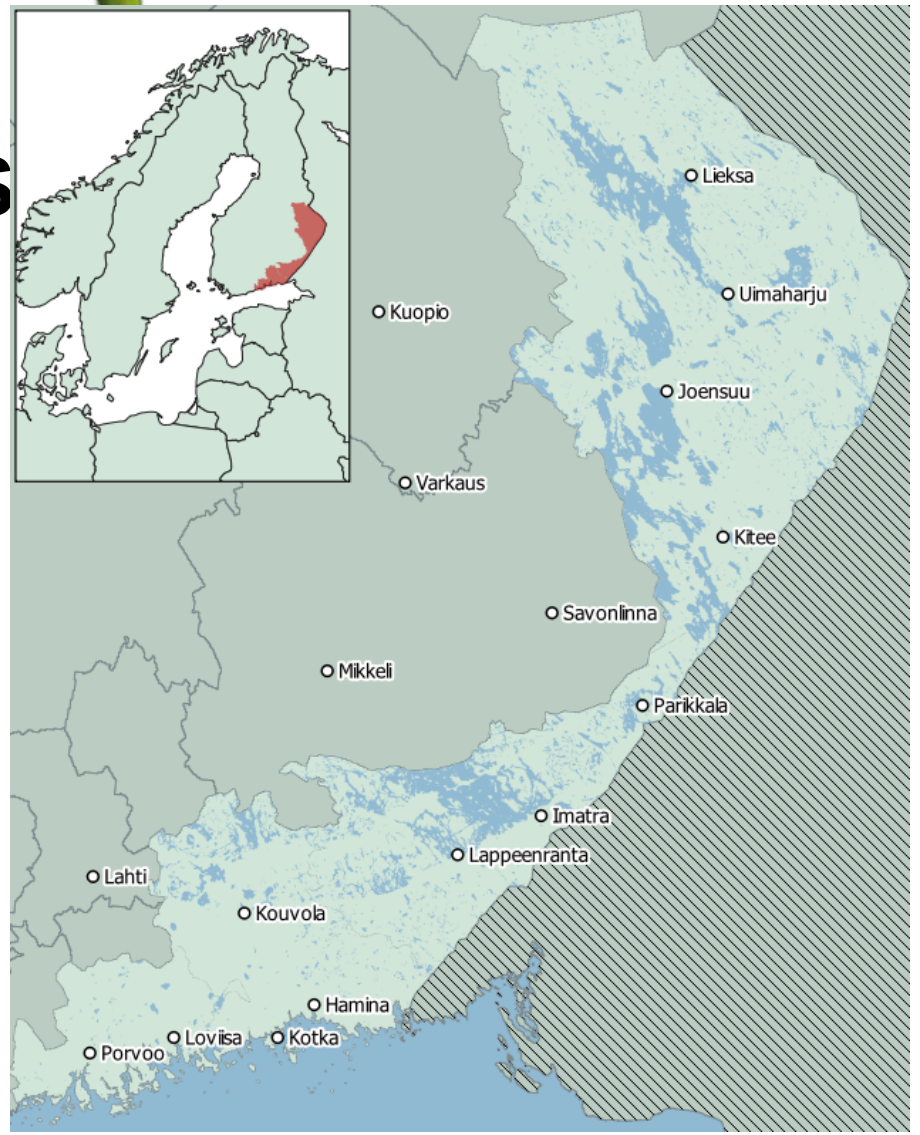
HYDROGEN VALLEY FOUNDATIONS

- **Traditional and competitive pulp mill production**
  - Annual bio CO2 emissions ~50% of total in Finland (10 Mtn CO2)
  - Existing logistics for wood handling
- **Remarkable resources for clean energy production**
  - Excellent wind conditions
  - Sparsely populated: Room for wind and solar power
  - Existing hydro- and nuclear power production
  - Existing bio energy (electricity and heat) production
- **Russian border**
  - Defence force radar issue
  - No energy transmission from Russia – gas, electricity, bio imports are cut for a long period
- **Existing infrastructure**
  - Gas network
  - Large export ports
- **The future role of the Porvoo refinery**



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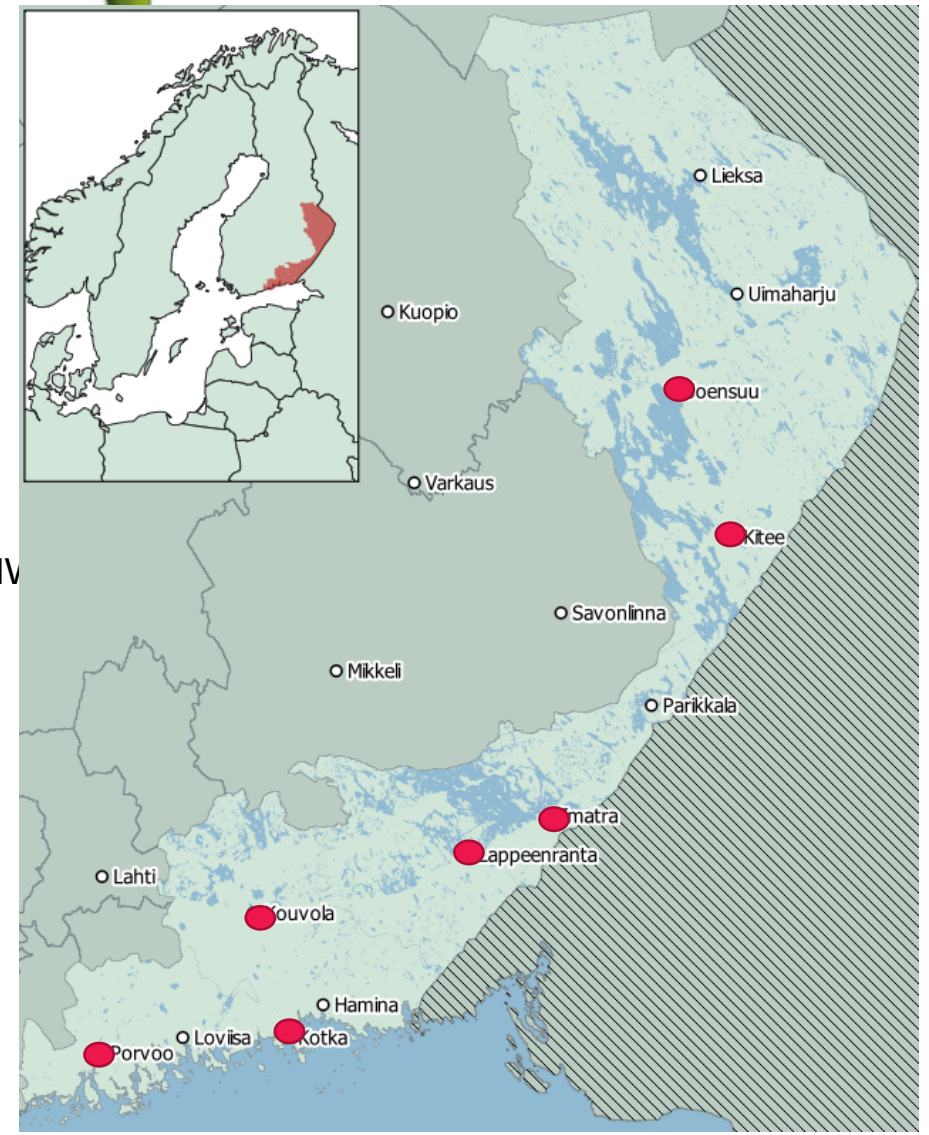
INVESTMENTS UNDER PLANNING

- Green and blue hydrogen production, Neste, Porvoo
- P2 Methanol production, ST1, Finnsementti, Lappeenranta
- Battery storage for electricity, Neoen, Lappeenranta
- Hydrogen pipeline, Ovako, Kemira, Gasgrid Finland, Joutseno-Imatra
- Green Hydrogen transition in production, Ovako, Imatra
- Several industrial scale solar production facilities (Forus Oy, Better Energy, 250 MW
- P2G production, P2X solutions, Savon Voima, Joensuu
- P2G prodution, Kotkan energia, Ren-Gas, Kotka
- Green Hydrogen transition in production, Solvay Chemicals, Kouvola
- Green Hydrogen transition in production, UPM Kaukas, Lappeenranta
- Green Methanol Production, Bakelite, Kitee
- Battery material production (2 projects), Kotka-Hamina
- Battery storage for electricity, Joensuu
- Several heat storage projects



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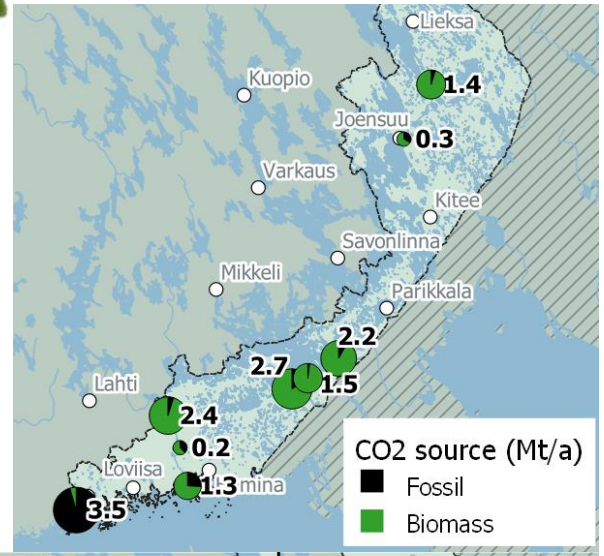
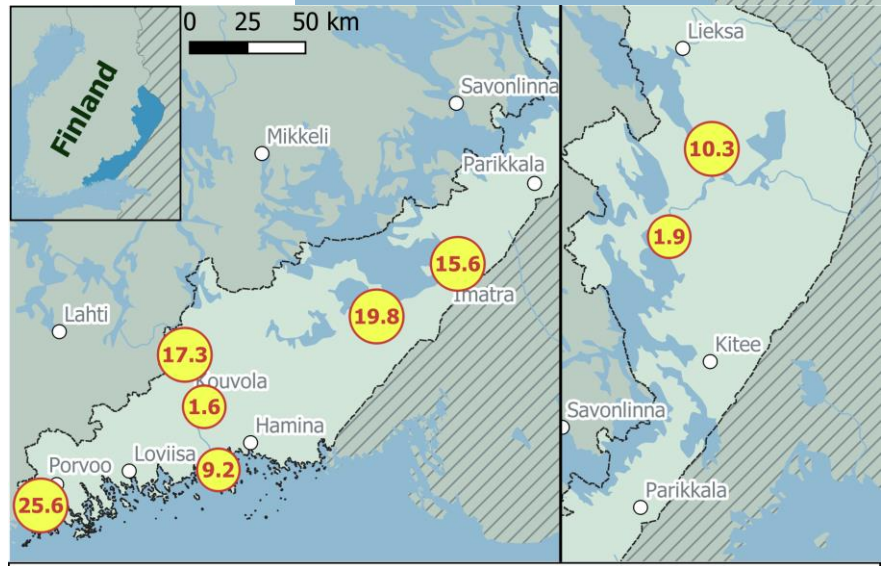
BIOGENIC CO_2 SOURCES

- Large emissions (>100 kt/a) CO_2
- Mainly biobased (10.8 Mt/a), located in the south

Scenario	Base			
CO_2 emission facility type	(All)	(All)	Pulp and paper	(All)
CO_2 type	Total	Biogenic	Biogenic	Biogenic
Portion of CO_2 utilized	100 %	100 %	100 %	20 %
CO_2 utilized (Mt)	15.5	10.8	9.5	2.2
Methanol production (Mt)	11.3	7.8	6.9	1.6
Hydrogen demand (Mt)	2.1	1.5	1.3	0.3
Electrolyser electricity demand (TWh)	**112**	**78**	**69**	**16**





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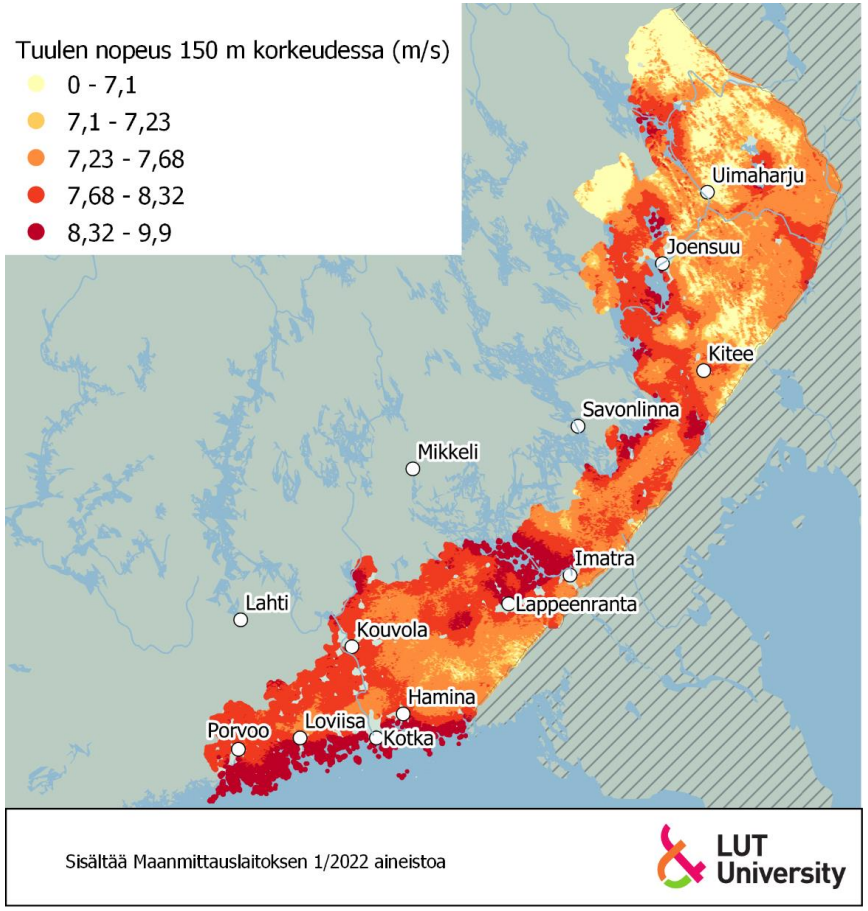
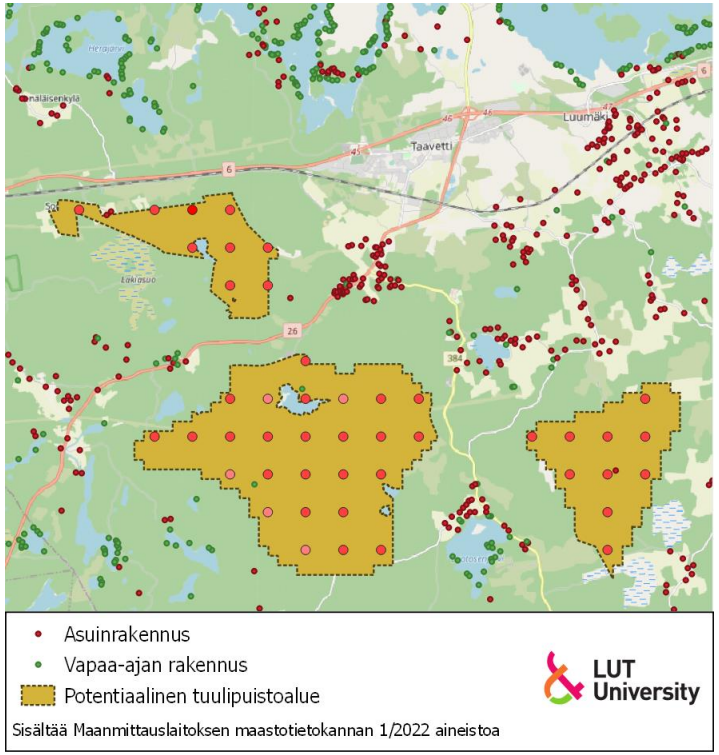
WINDPOWER POTENTIAL





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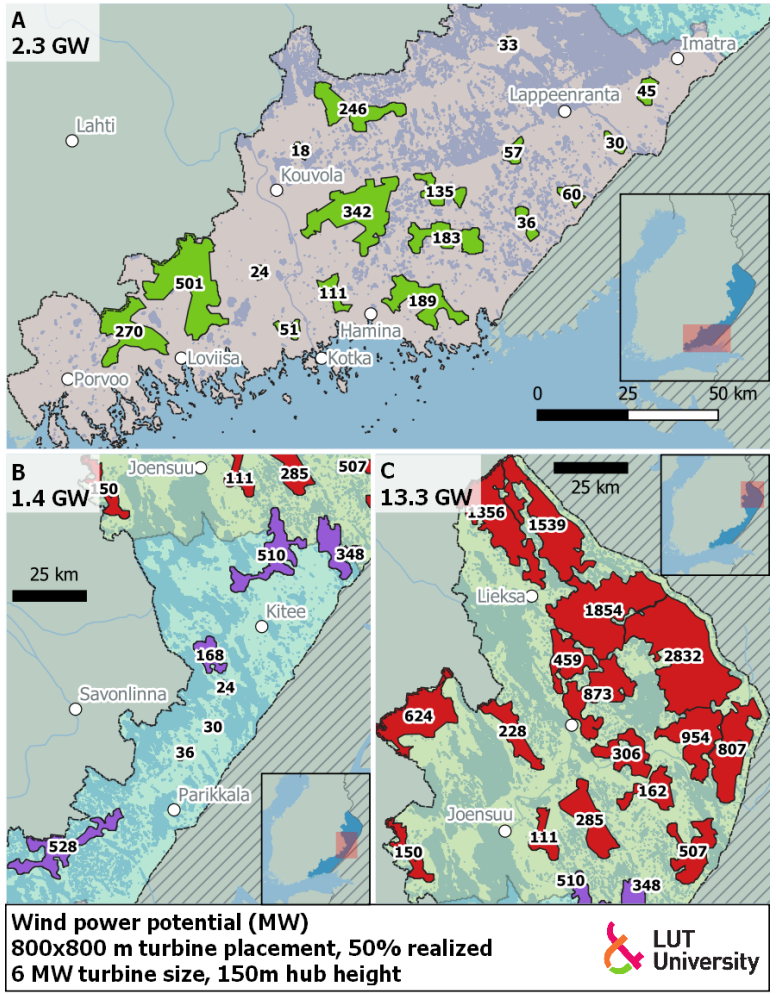
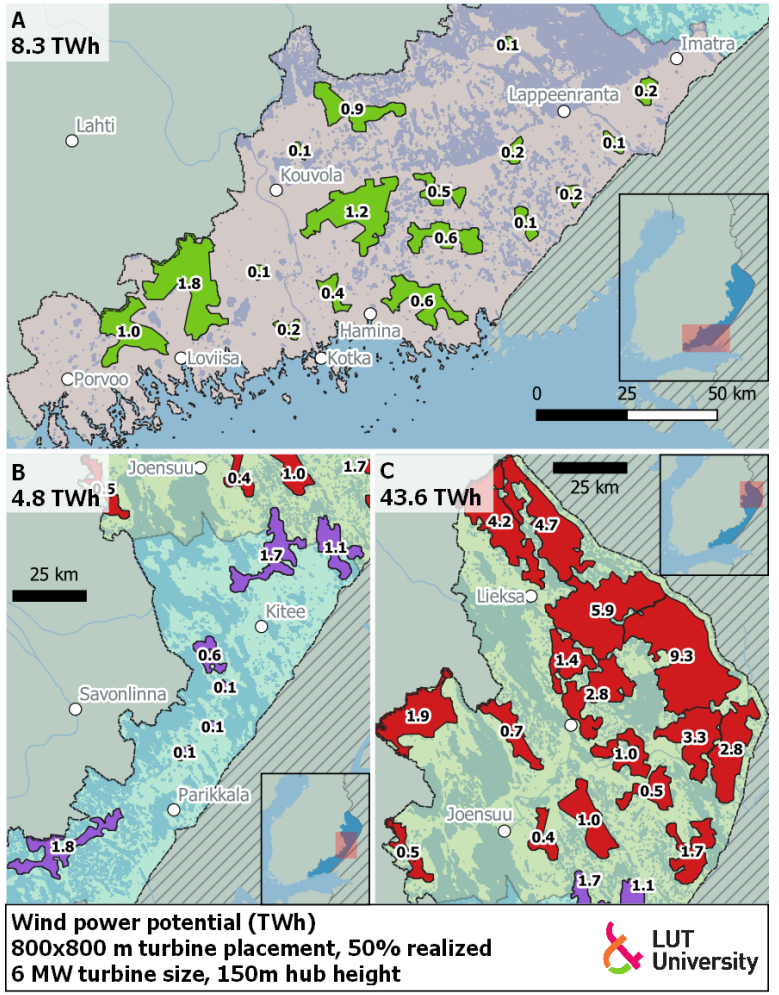
WINDPOWER RESULTS

- Scenario approximately 50 % will be built

TOTAL 17 GW



TOTAL 57 TWh



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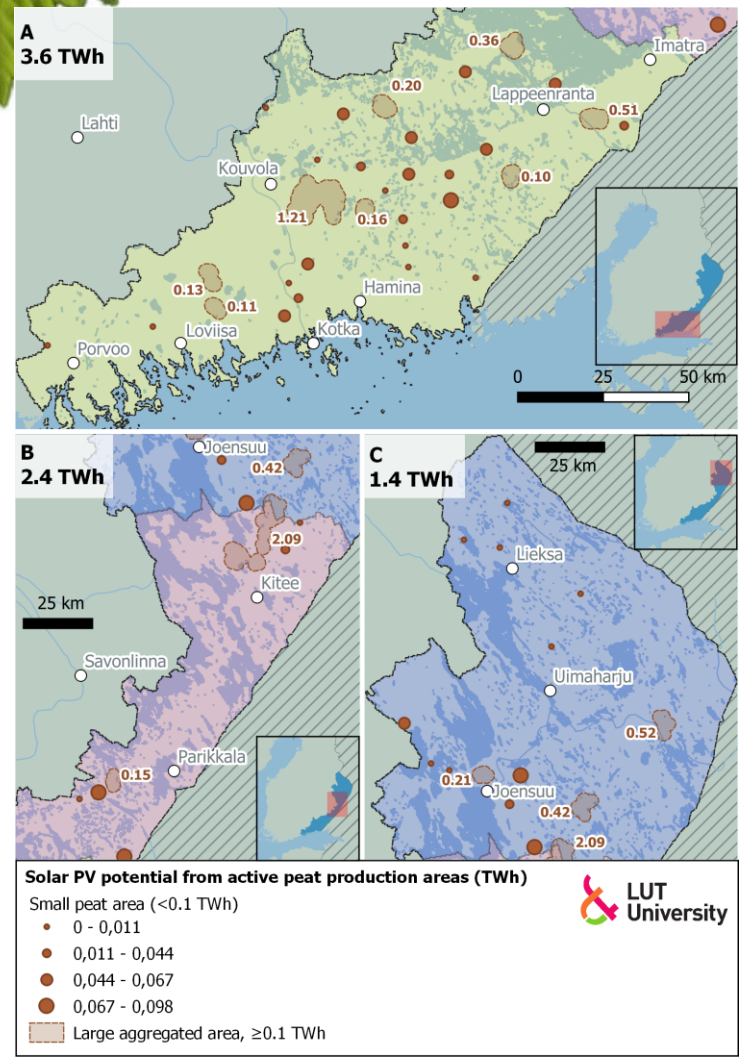
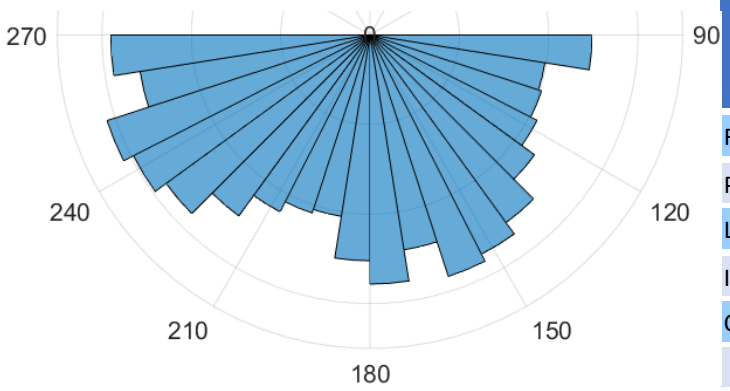
SOLAR POTENTIAL

Peat production areas	7,4 TWh/a
Roof tops	3,3 TWh/a
Total	**10,7 TWh/a**

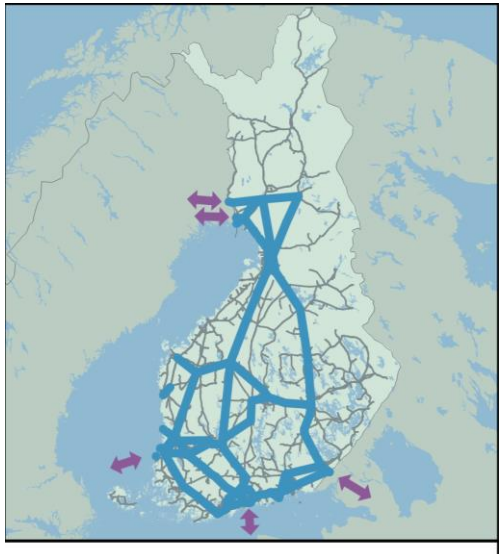


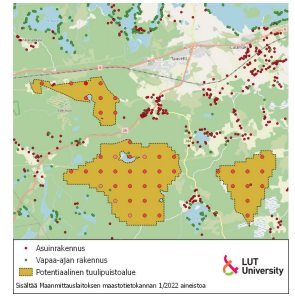
Roof directions

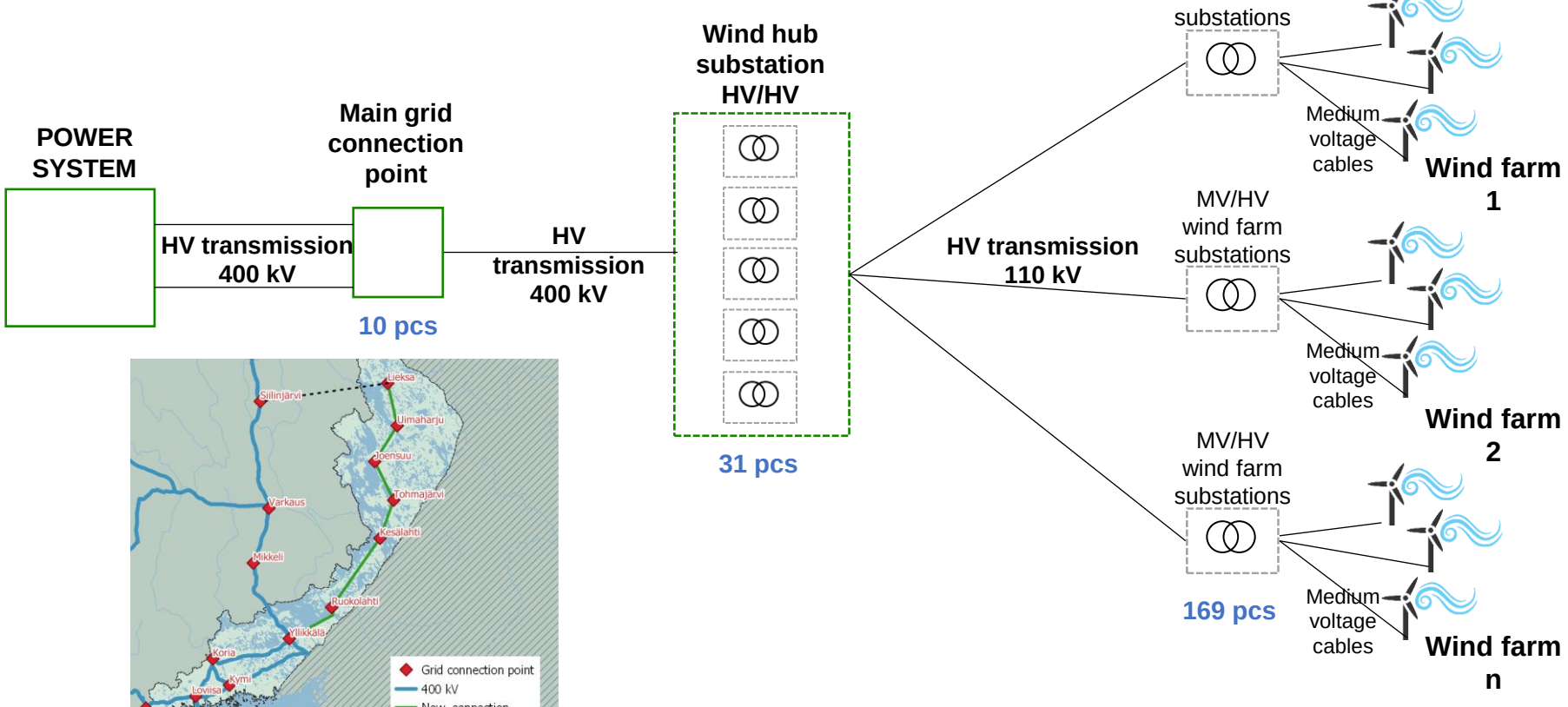


Building type	Number	Rooftop surface, km²	Avg. size, m²/roof	Rooftop potential, S_n, MVA	Avg. size kVA/roof	Annual energy TWh/a
Residental	160 232	27	171	1 350	8,6	1,1
Public	10 600	7	669	350	33,5	0,3
Leisure	58 810	4	70	200	3,5	0,2
Industry	4 917	6	1159	300	58,0	0,3
Other	401 006	33	83	1 650	4,2	1,4
Total	**635 565**	**78**	**122**	**3 850**	**6,1**	**3,3**

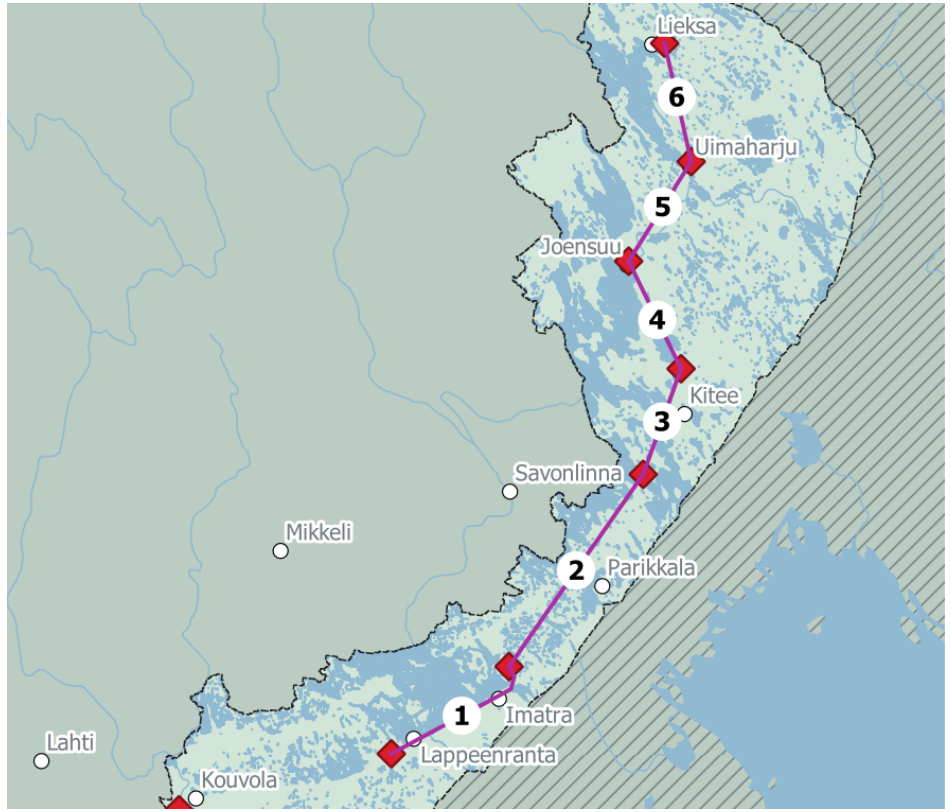
ELECTRICITY TRANSFER

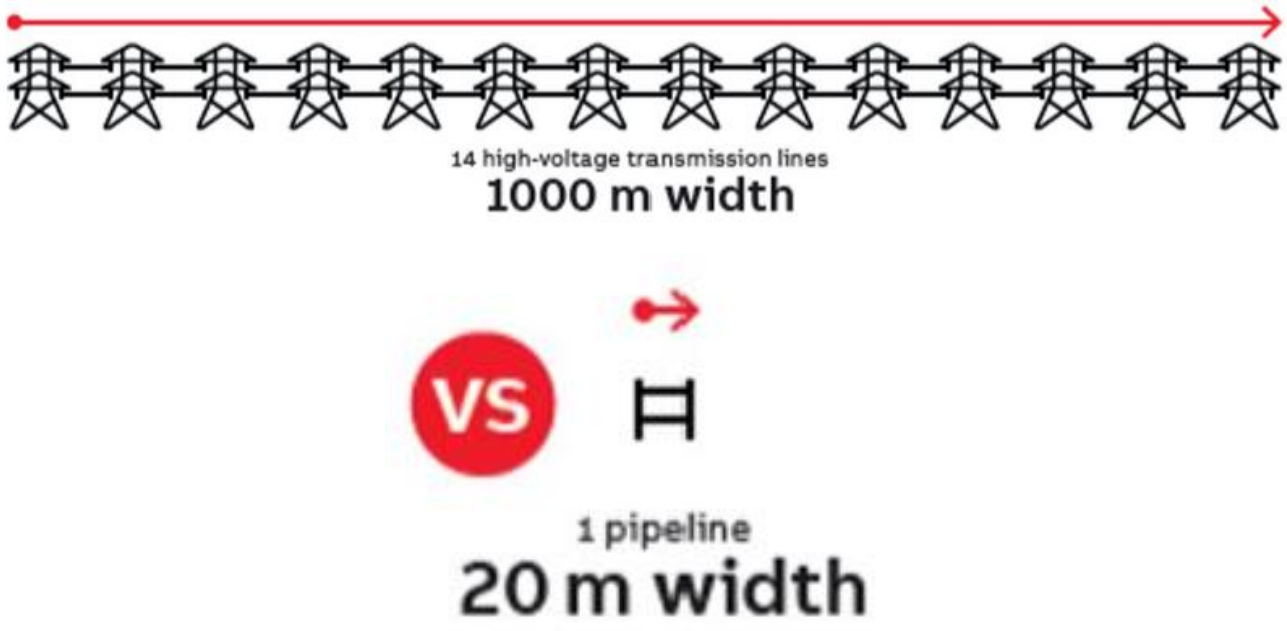






HYDROGEN VS ELECTRICITY





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SOCIAL IMPACTS

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SUMMARY OF THE SOCIAL IMPACTS

	MEUR		MEUR
Investments	50% scenario		100 % scenario
Wind power	20 400		40 800
Solar PV	5 464		10 928
Infrastructure	10,1		20,2
TOTAL	25 874		51 748
New jobs			
Wind power	14 500		29 000
Solar PV	14 500		29 000
Infrastructure	11		23
TOTAL	29 011		58 023
Annual incomes	**MEUR**		**MEUR**
Real estate tax/a	82		164
Land leases/a	82		164
Income tax	1,1		2,3
TOTAL	165		330

When refined to methanol

- Investments additional 20-40 BEUR
- 7,8 million t/a
- Annual revenue 8 mrd EUR/a
- About the same amount that transport sector in Finland consumes annually

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HOW DO WE GET THERE

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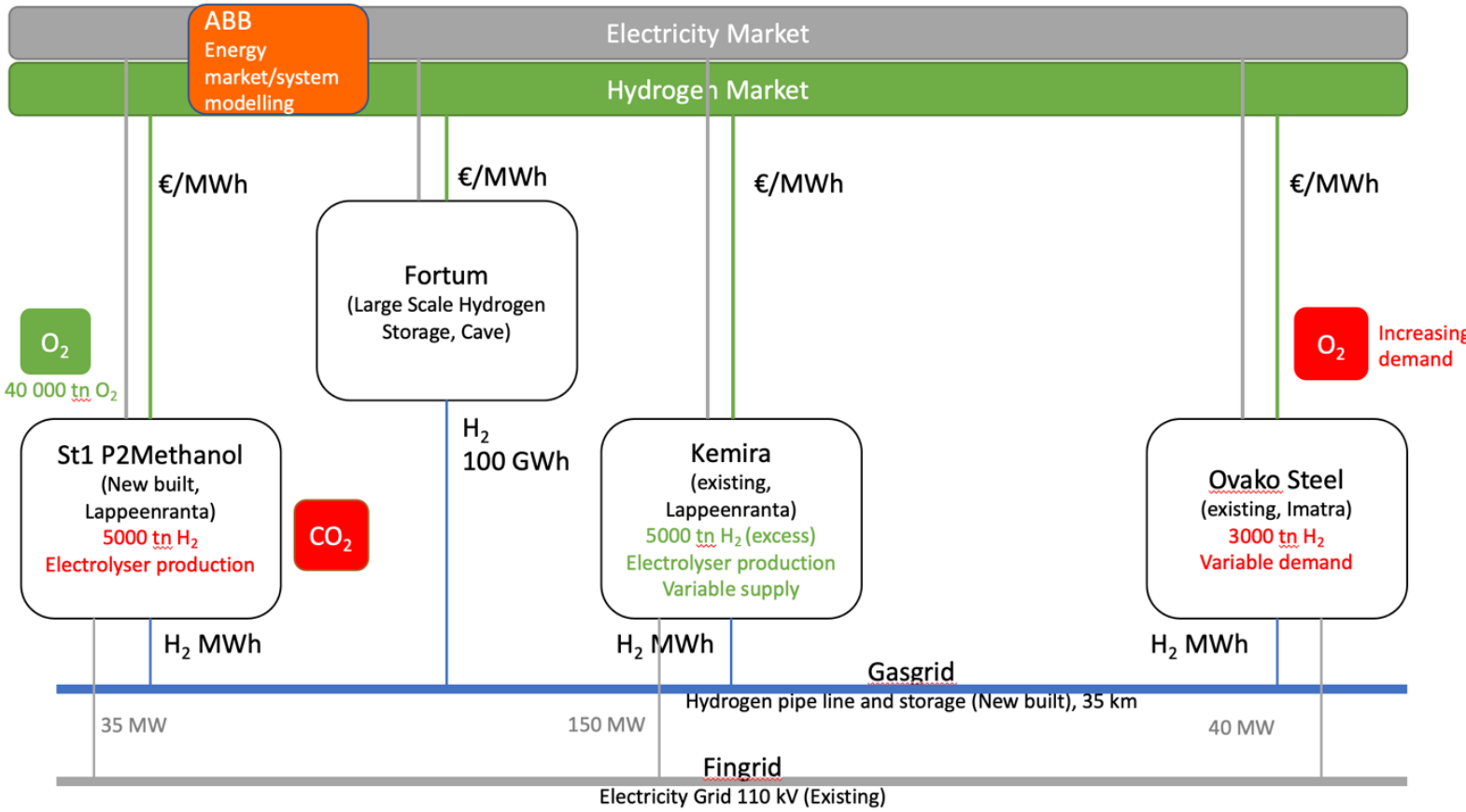
TODO & NEXT STEPS

- Solve the radar problem restricting the wind power investment in half of the Finland
- Investments in infrastructure (electricity, hydrogen)
- Speeding up research in industrial scale together with firms
  - EU South-East Hydrogen Valley applications was made in September ~25 M€ / 6 years



South-East Finland Hydrogen Valley project

RESEACH REPORT

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