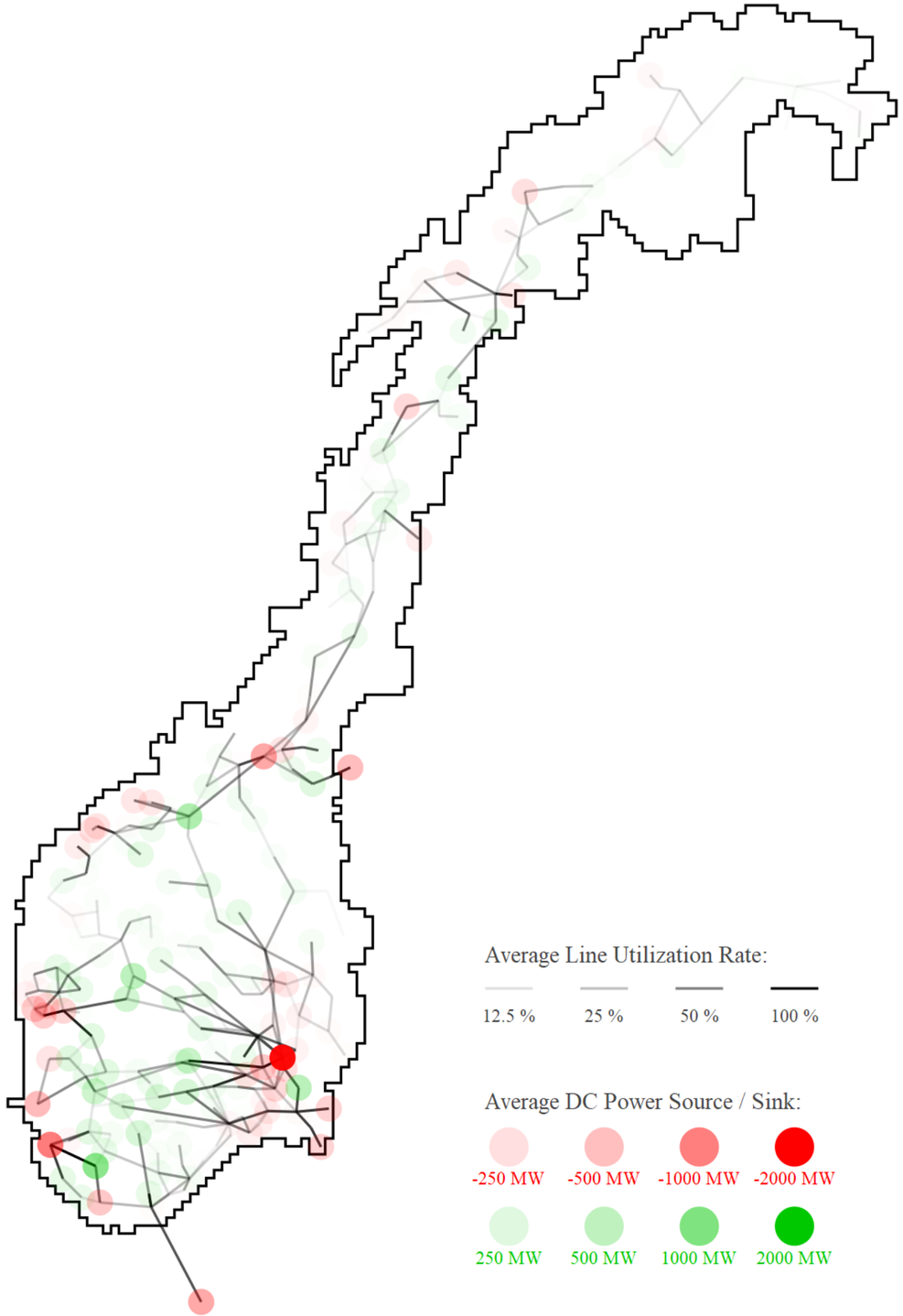


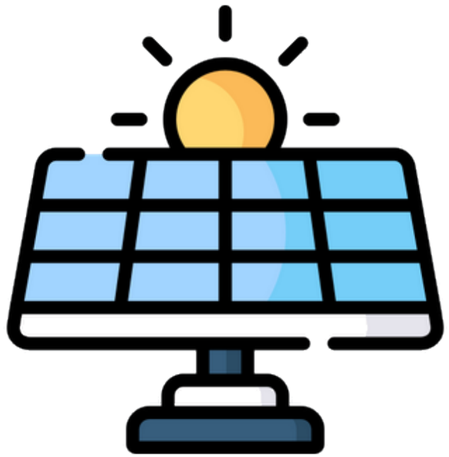
The roles and impacts of active end-users and DSOs during the transition towards smart distribution grids

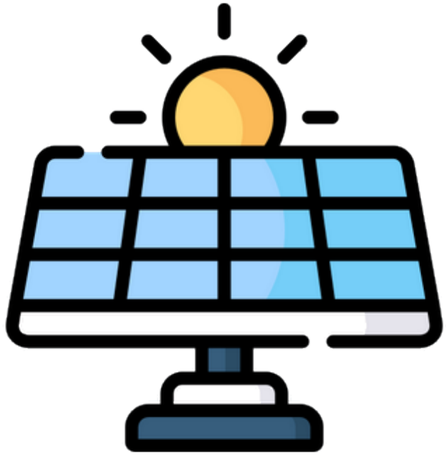
Dung-Bai (Tony) Yen
02.06.2023
Trondheim, Norway

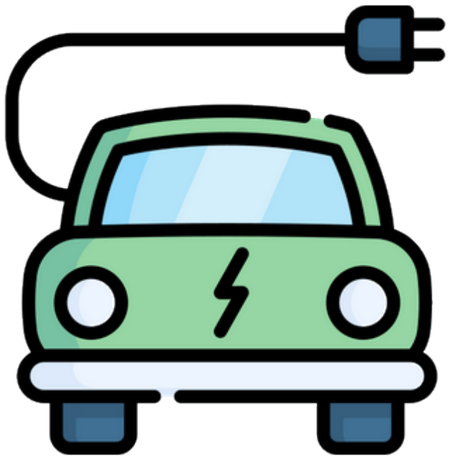
CINELDI
Centre for intelligent electricity distribution
- to empower the future Smart Grid

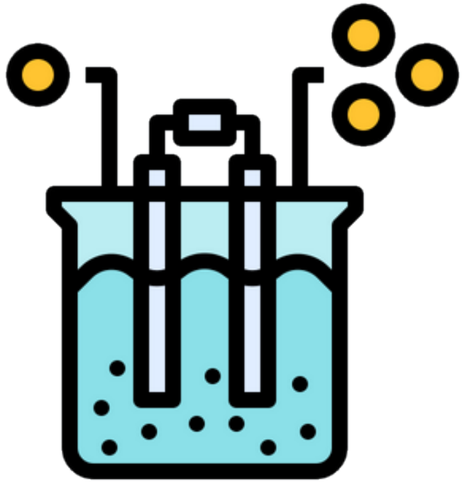
NTNU

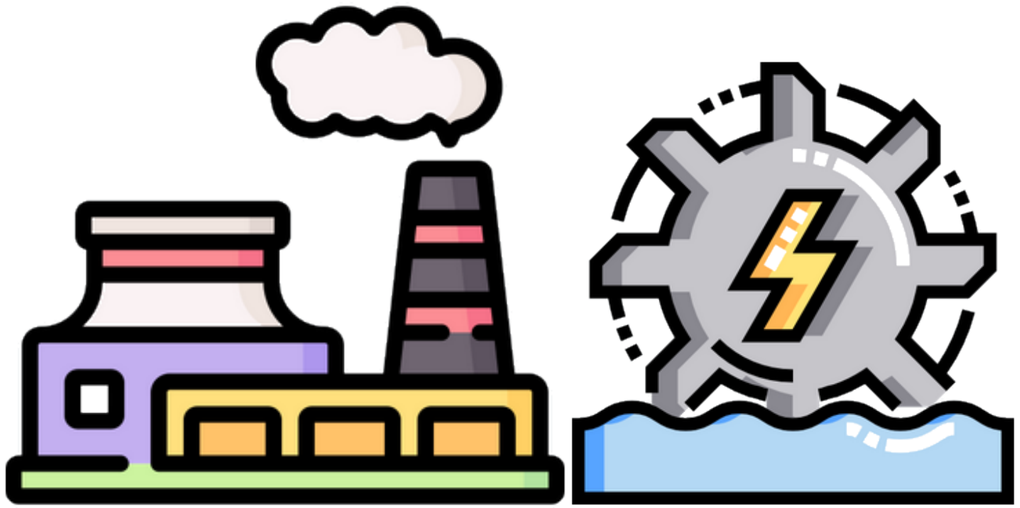
Motivation

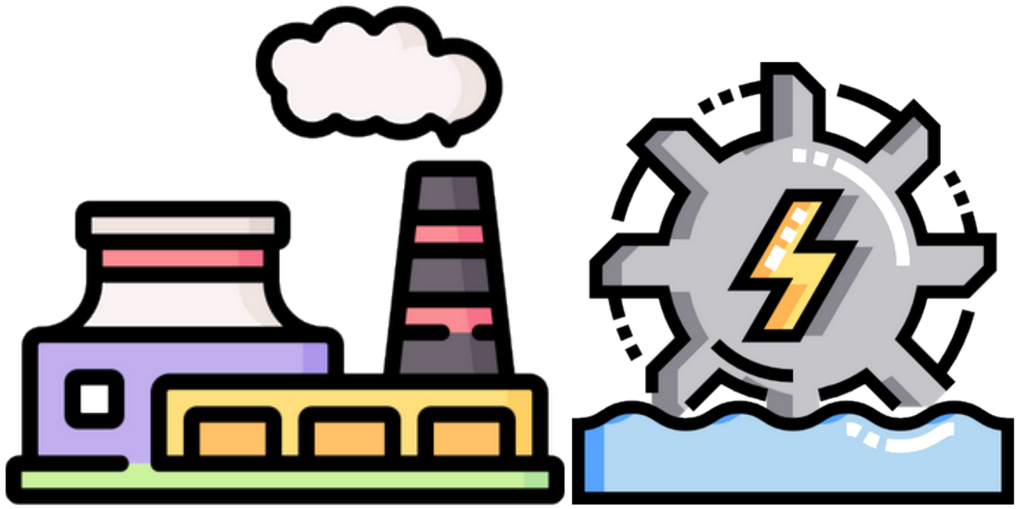




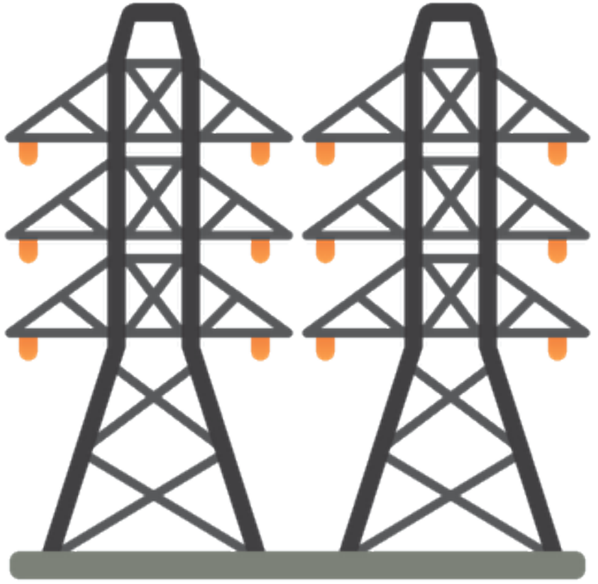








Research Questions



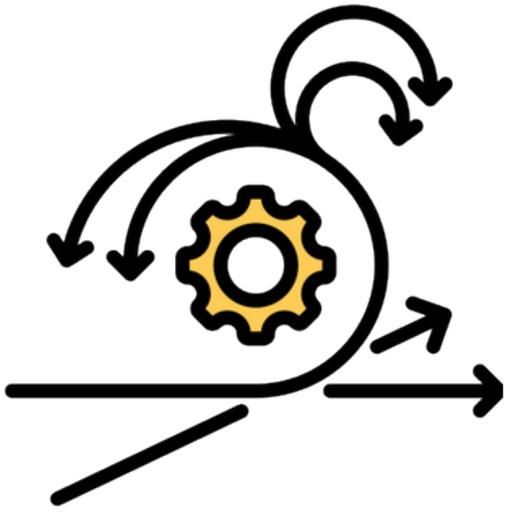
Active End-Users and DSOs' Roles in...

Short Term Operation

Long Term Transition

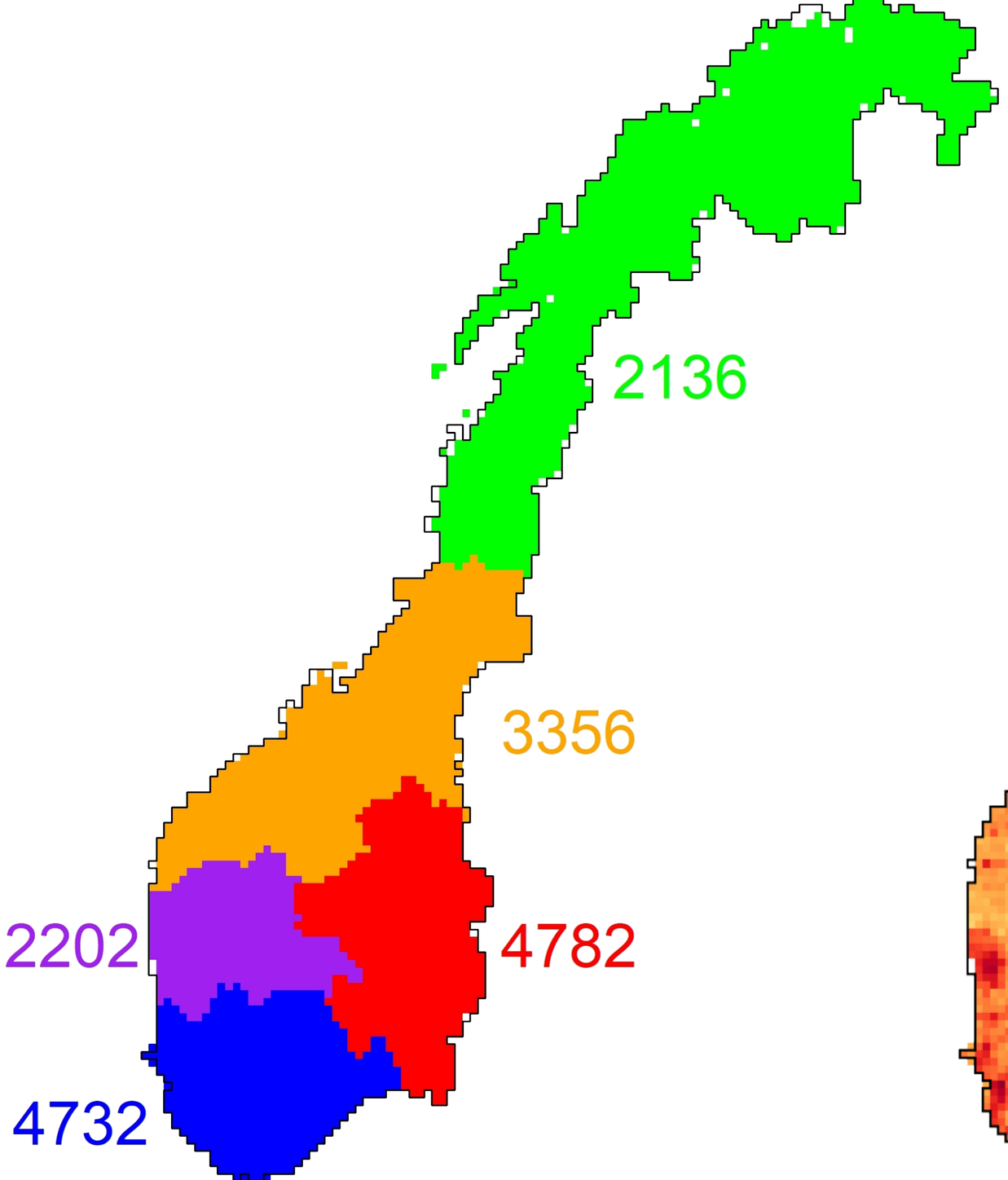
System Resilience

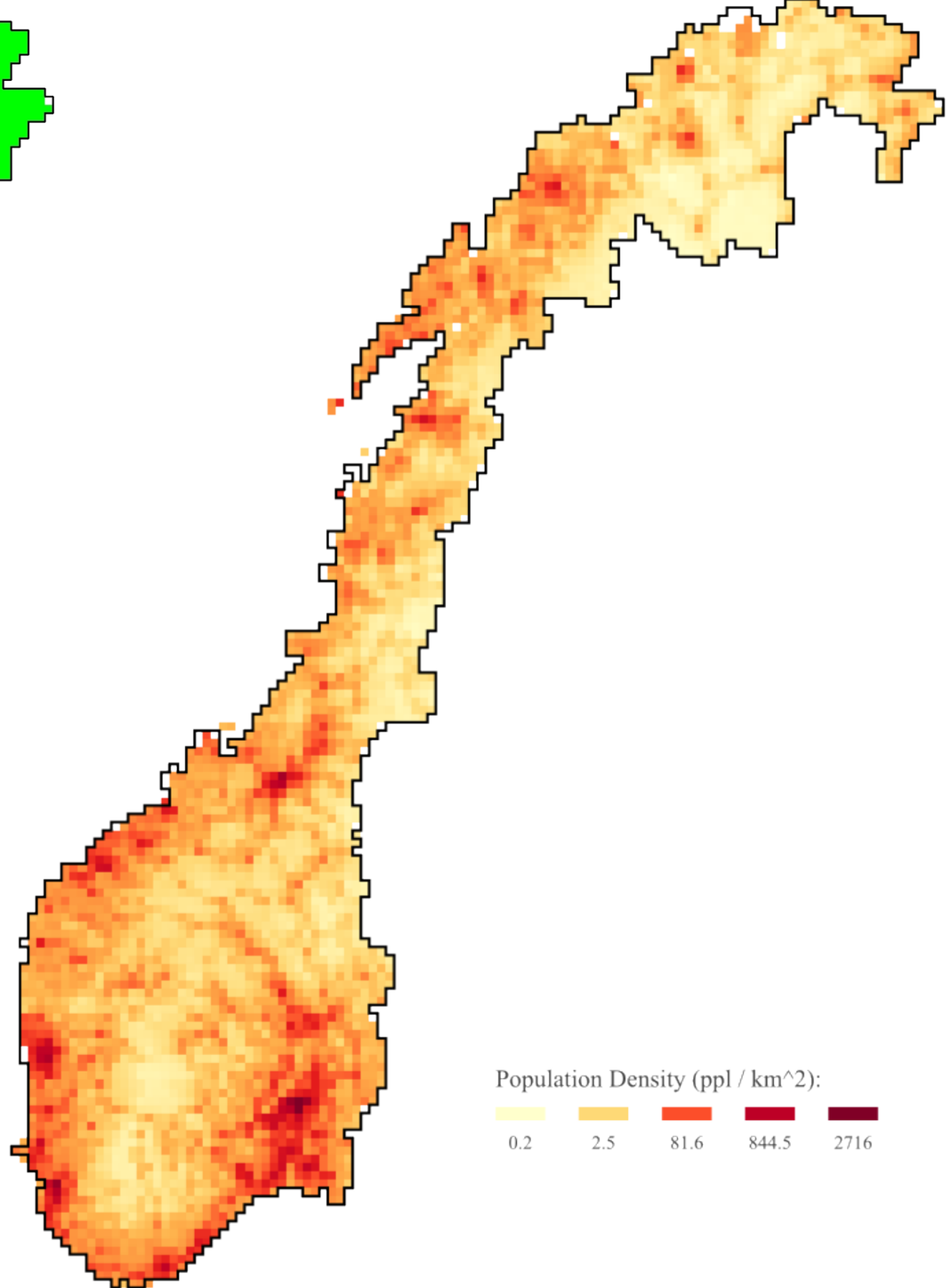
Pathway Sensitivity

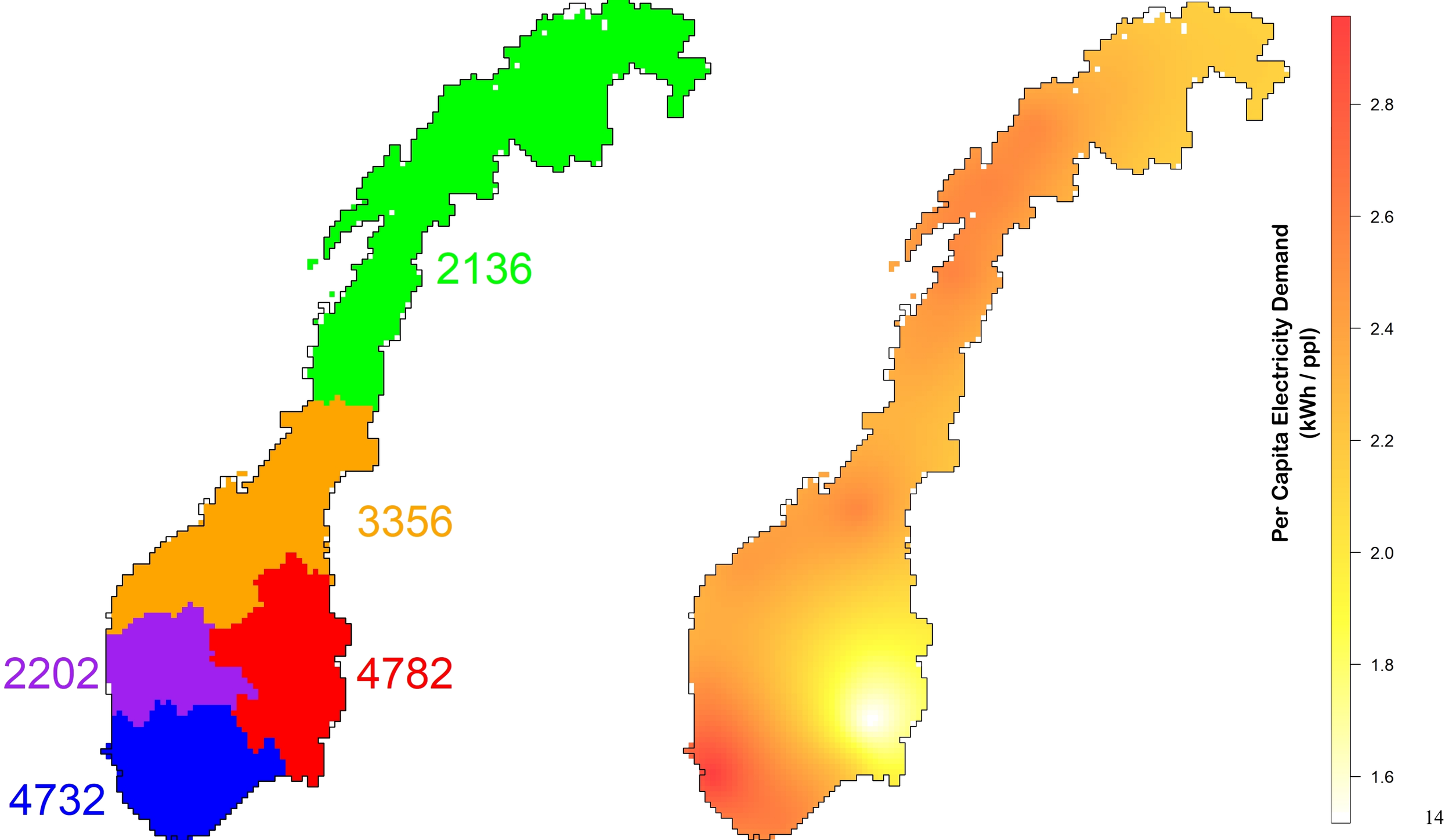


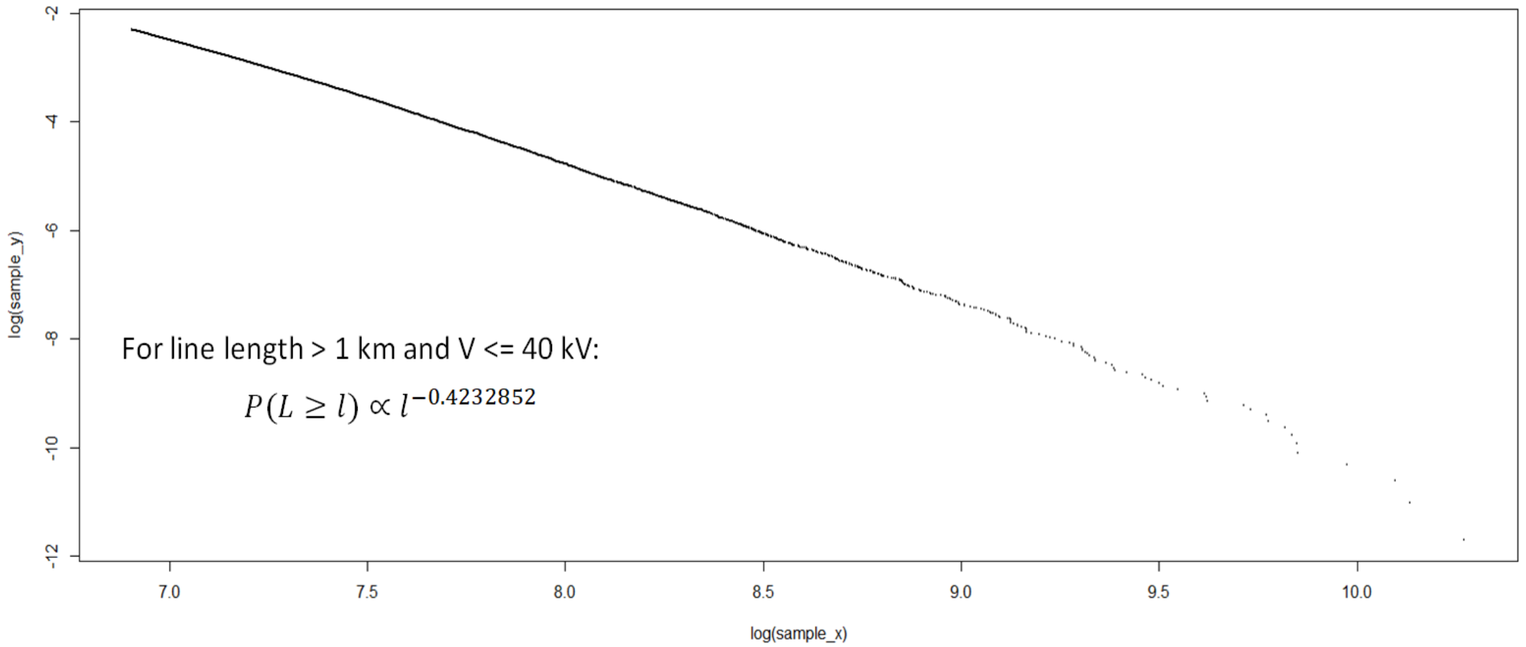
Publication

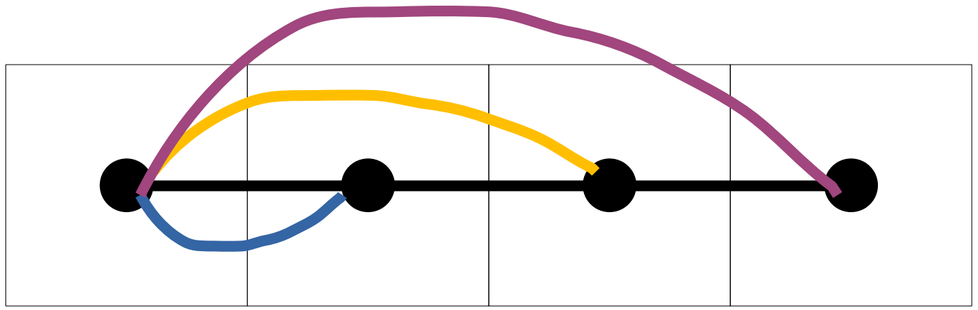
1st Paper:
Active End-User Participation under a TSO-DSO Coordination Scheme for Norway


2136
3356
2202
4782
4732


Population Density (ppl / km^2):
0.2
2.5
81.6
844.5
2716


2136
3356
2202
4782
4732
Per Capita Electricity Demand
(kWh / ppl)
2.8
2.6
2.4
2.2
2.0
1.8
1.6



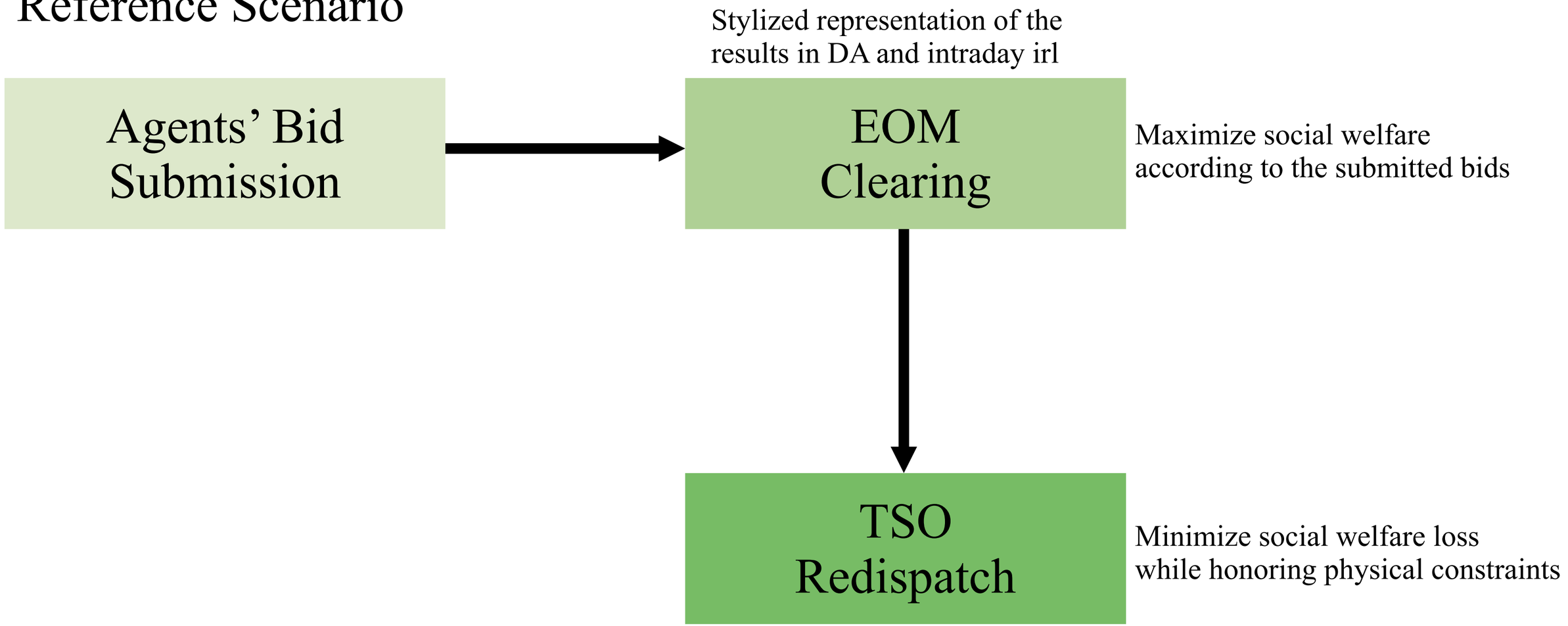


Conductivity of lines, blue: k
Conductivity of lines, orange: k * 2^(-0.5– 1– 1– 1)
Conductivity of lines, purple: k * 3^(-0.5 – 1– 1 – 1)

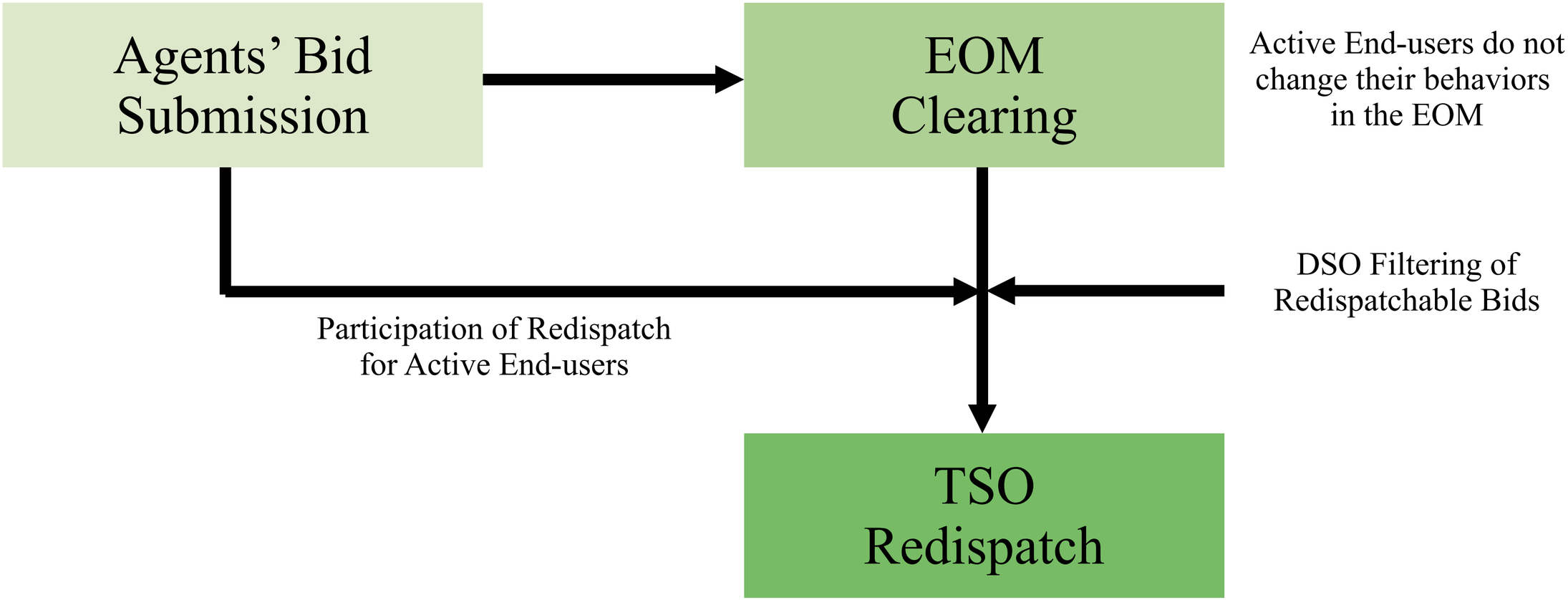
$$\Delta I(x_1) = \frac{\rho_N(\alpha-1)l_{\mathrm{m}}^{\alpha-1}}{2\pi z}\int_{\mathbf{R}^2\setminus\mathbf{B}_{l_{\mathrm{m}}}(x_1)}\frac{V(x_1)-V(x_2)}{|x_1-x_2|^{2+\alpha}}dx_2 \longrightarrow$$

Fractional Laplacian operator acting on the voltage field

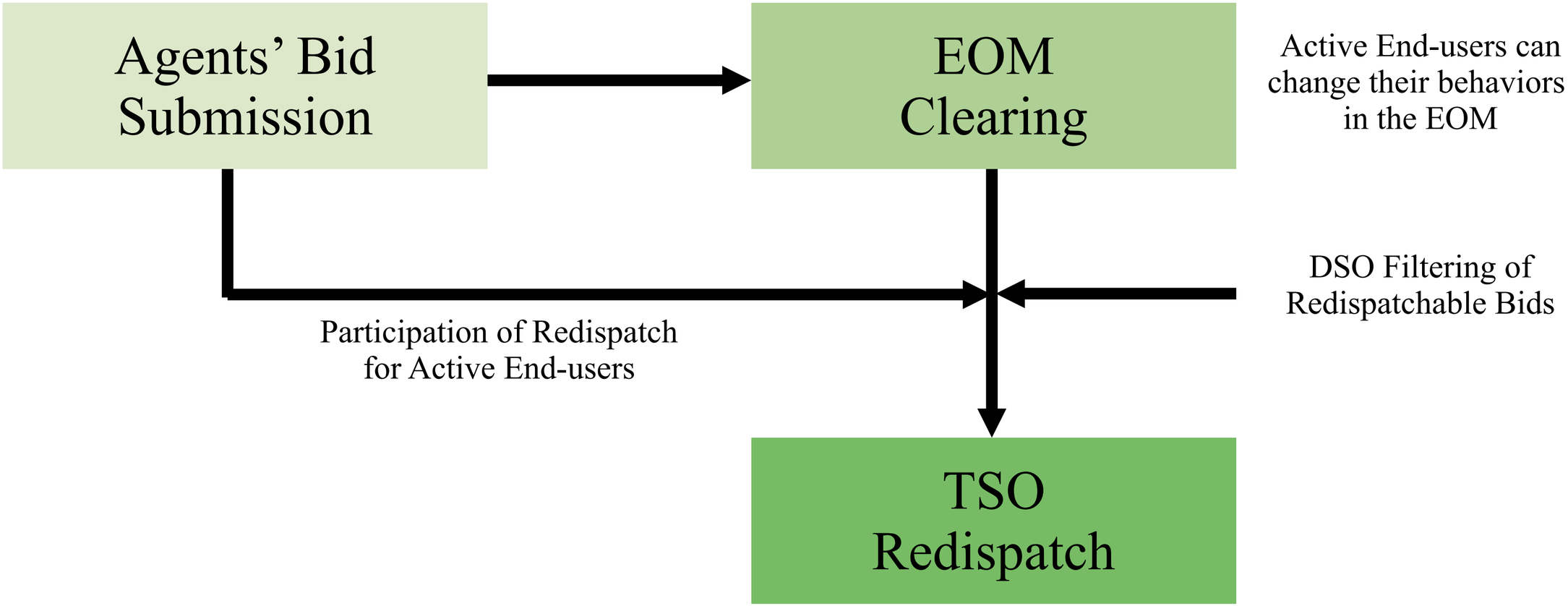
Reference Scenario



Partially Flexible Scenario

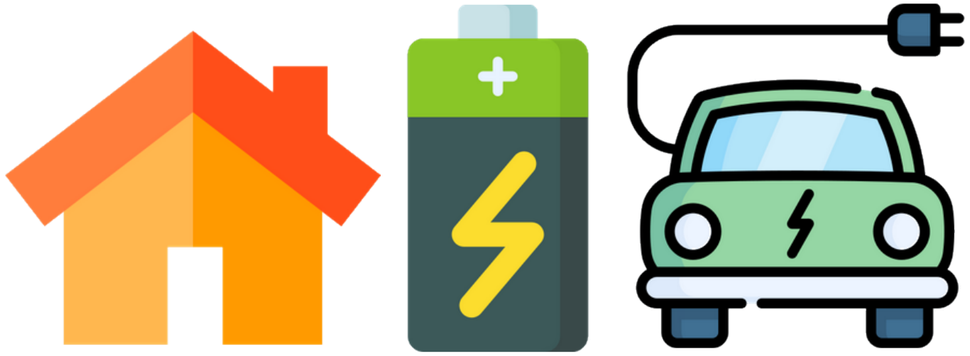


Fully Flexible Scenario

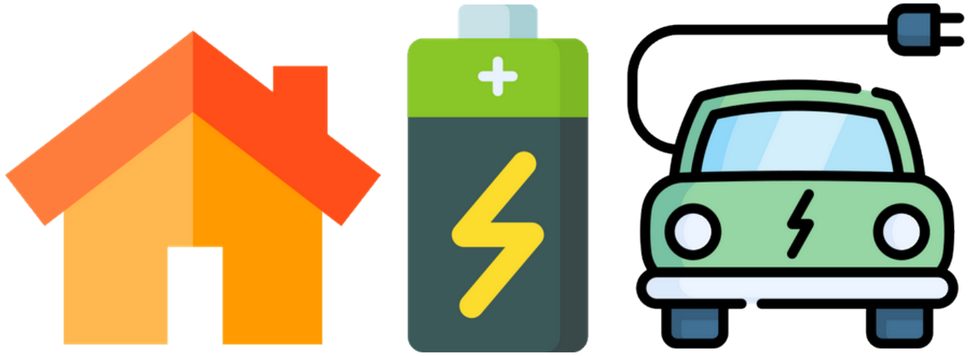


Inflexible End-users

Passive End-users



Active End-users



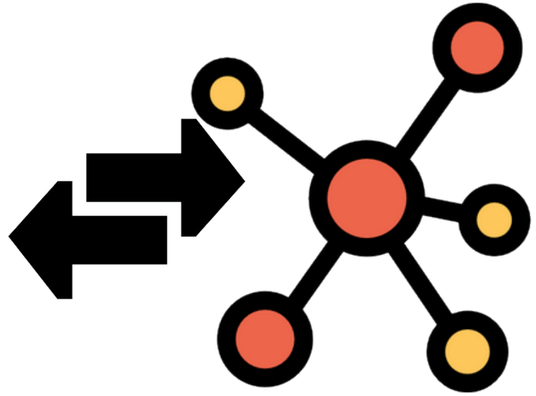


Table 3: Cost in EOM (in million EUR), redispatch cost (in million EUR), and total cost (in million EUR) in the scenarios between (a) 01 Jan to 14 Jan and (b) 01 July to 14 July.

(a)

	Reference	**Partially Flexible**	**Fully Flexible**
Cost in EOM	262.945	262.945	267.927
Redispatch Cost	42.021	41.785	36.438
Total Cost	304.966	304.730	304.365

(b)

	Reference	**Partially Flexible**	**Fully Flexible**
Cost in EOM	96.245	96.245	96.036
Redispatch Cost	53.684	53.588	53.888
Total Cost	149.928	149.833	149.924

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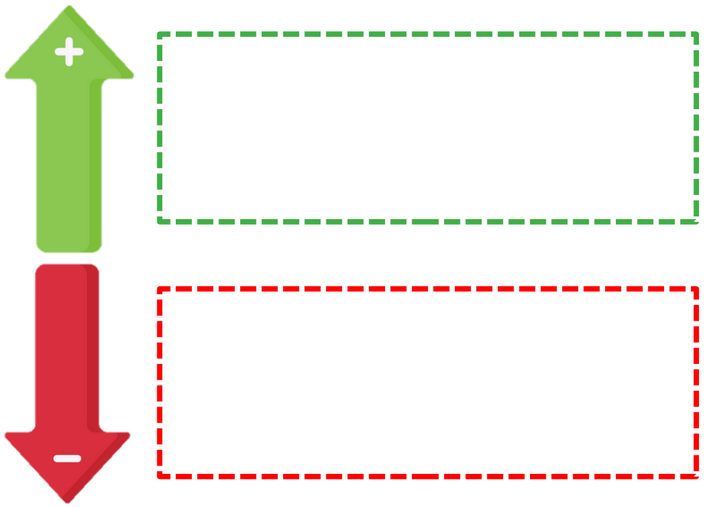
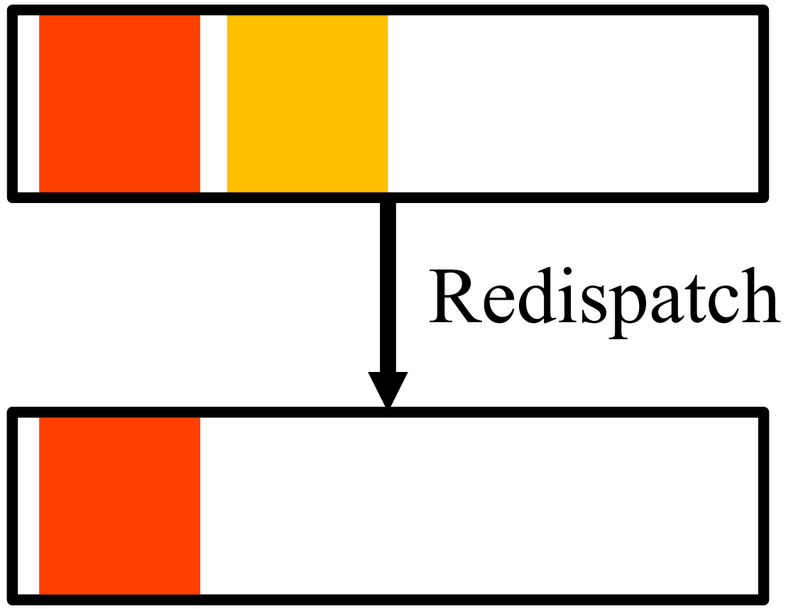


Upward Redispatch

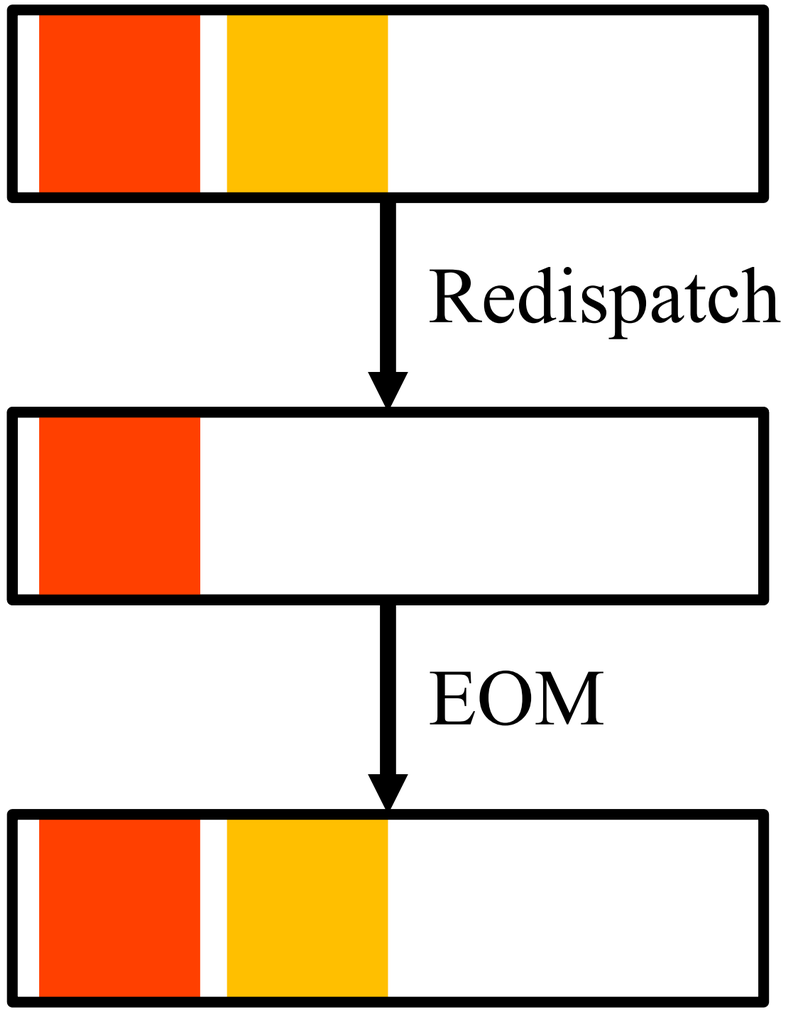
Downward Redispatch

Upward Redispatch



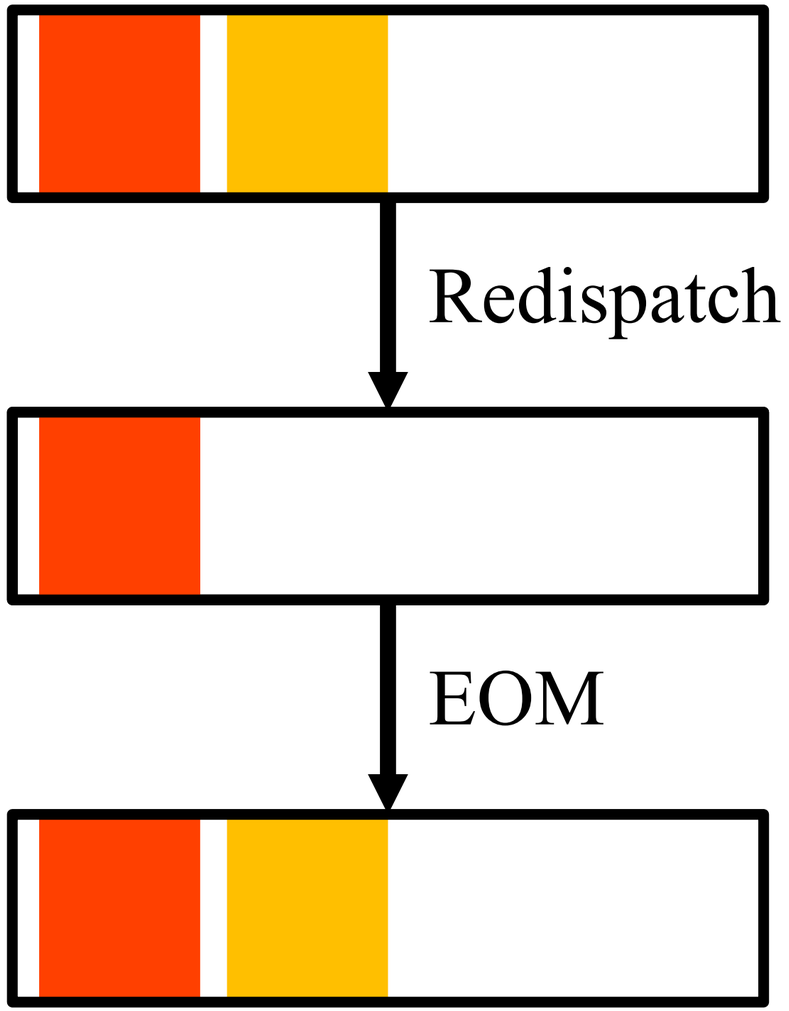
Downward Redispatch

Upward Redispatch

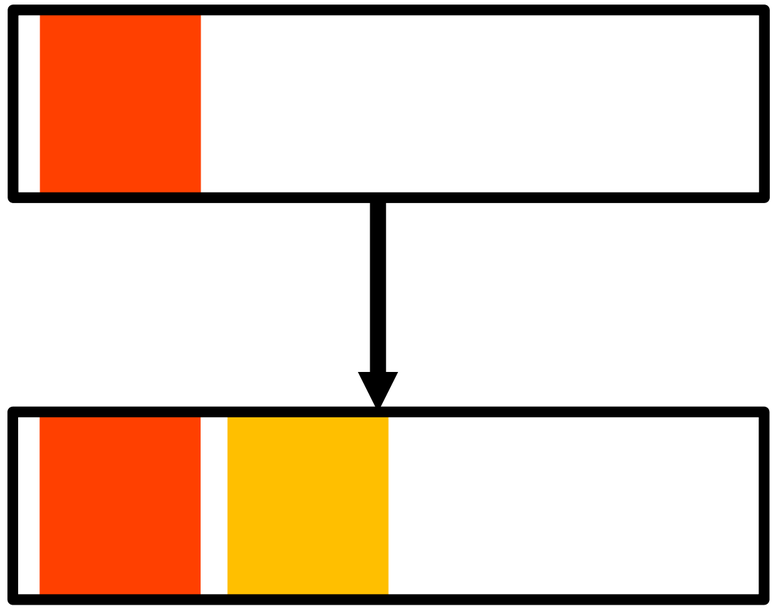


Downward Redispatch

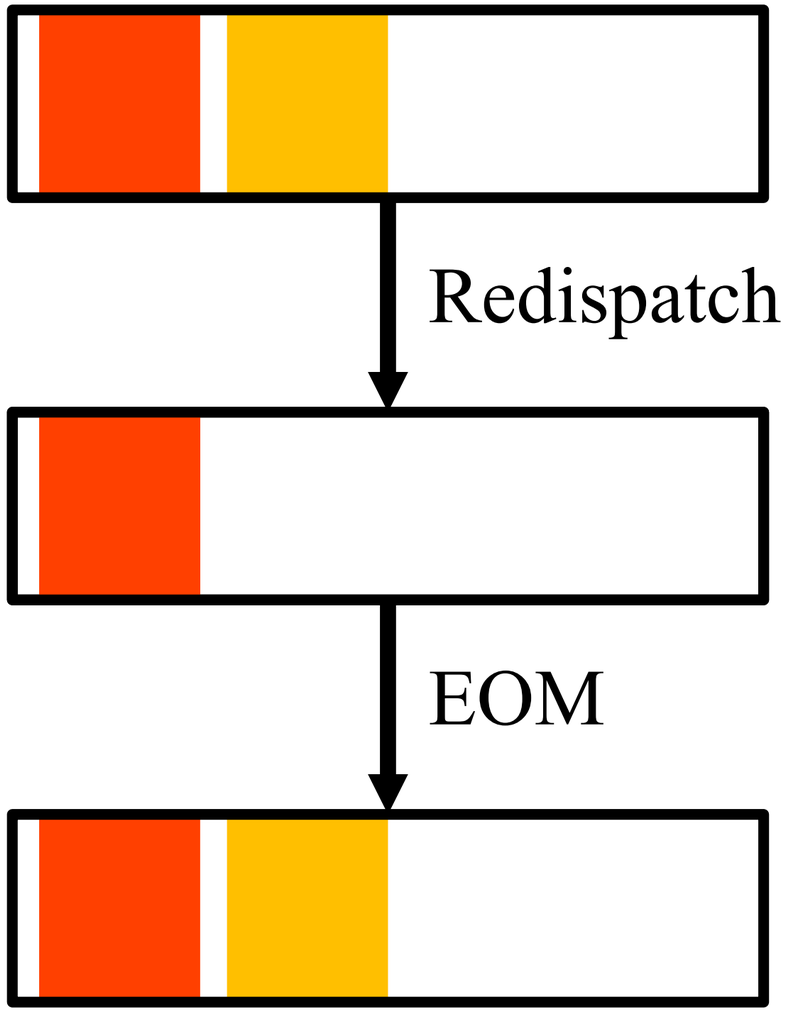
Upward Redispatch



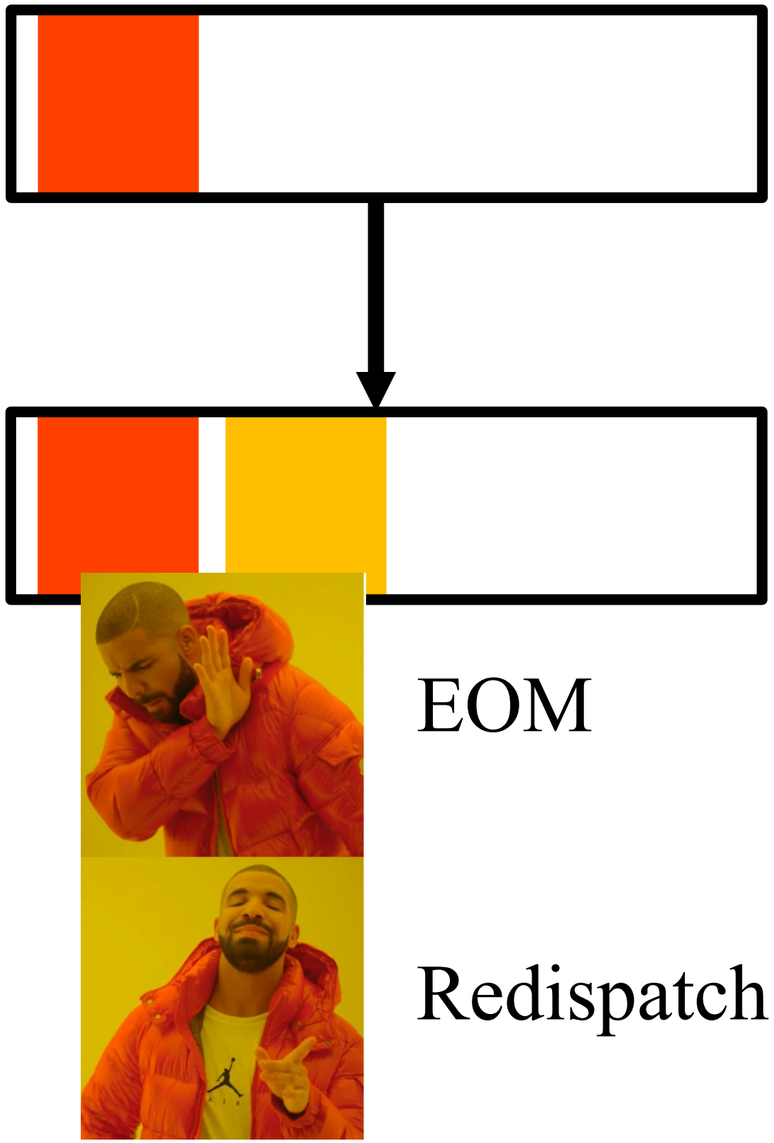
Downward Redispatch

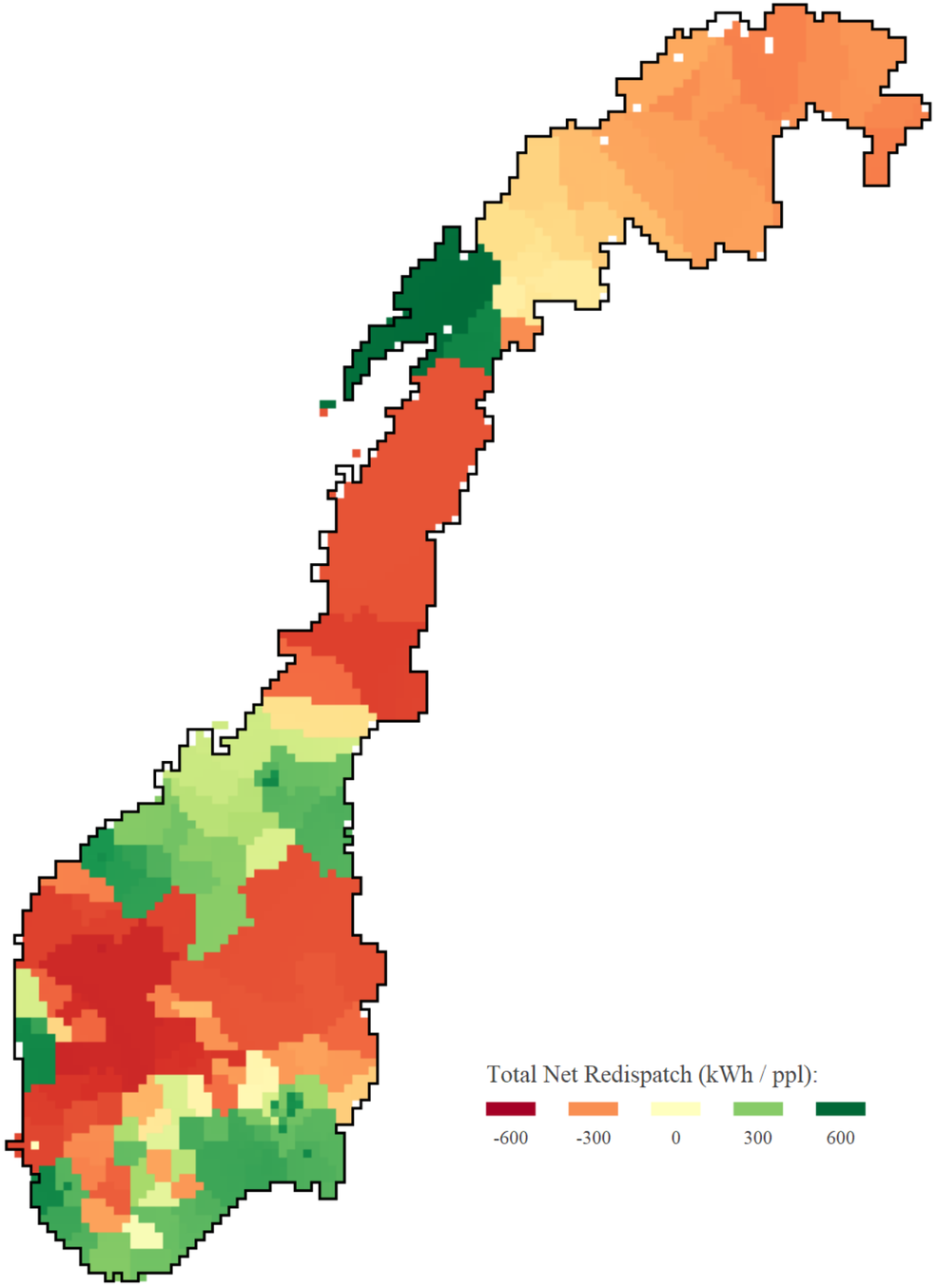


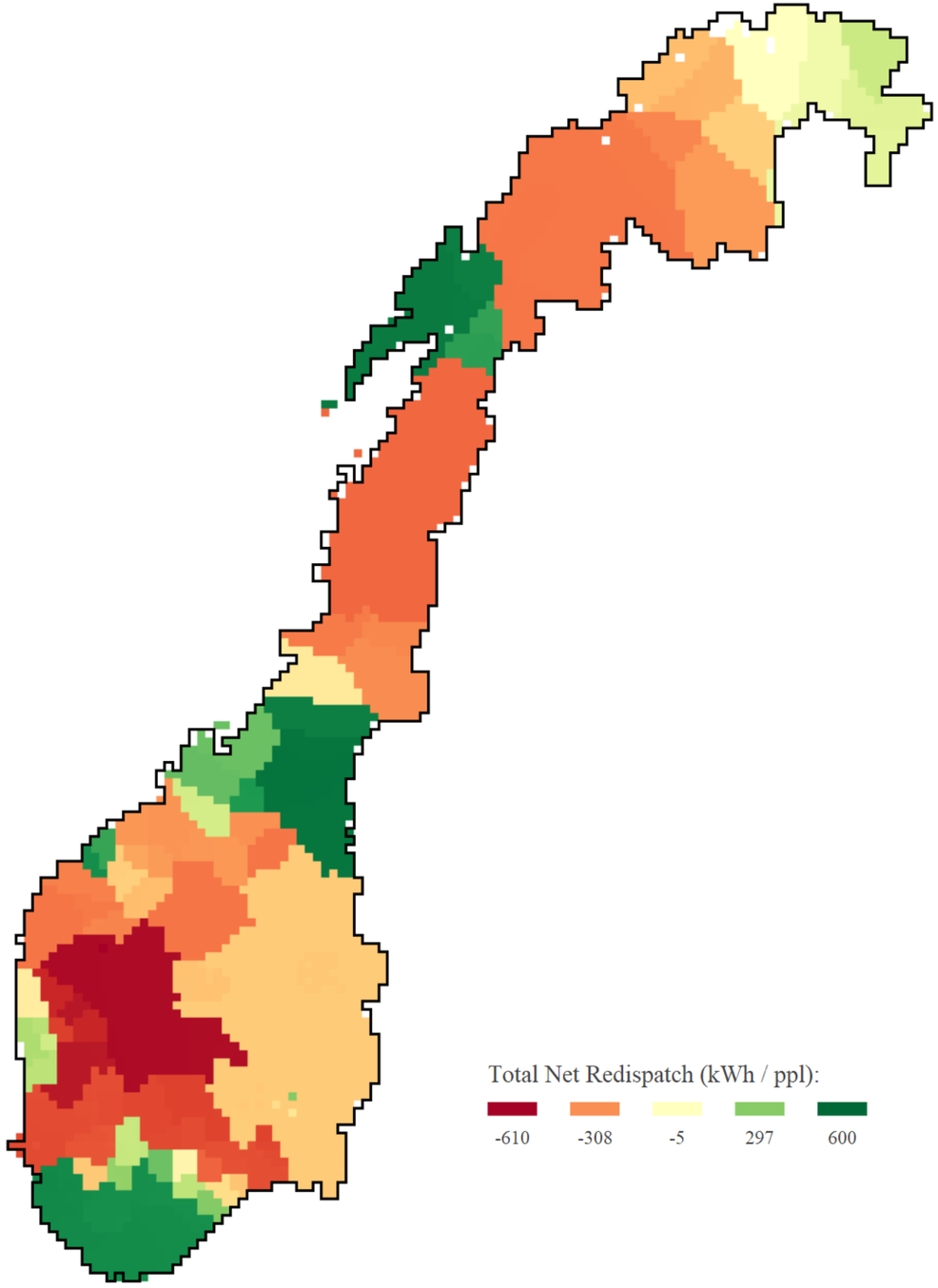
Upward Redispatch

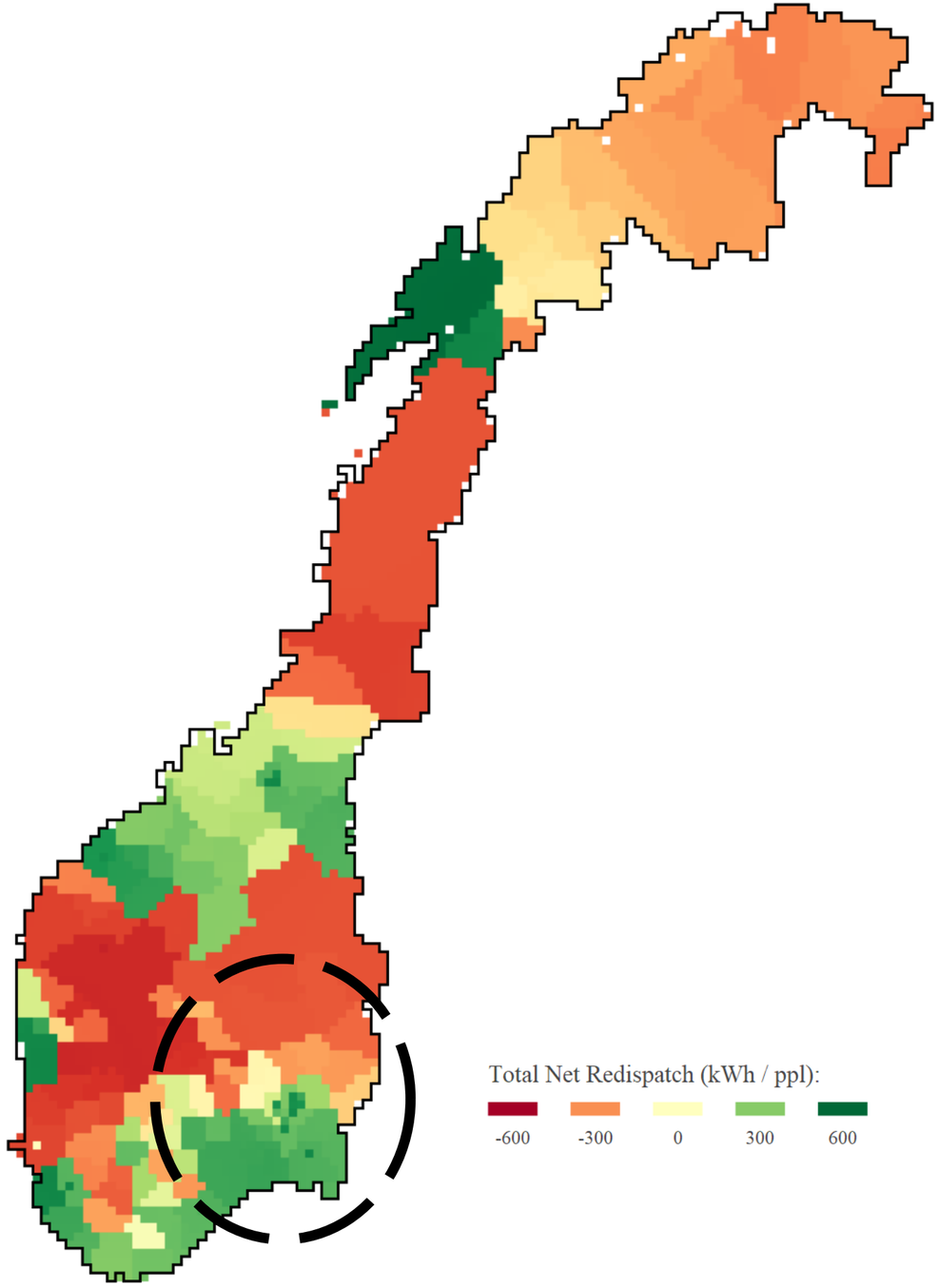


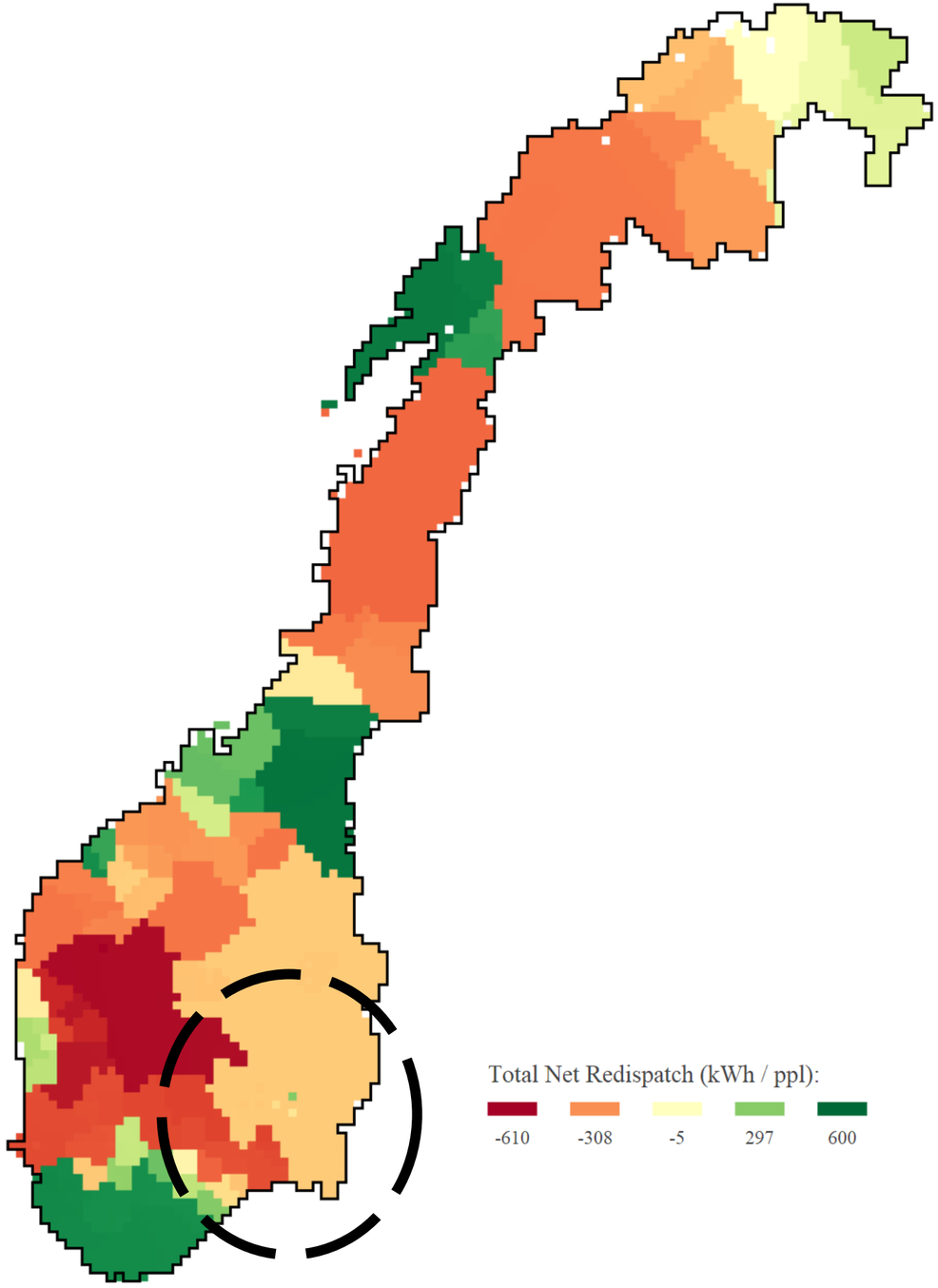
Downward Redispatch

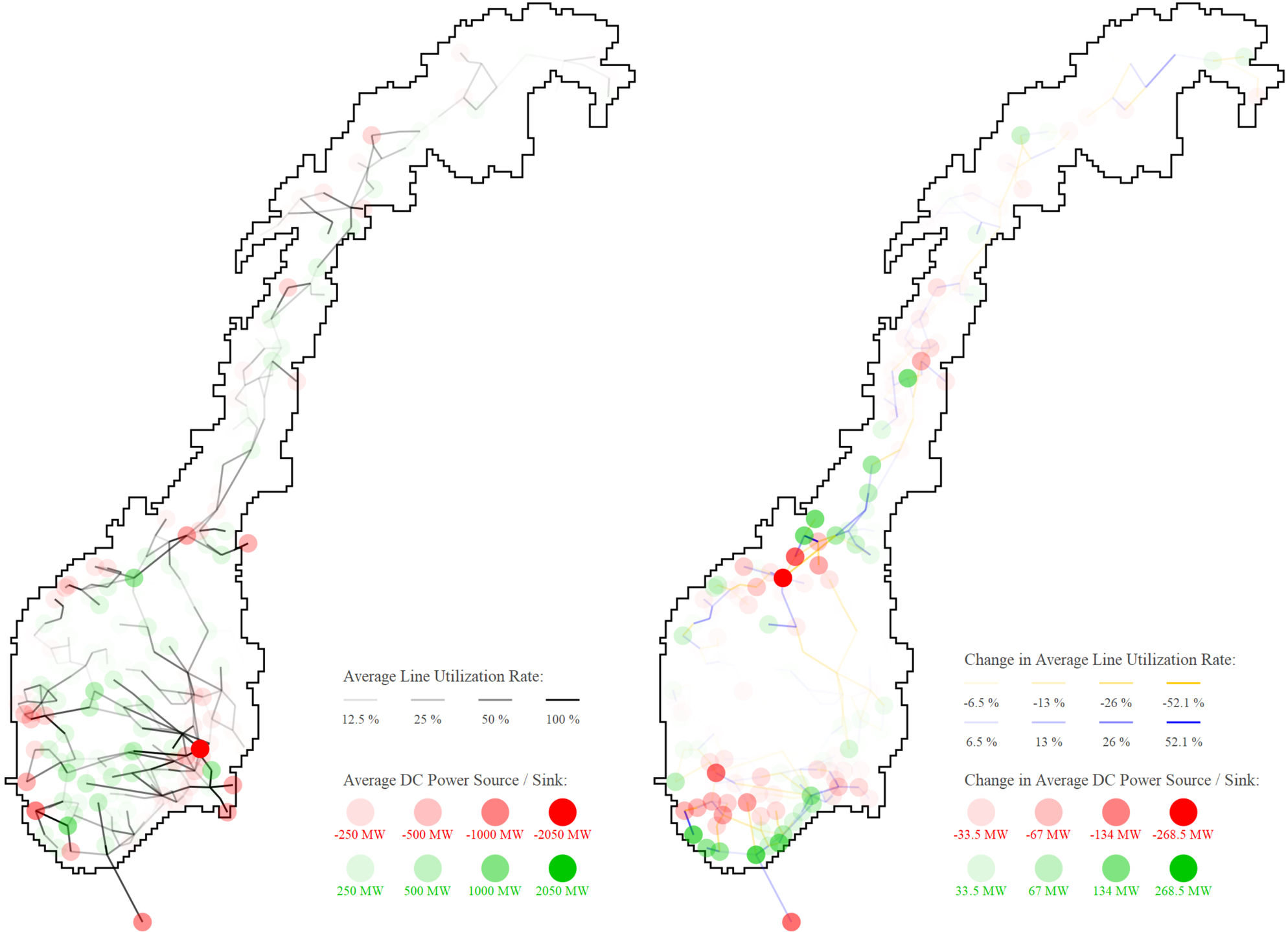


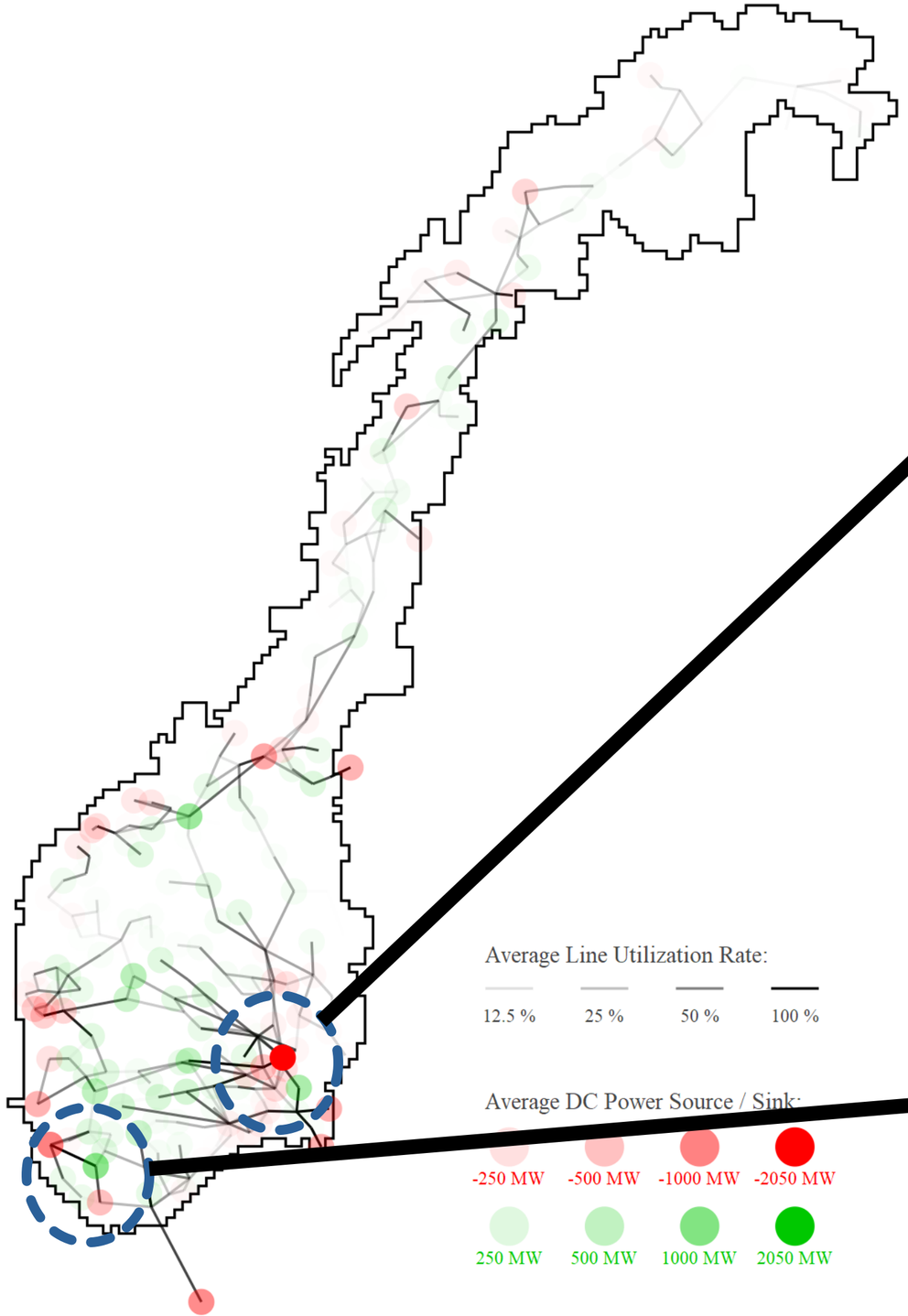

Total Net Redispatch (kWh / ppl):
-600
-300
0
300
600

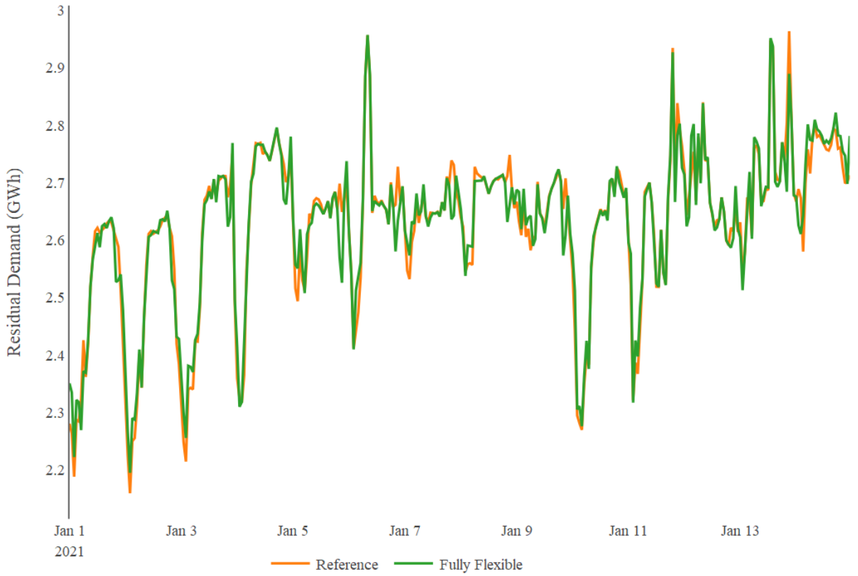

Total Net Redispatch (kWh / ppl):
-610
-308
-5
297
600


Total Net Redispatch (kWh / ppl):
-600
-300
0
300
600


Total Net Redispatch (kWh / ppl):
-610
-308
-5
297
600


Average Line Utilization Rate:
12.5 %
25 %
50 %
100 %
Average DC Power Source / Sink:
-250 MW
-500 MW
-1000 MW
-2050 MW
250 MW
500 MW
1000 MW
2050 MW
Change in Average Line Utilization Rate:
-6.5 %
-13 %
-26 %
-52.1 %
6.5 %
13 %
26 %
52.1 %
Change in Average DC Power Source / Sink:
-33.5 MW
-67 MW
-134 MW
-268.5 MW
33.5 MW
67 MW
134 MW
268.5 MW


Average Line Utilization Rate:
12.5 %
25 %
50 %
100 %
Average DC Power Source / Sink:
-250 MW
-500 MW
-1000 MW
-2050 MW
250 MW
500 MW
1000 MW
2050 MW


Residual Demand (GWh)
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
Jan 1
2021
Jan 3
Jan 5
Jan 7
Jan 9
Jan 11
Jan 13
Reference
Fully Flexible


Residual Demand (GWh)
−0.7
−0.8
−0.9
−1
−1.1
−1.2
−1.3
−1.4
Jan 1
2021
Jan 3
Jan 5
Jan 7
Jan 9
Jan 11
Jan 13
Reference
Fully Flexible

Table 6: Population density weighted median of average electricity prices (EUR / MWh) for different types of end-users in different bidding zones in scenario 3 between (a) 01 Jan to 14 Jan and (b) 01 July to 14 July.

(a)

Zones	Inflexible	Passive	Active Flexible
#1	75.816	75.474	62.506
#2	78.812	78.329	66.412
#3	48.951	48.674	42.389
#4	36.636	36.233	32.107
#5	77.353	77.134	68.280

(b)

Zones	Inflexible	Passive	Active Flexible
#1	72.882	74.285	64.491
#2	73.597	73.494	63.808
#3	38.086	38.021	32.101
#4	28.074	27.933	24.964
#5	68.445	68.349	58.001

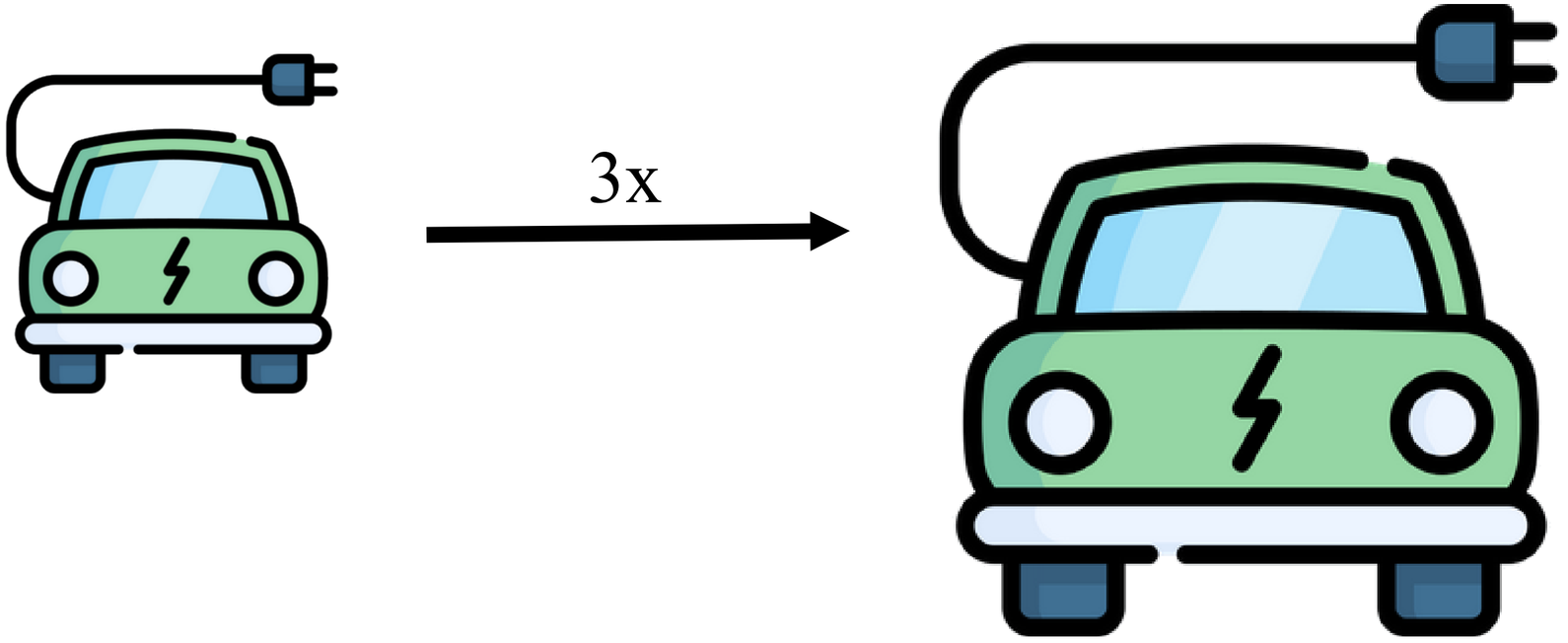


Table 4: Cost in EOM (in million EUR), redispatch cost (in million EUR), and total cost (in million EUR) in the 3x EV Scenario between (a) 01 Jan to 14 Jan and (b) 01 July to 14 July.

	0101 - 0114	**0701-0714**
Cost in EOM	268.042	95.983
Redispatch Cost	35.927	53.628
Total Cost	303.970	149.612

Future Plans

2nd Paper: 06 – 12.2023
3rd Paper: 09.2023 – 03.2024
4th Paper: 06 – 12.2024

Thank You

dung.b.yen@ntnu.no

https://www.reddit.com/r/solarpunk/comments/nw5had/art_by_daniel_clarke/