

Seasonal Storage Basic Models

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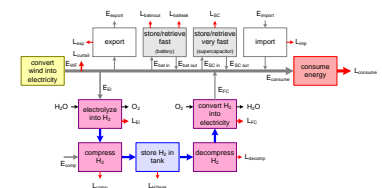
Abstract

A set of basic models that will form a high-level conceptual model for storing renewable energy to cope with seasonal variations.

Distribution

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Starting Point: Irish Energy Data

NI: Northern Ireland IE: Ireland		GMT Offset	NI Generation	NI Demand	NI Wind Availability	NI Wind Generation	NI Solar Availability	NI Solar Generation	IE Generation	IE Demand	IE Wind Availability	IE Wind Generation	SNSP
01-01-2020 00:00	0	805.808	736.418	268.222	267.818	0	0	2708.45	3035.95	331.08	324.1	21.3%	
01-01-2020 00:15	0	808.93	727.636	271.798	272.509	0	0	2757.59	3001.06	332.35	324.88	19.8%	
01-01-2020 00:30	0	799.635	715.448	264.655	264.816	0	0	2765.93	2956.65	326.64	318.97	19.2%	
01-01-2020 00:45	0	781.243	704.161	256.279	255.498	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 01:00	0	828.025	714.902	256.845	257.602	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 01:15	0	852.065	708.819	265.536	265.553	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 01:30	0	802.759	693.102	269.476	269.548	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 01:45	0	813.181	680.919	289.076	287.469	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 02:00	0	829.529	669.815	307.113	305.538	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 02:15	0	838.336	655.935	325.403	324.447	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 02:30	0	845.129	640.637	336.459	334.505	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 02:45	0	852.376	624.397	342.903	339.328	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 03:00	0	880.49	615.8	366.08	362.413	0	0	2741.16	2912.98	319	311.37	18.7%	
01-01-2020 03:15	0	840.47	605.929	364.687	299.381	0	0	2741.16	2912.98	319	311.37	18.7%	

<https://www.eirgridgroup.com/how-the-grid-works/renewables/>



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Simulation Using Hydrogen Storage

wind trace data		
year	day	production
2018	1	44214
2018	2	39969
2018	3	51687
2018	4	19293
2018	5	15842
2018	6	26849
2018	7	14014
2018	8	43098
2018	9	50887

use
- daily use
21370

surplus
22844
18599
30317
-2077
-5528
5479
-7356
21729
29517

convert
* η_{H_2}
50%

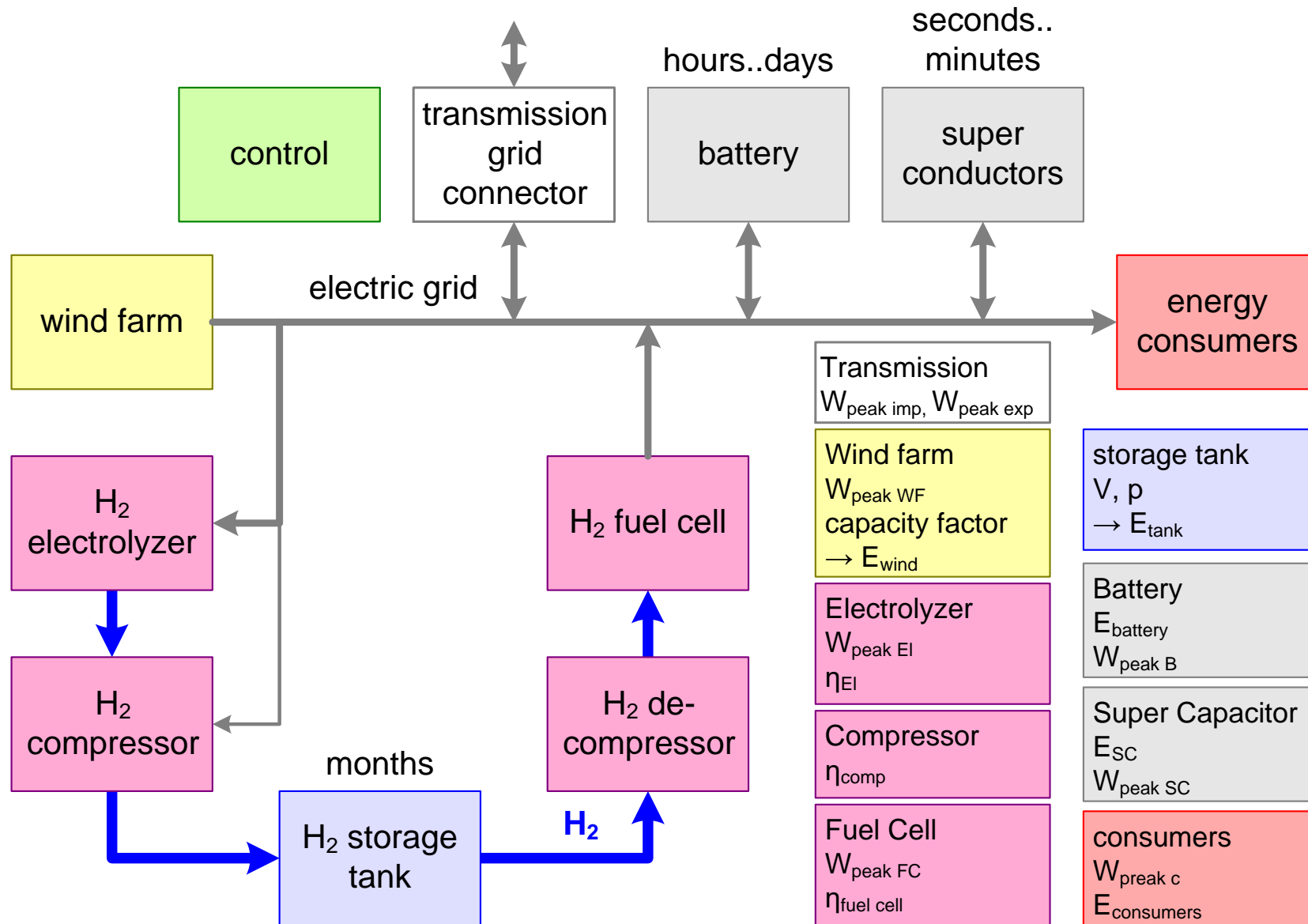
store/retrieve	
delta	storage
11422	700000
9300	709300
15159	724458
-2077	722382
-5528	716854
2740	719593
-7356	712237
10864	723101
14759	737860

aggregated production		
	2017	2018
jan	1179179	842549
feb	849591	1221703
mar	881203	1134683
apr	653040	863695
may	571785	503499
jun	322225	544853
jul	351038	522236
aug	618113	746528
sep	832528	710308
oct	968051	946287
nov	1270278	710351
dec	1041645	1100137
unscaled	9538677	9846828

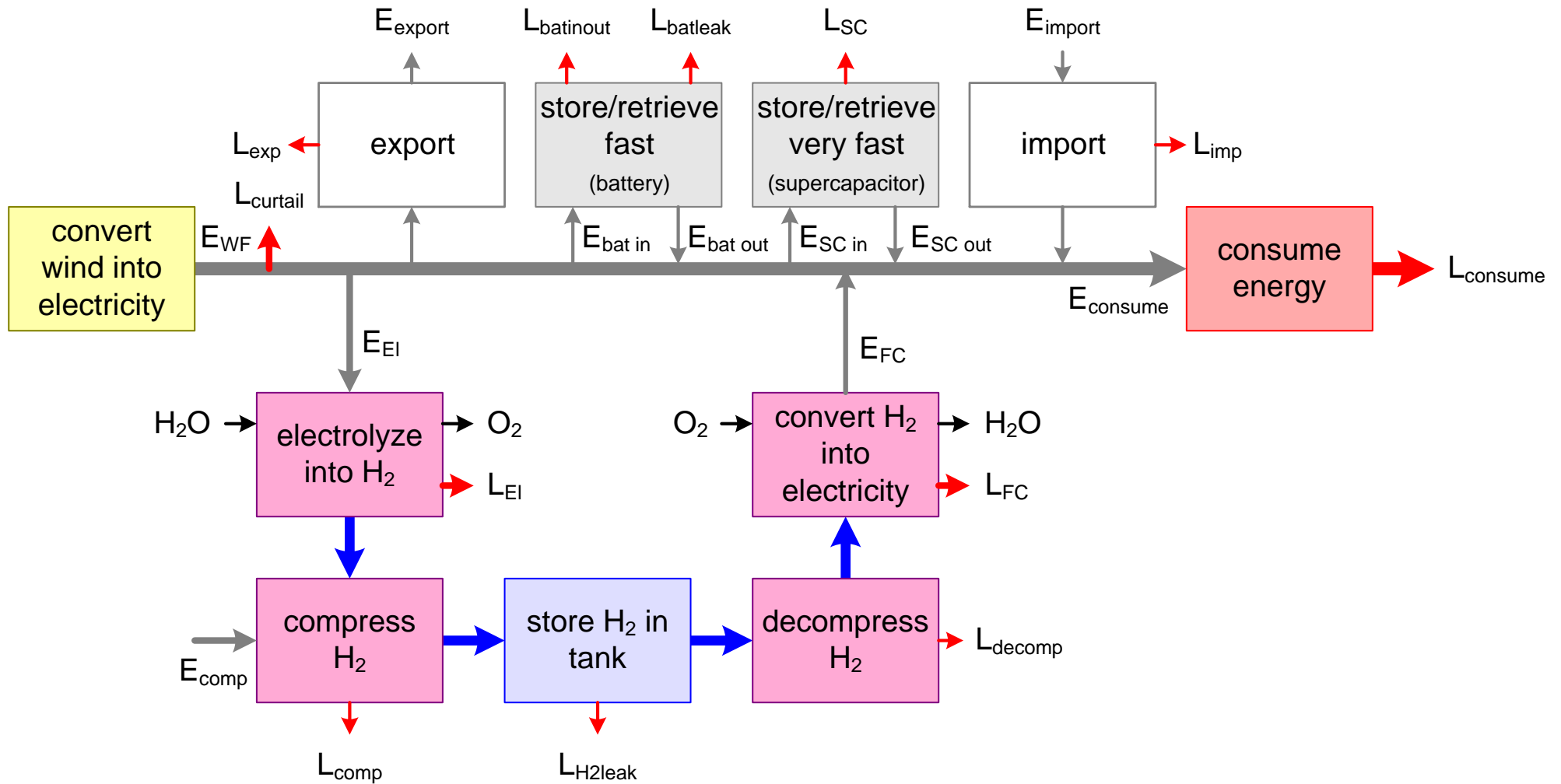
aggregated surplus				
surplus +		surplus -		
	2017	2018		
	2017	2018	2017	2018
	583321	337872	-66607	-157789
	316200	669854	-64965	-46508
	368354	536118	-149616	-63901
	209203	310924	-197259	-88325
	100599	114026	-191280	-272992
	78620	122038	-397491	-218281
	49842	125676	-361270	-265906
	159892	242967	-204244	-158904
	319105	262903	-127673	-193691
	425785	389846	-120199	-106025
	659014	232856	-29831	-163602
	466746	530776	-87566	-93105
	3736680	3875856	-1998003	-1829028

aggregated store/retrieve				
store		retrieve		
	2017	2018		
	2017	2018	2017	2018
	291660	168936	-66607	-157789
	158100	334927	-64965	-46508
	184177	268059	-149616	-63901
	104601	155462	-197259	-88325
	50300	57013	-191280	-272992
	39310	61019	-397491	-218281
	24921	62838	-361270	-265906
	79946	121483	-204244	-158904
	159553	131452	-127673	-193691
	212892	194923	-120199	-106025
	329507	116428	-29831	-163602
	233373	265388	-87566	-93105
	1868340	1937928	-1998003	-1829028

Block Diagram



Functional Model



Scenarios for Energy Flows

How to utilize the options?

- *direct consumption*
- *battery storage*
- *Hydrogen storage*
- *over-sized generation*
- *import, export*
- *demand control*

