Supplementary Material

Proximate analysis

Proximate analysis and ultimate analysis were conducted on dried sludge samples. The moisture content was measured according to ASTM E871-82. The ash content was determined according to ASTM E1755-01. The volatile matter content was analyzed according to ASTM E872-82. The fixed carbon content was calculated based on the following equation:

$$\text{Fixed carbon}\ (\%) = 100\% - \text{Moisture}\ (\%) - \text{Ash}\ (\%) - \text{Volatile matter}\ (\%) \quad (1)$$

Table S1. Proximate and element analysis of raw sludge

Proximate analysis	Raw sludge	Element analysis	Raw sludge
Moisture (%)	9.73±1.41	C (%)	39.27
Ash (%)	18.9±0.9	N (%)	9.15
Volatile Matter (%)	61.35±1.36	H (%)	6.57
Fixed carbon (%)	10.01±2.41	S (%)	1.59

Table S2 Surface element concentration of SC-900 and SWC-900

Samples	Mass concentration (%)						
	O 1s	N 1s	C 1s	Cl 2p	S 2p	Si 2s	P 2p
SC-900	15.87	7.85	67.66	2.87	1.28	4.29	0.18
SWC-900	9.27	3.74	82.43	0.79	0.1	0.37	3.3

Table S3 Deconvolution results of C 1s spectra

Samples	C 1s					
	C-C	C-N	C-O	C=O	O-C=O	Pi-pi*
SC-900	57.61%	20.26%	8.29%	7.15%	3.84%	2.85%
SWC-900	64.60%	8.15%	11.78%	4.71%	4.65%	6.12%

Table S4 Deconvolution results of N 1s spectra

Samples	N 1s			
	Pyridinic-N	Nitrile/imine-N	Pyrrolic-N	Graphitic-N
SC-900	34.73%	35.86%	18.51%	10.90%
SWC-900	14.71%	N.A.	41.63%	43.66%

Table S5 Deconvolution results of O 1s spectra

Samples	O 1s			
	C=O	C-O aliphatic	C-O aromatic	O_{2-}
SC-900	33.51%	52.43%	14.06%	N.A.
SWC-900	27.49%	43.47%	N.A.	29.05%

Table S6 Metal concentrations in precursors and products

Element concentration (ppm)		K	Ca	Na	Mg	Al	Zn	Fe	Cu	Mn
Precursor	Control freshwater sludge	3045	3547	4277	5837	1641	190	1751	165	27
	Sludge after mixing with seawater	4558	4478	25804	7735	1226	153	1355	136	16
Product	SC-600 (ww)	732	6031	5875	6141	3642	52	3101	462	BDL*
	SC-750 (ww)	995	9496	3808	5718	5660	185	4704	564	27
	SC-900 (ww)	555	5489	2368	4738	7215	257	6347	938	15
	SWC-600 (ww)	2231	8201	22430	14162	2218	141	1198	123	27
	SWC-750 (ww)	1755	12068	19761	5493	5045	118	2026	202	BDL*
	SWC-900 (ww)	1019	5029	10611	2104	6101	78	5603	681	BDL*

Table S7. Summary of sewage sludge and similar biomass derived capacitive carbon

Precursor	Synthesis method	Surface area	Electrode system	Max specific capacitance per mass	Max specific capacitance per area	Reference
Sewage sludge	Pre-load activation agents from natural seawater followed by pyrolysis and HCl washing	457 m_2/g	Three-electrode systems in 1M Na_2SO_4	114 F/g	24.9 uF/cm_2	This study
Cornstalk cores	Molten salt (NaCl/KCl) pyrolysis at 800℃	1588 m_2/g	Three-electrode system in 1M H_2SO_4	407 F/g	25.6 uF/cm_2	Wang et al., (2018)
Mixed biomass wastes of sewage sludge and coconut shell	Carbonization at 700 ℃ followed by HCl washing and KOH activation	3003 m_2/g	Three-electrode systems in 6M KOH	420 F/g	14 uF/cm_2	Peng et al., (2018)
Sewage sludge	HF washing followed by carbonization at 700 ℃ and KOH activation	2839 m_2/g	Three-electrode systems in 1M Na_2SO_4	340 F/g	12 uF/cm_2	Feng et al., (2015)
Sewage sludge	Carbonization at 800 ℃ followed by HF washing	331 m_2/g	Three-electrode system in 0.5M Na_2SO_4	178 F/g	53.8 uF/cm_2	Yuan et al., (2015)
Egg white	Mesoporous Cellular Foam templating followed by carbonization	810 m_2/g	Three-electrode system in 1M H_2SO_4	390 F/g	48.1 uF/cm_2	Li et al., (2013)

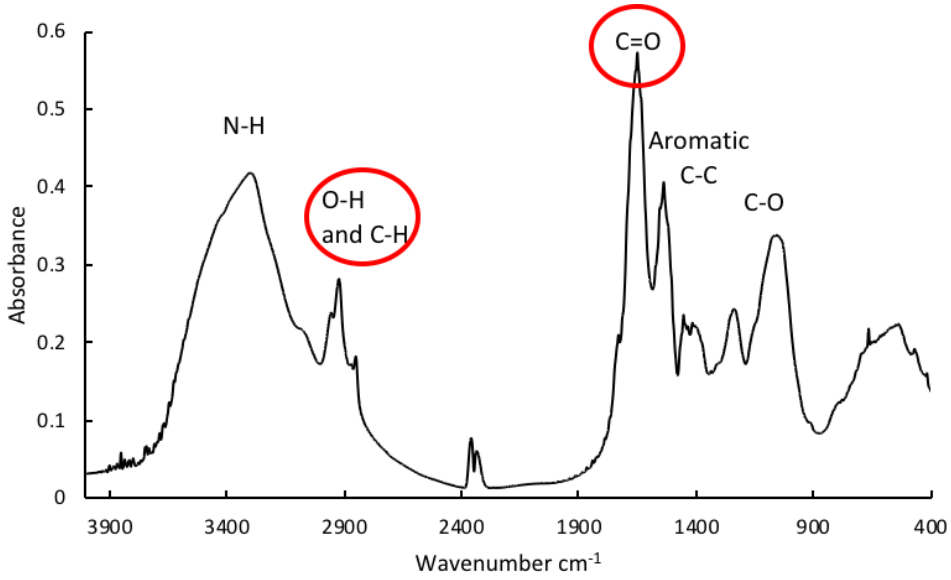

Figure S1 FTIR spectra of raw sewage sludge

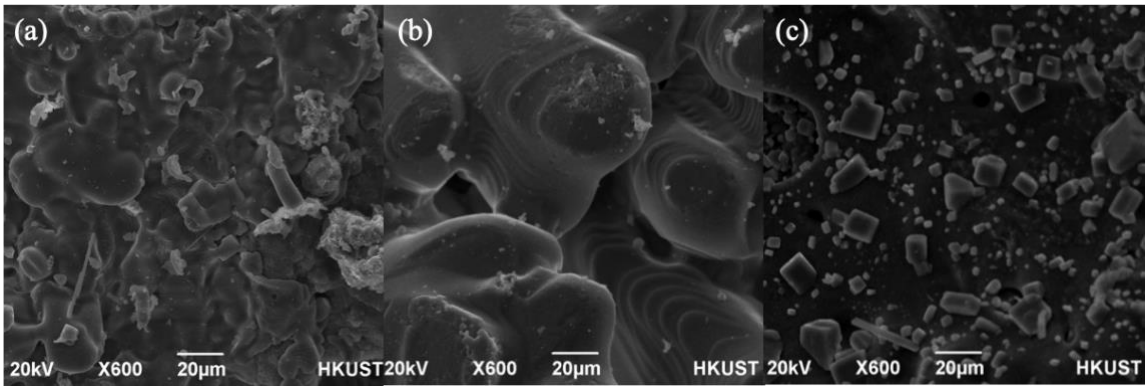

Figure S2 (a-b) Surface morphology of SC; (c) Mineral crystals observed by SEM

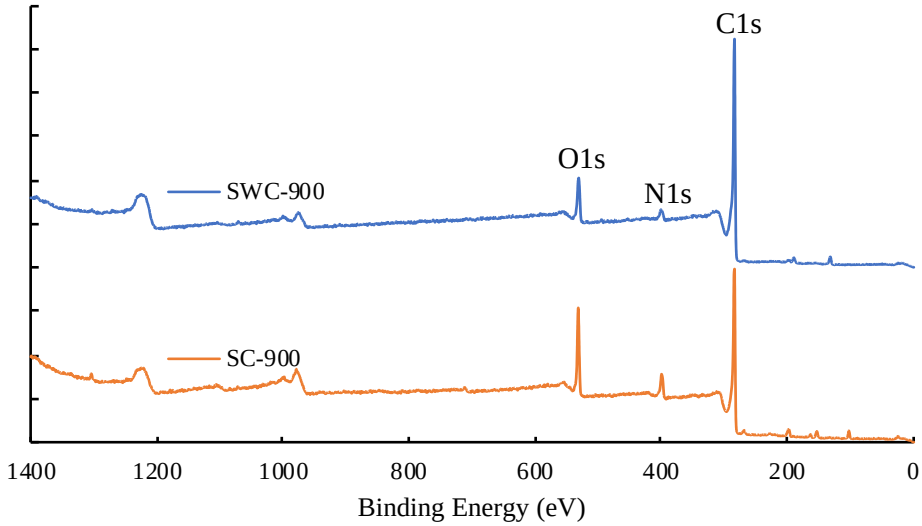

Figure S3. XPS survey of SC-900 and SWC-900

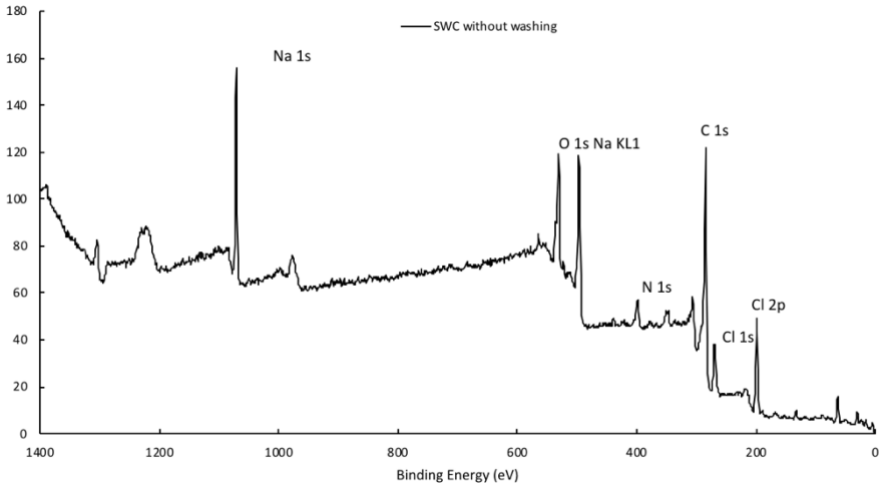

Figure S4 XPS survey spectra of SWC-900 (ww)

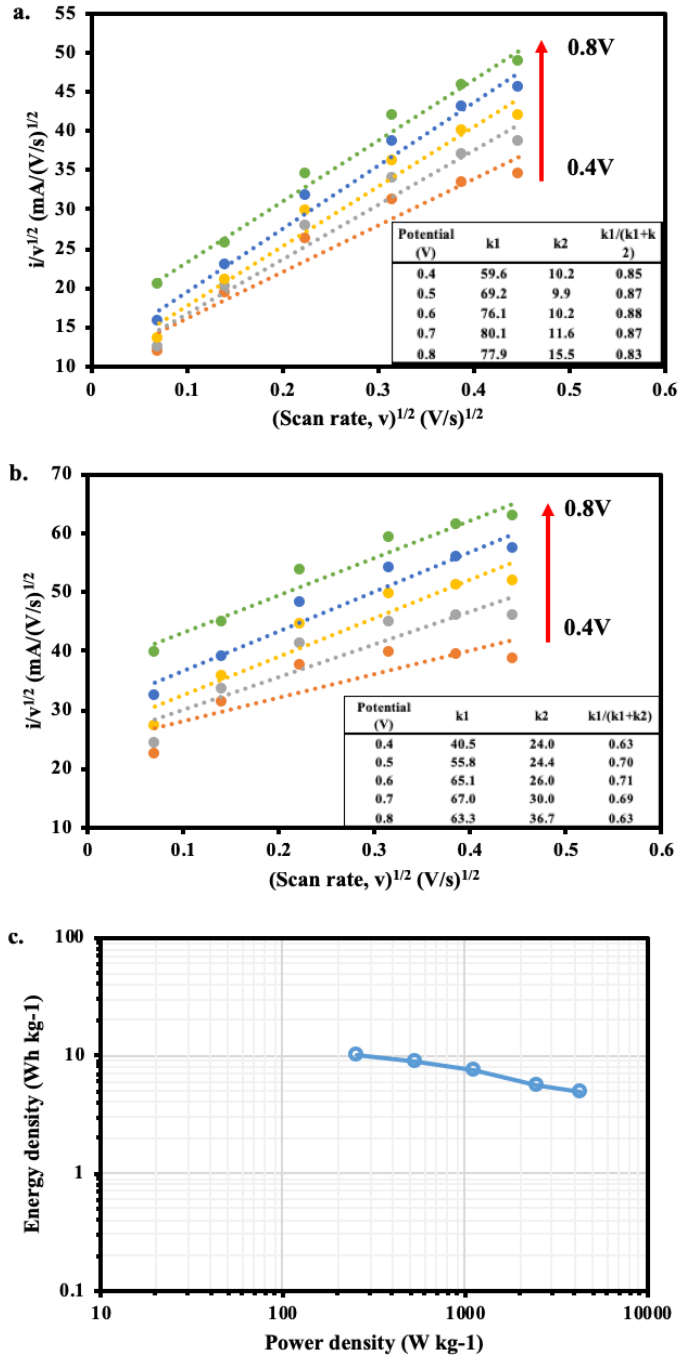

Figure S5 (a) Quantification of the contribution of pseudo-capacitance in SWC-900 at different potential. The inset in (a) shows the value of k1, the contribution of EDLC and k2, the contribution of PC. (b) Quantification of the contribution of pseudo-capacitance in SC-900 at different potential. (c) Ragone plot of SWC-900.

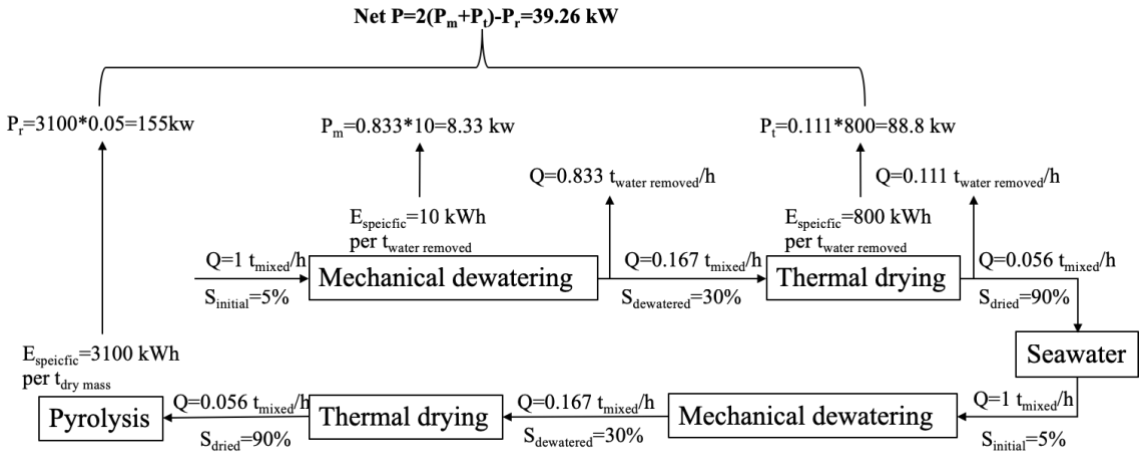

Figure S6 Energy requirement of "Seawater in sludge" approach assuming 1 ton sludge mixed liquid treated

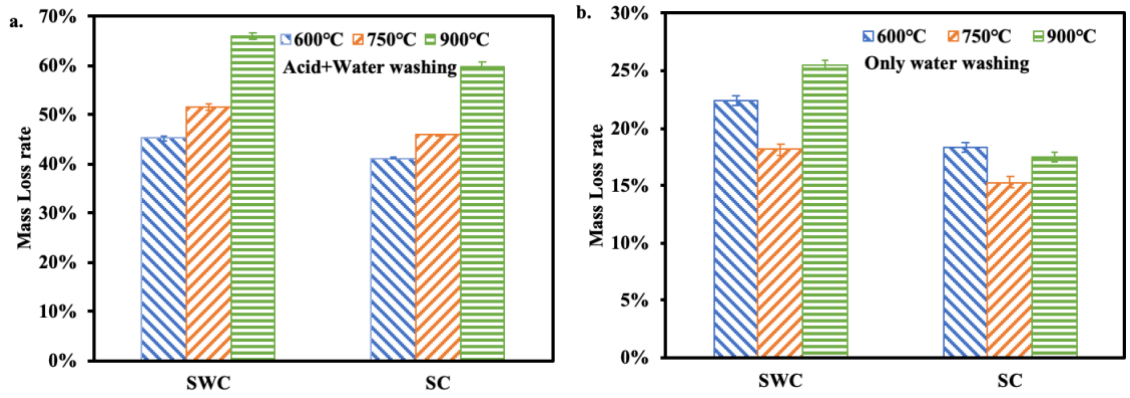

Figure S7 Mass loss rate of washing with acids and water

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