

## Supplementary Material

### A novel data mining framework to investigate causes of boiler failures in waste-to-energy plants

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### Section S1 – Summary information about variables

Table S1. List of failure-related operational variables with full name, short name, and unit, of each

Full Name	Short Name	Unit
Temperature of Flue-gas at Superheater 3 Roof Left	T-BSH3rl	°C
Temperature of Flue-gas at Superheater 3 Roof Middle	T-BSH3rm	°C
Temperature of Flue-gas at Superheater 3 Roof Right	T-BSH3rr	°C
Temperature of Flue-gas at Superheater 3 Left	T-BSH3l	°C
Temperature of Flue-gas at Superheater 3 Right	T-BSH3r	°C
Temperature of Flue-gas at Superheater 2 Roof Left	T-BSH2rl	°C
Temperature of Flue-gas at Superheater 2 Roof Middle	T-BSH2rm	°C
Temperature of Flue-gas at Superheater 2 Roof Right	T-BSH2rr	°C
Temperature of Flue-gas at Superheater 2 Left	T-BSH2l	°C
Temperature of Flue-gas at Superheater 2 Right	T-BSH2r	°C
Temperature of Flue-gas at Superheater 1 Roof Left	T-BSH1rl	°C
Temperature of Flue-gas at Superheater 1 Roof Middle	T-BSH1rm	°C
Temperature of Flue-gas at Superheater 1 Roof Right	T-BSH1rr	°C
Temperature of Flue-gas at Superheater 1 Left	T-BSH1l	°C
Temperature of Flue-gas at Superheater 1 Right	T-BSH1r	°C
Temperature of Flue-gas at Economizer 3 Roof Left	T-BEM3rl	°C
Temperature of Flue-gas at Economizer 3 Roof Right	T-BEM3rr	°C
Temperature of Flue-gas at Economizer 2 Roof Left	T-BEM2rl	°C
Temperature of Flue-gas at Economizer 2 Roof Right	T-BEM2rr	°C
Temperature of Flue-gas before Flue-gas Treatment 1	T-BbGT1	°C
Temperature of Flue-gas before Flue-gas Treatment 2	T-BbGT2	°C
Temperature of Flue-gas before Economizers	T-BbEM1	°C
Temperature of Flue-gas after Economizers	T-BaEM1	°C
Oxygen Concentration in Flue-gas after Economizers	OC-aEM	vol %
Temperature of Flue-gas before Superheaters	T-BbSH	°C
Temperature of Furnace (1 <sup>st</sup> flue-gas passage)	T-F	°C
Temperature of Furnace after 2 seconds (1 <sup>st</sup> flue-gas passage)	T-Fa2s	°C
Temperature of Furnace - near Roof (1 <sup>st</sup> flue-gas passage)	T-Frf	°C
Temperature of Furnace - above Grate 1	T-FaG1	°C
Temperature of Furnace - above Grate 2	T-FaG2	°C
Temperature of Furnace - Low Measuring Point 1 (1 <sup>st</sup> flue-gas passage)	T-Flp1	°C

Temperature of Furnace - Low Measuring Point 2 (1 <sup>st</sup> flue-gas passage)	T-Flp2	°C
Temperature of Furnace - Far down, near end of grate	T-FeoG	°C
Temperature of Furnace (1 <sup>st</sup> flue-gas passage)	T-Fsncr	°C
Temperature of Furnace 2 (1 <sup>st</sup> flue-gas passage)	T-Fun	°C
Pressure of Furnace	P-F	mbar
Temperature of Feedwater	T-FW	°C
Pressure of Feedwater	P-FW	bar
Temperature of Feedwater before Economizer 2 A	T-FWbEM2a	°C
Temperature of Feedwater before Economizer 2 B	T-FWbEM2b	°C
Temperature of Feedwater after Economizer 3 A	T-FWaEM3a	°C
Temperature of Feedwater after Economizer 3 B	T-FWaEM3b	°C
Temperature of Feedwater after Economizer 3	T-FWaEM3	°C
Temperature of steam after Superheater 1	T-SaSH1	°C
Temperature of steam before Superheater 2	T-SbSH2	°C
Temperature of steam after Superheater 2	T-SaSH2	°C
Temperature of steam before Superheater 3	T-SbSH3	°C
Temperature of steam after Superheater 3	T-SaSH3	°C
Flow Rate of Primary Air	FL-PA	m <sup>3</sup> /h
Flow Rate of Secondary Air	FL-SA	m <sup>3</sup> /h
Temperature of Primary Air	T-PA	°C
Temperature of Secondary Air	T-SA	°C
Pressure of Steam Dome	P-SD	bar
Flow Rate of Steam before Turbine	FL-S	ton/h
Pressure of Steam before Turbine	P-S	bar
Flow Rate Difference between Steam and Feedwater	DF-S-FW	ton/h
Flow Rate of Feedwater	FL-FW	ton/h
Concentration of CO before Hose Filter	C-CO	mg/Nm <sup>3</sup>
Concentration of HCL before Hose Filter	C-HCL	mg/Nm <sup>3</sup>
Concentration of SO2 before Hose Filter	C-SO2	mg/Nm <sup>3</sup>
Concentration of NH3 before Hose Filter	C-NH3	mg/Nm <sup>3</sup>
Concentration of NO2 before Hose Filter	C-NO2	mg/Nm <sup>3</sup>
Concentration of NO before Hose Filter	C-NO	mg/Nm <sup>3</sup>
Concentration of H2O before Hose Filter	C-H2O	mg/Nm <sup>3</sup>
Flow Rate of Flue-gas before Hose Filter	FL-G	Nm <sup>3</sup> /h
Flow Rate of Make-up Feedwater	FL-MW	m <sup>3</sup> /h

## Section S2 – Deep Embedded Clustering (DEC) structure

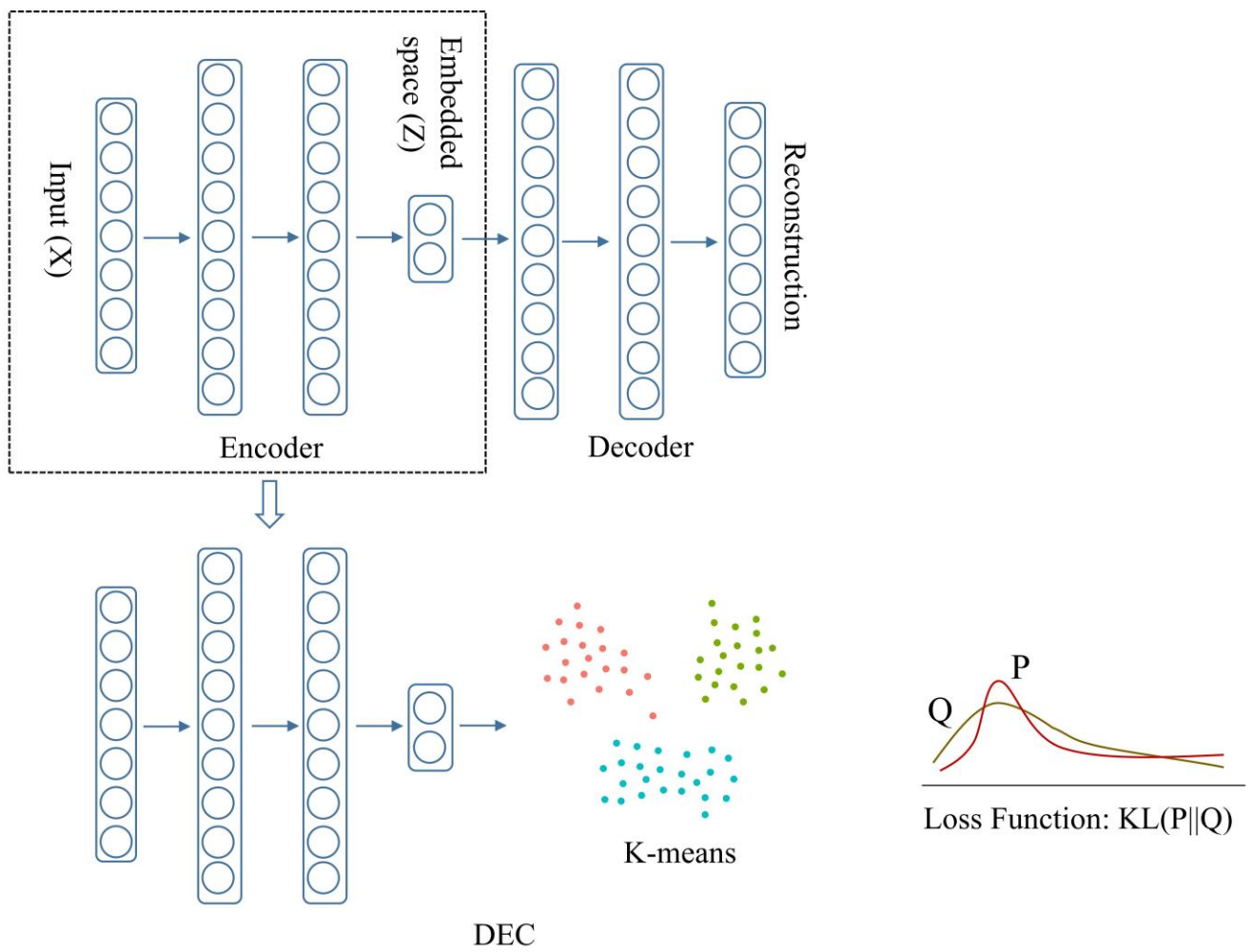


Figure S1. DEC structure

## Section S3 - Complete clustering results for dataset A

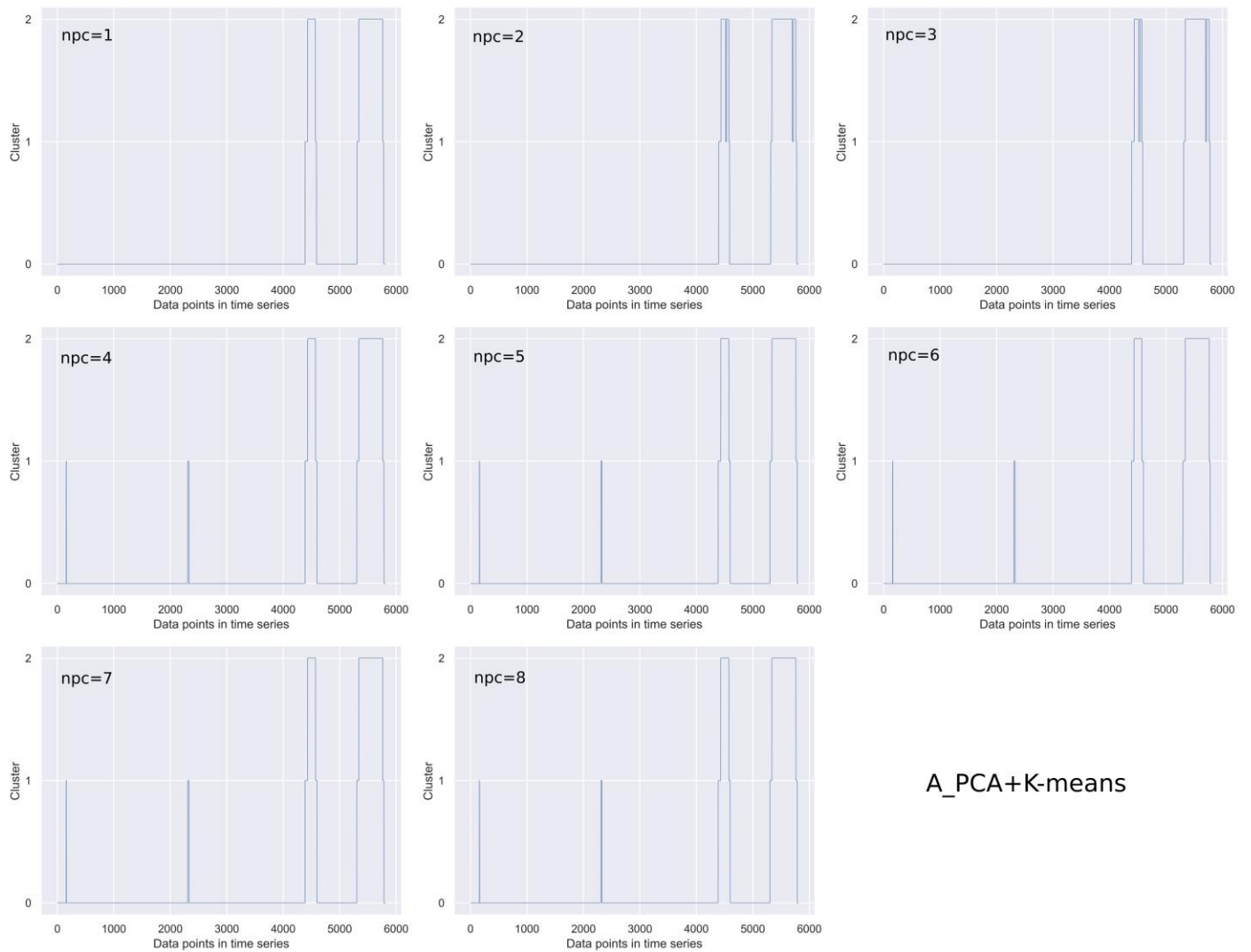


Figure S2. Complete clustering results for PCA+K-means for dataset A

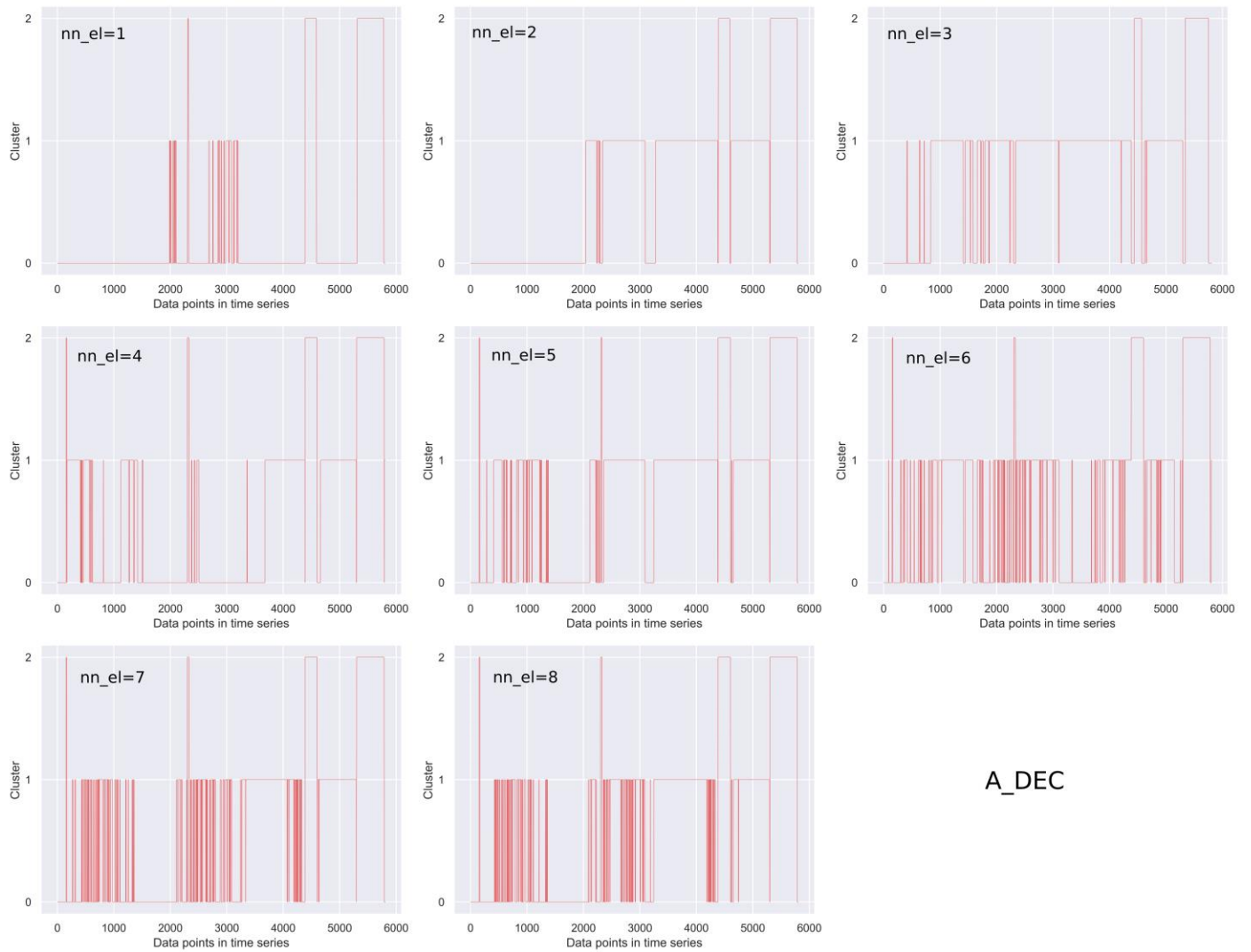


Figure S3. Complete clustering results for DEC for dataset A

## Section S4 - Complete clustering results for dataset *B*

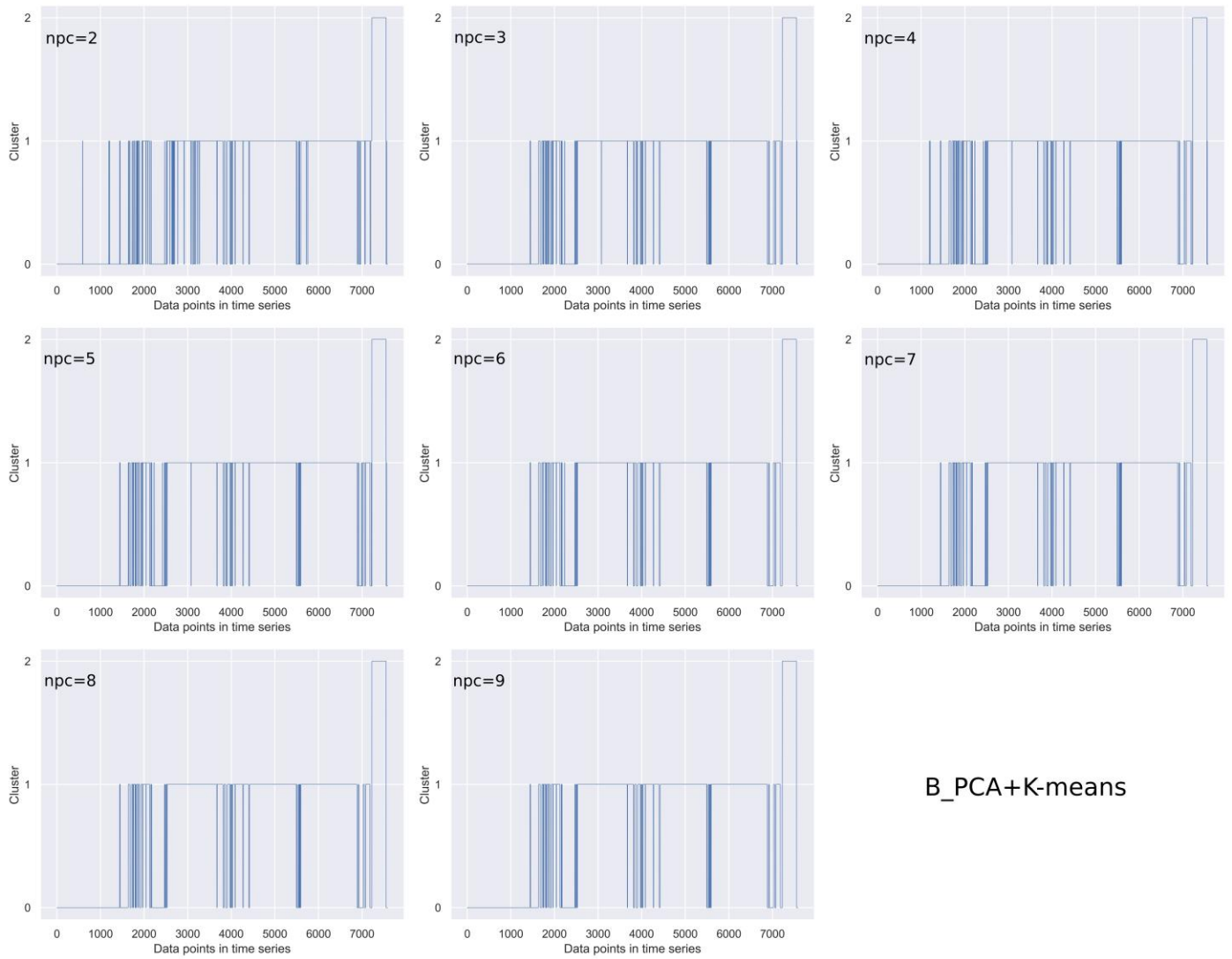
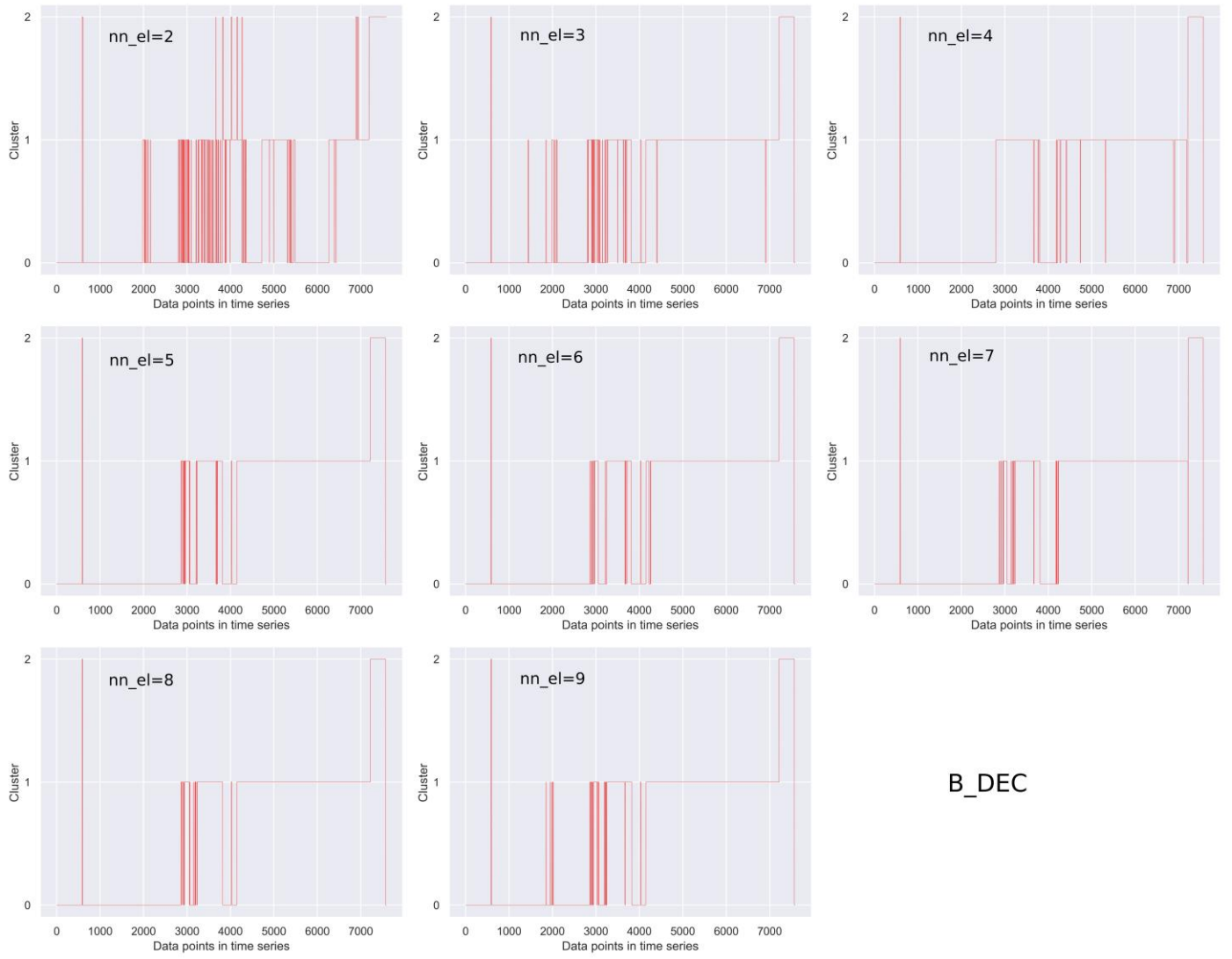


Figure S4. Complete clustering results for PCA+K-means for dataset *B*

Figure S5. Complete clustering results for DEC for dataset *B*