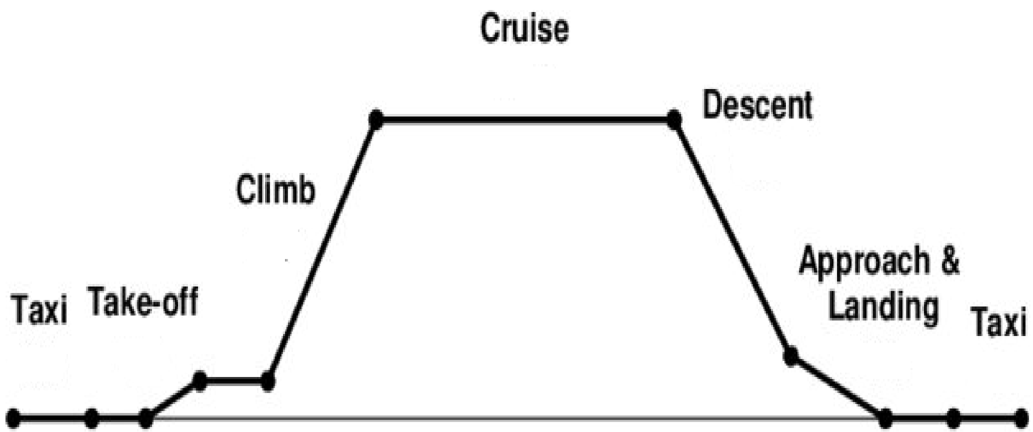
Tutorial 2 - Analysis of electrical power architecture for a typical 130-150 PAX aircraft



The AC voltage at the P.O.R (Point Of Regulation) is 230 V.

2 types of loads:
- non-essential electrical loads
- essential electrical loads => supplied even in the event of failure

	Taxi		Cruise		Landing	
	Non-essential	essential	Non-essential	essential	Non-essential	essential
Environment Conditioning System (ECS)	105 kW 230 VAC CF = 400 Hz cos φ = 0,8	5 kW 28 VDC	105 kW 230 VAC CF = 400 Hz cos φ = 0,8	5 kW 28 VDC	10 kW 230 VAC CF = 400 Hz cos φ = 0,8	5 kW 28 VDC
Ice Protection System (IPS)	5 kW 270 VDC	5 kW 28 VDC	40 kW 270 VDC	5 kW 28 VDC	5 kW 270 VDC	5 kW 28 VDC
Navigation & communication		5 kW 28 VDC		5 kW 28 VDC		5 kW 28 VDC
Cabin equipment	2 kW 230 VAC CF = 400 Hz cos φ = 0,9		20 kW 230 VAC CF = 400 Hz cos φ = 0,9		2 kW 230 VAC CF = 400 Hz cos φ = 0,9	
APU starter	0 kW	10 kW 28 VDC	0 kW	0 kW	0 kW	0 kW
Actuation system	5 kW 230 VAC VF = 400→800 Hz cos φ = 0,95	10 kW 230 VAC VF = 400 →800 Hz cos φ = 0,95	20 kW 230 VAC VF = 400→800 Hz cos φ = 0,95	75 kW 230 VAC VF = 400→800 Hz cos φ = 0,95	10 kW 230 VAC VF = 400→800 Hz cos φ = 0,95	30 kW 230 VAC VF = 400→800 Hz cos φ = 0,95
Landing gear	0 kW	5 kW 230 VAC VF = 400→800 Hz cos φ = 0,95	0 kW	0 kW	0 kW	30 kW 230 VAC VF = 400→800 Hz cos φ = 0,95

CF : constant frequency

VF : variable frequency

Question 1

Power types	kW	kVAR	kVA
28 VDC loads	15 kW	0	
270 VDC loads	40 kW	0	
230V CF loads	20 KW @ cos φ = 0,9 105 KW @ cos φ = 0,8	Q = Ptanφ = 9.7 kVAR Q = Ptanφ = 78.8 kVAR	
230V VF loads	95 KW @ cos φ = 0,95	31.2	
Total	275 kW	119.7 kVAR	$S = \sqrt{P^2 + Q^2}$=300 kVA

Power from generators = 300/0.8 = 375 kVA

Question 2

- Essential loads

Croisière

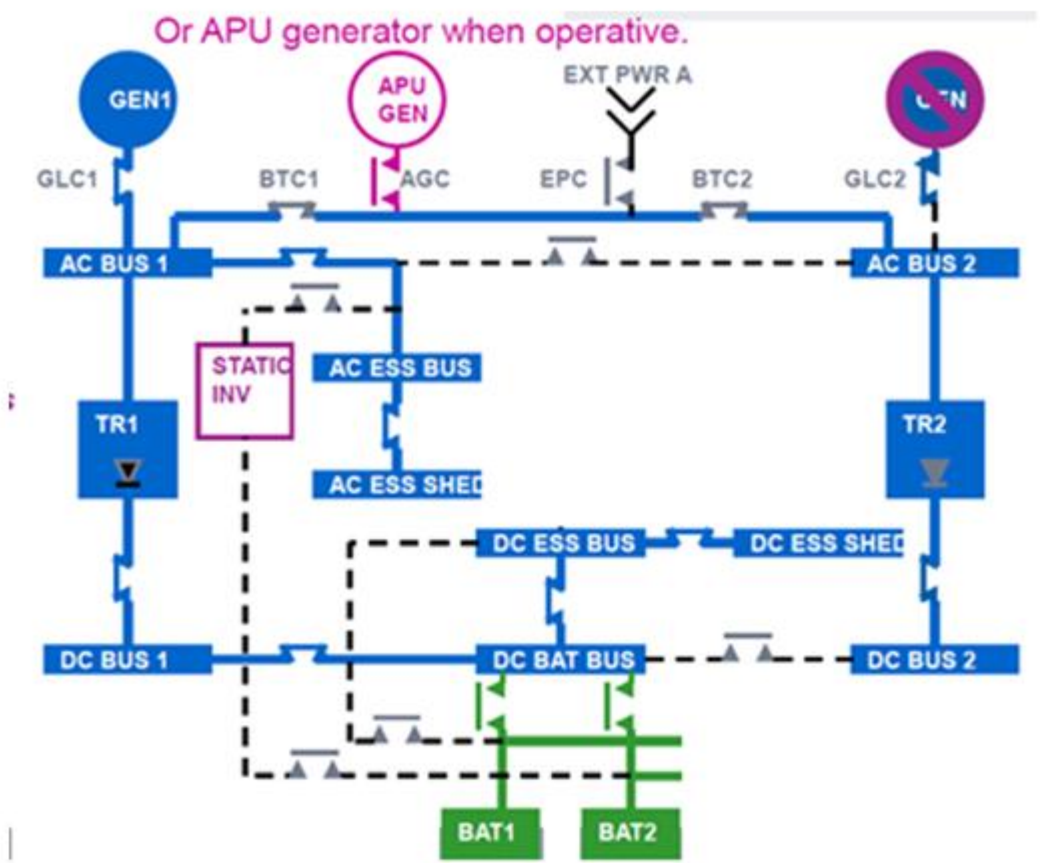
Power types	kW	kVAR	kVA
28 VDC loads	15 kW	0	
230V VF loads	75 KW @ cos φ = 0,95	24.6 kVA	
Total	90 kW	24.6 kVAR	$S = \sqrt{P^2 + Q^2}$= 93 kVA

Atterrissage

Power types	kW	kVAR	kVA
28 VDC loads	15 kW	0	
230V VF loads	60 KW @ cos φ = 0,95	19.7 kVAR	
	75	19.7 kVAR	$S = \sqrt{P^2 + Q^2}$ = 77.5 kVA

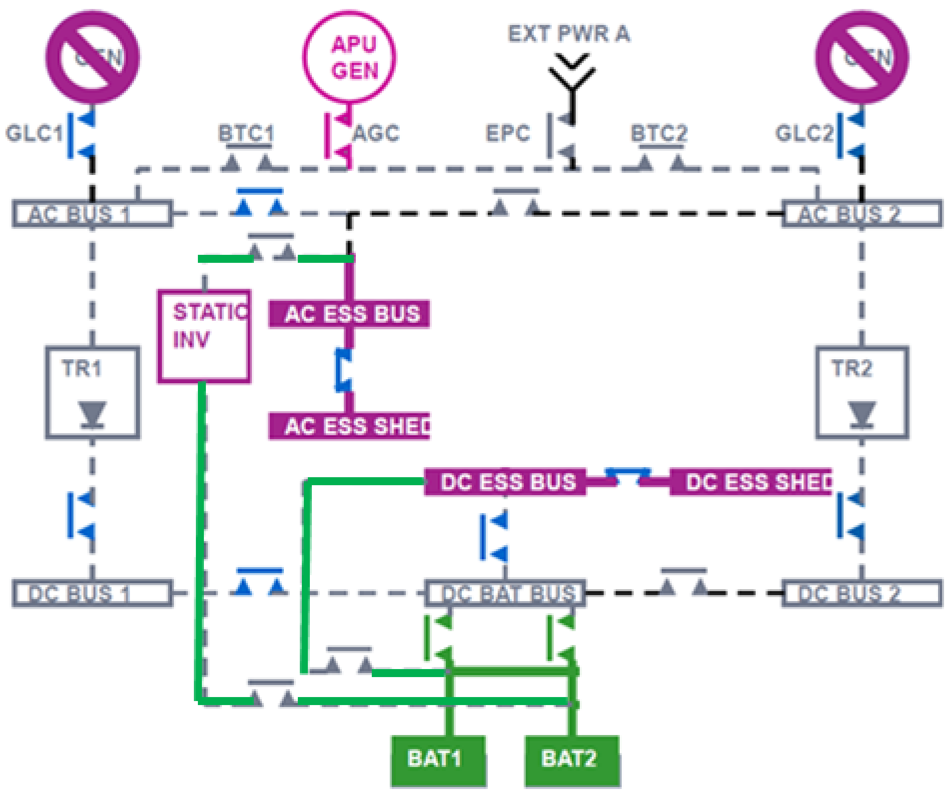
Question 3 - Engine failure

Distribution de puissance dans le cas d'une panne moteur



Question 3 - Failure of one engine + AC bus

Distribution de puissance dans le cas de double panne moteur et de panne du bus AC



Battery pack:

Apparent power during the cruise: 93 kVA

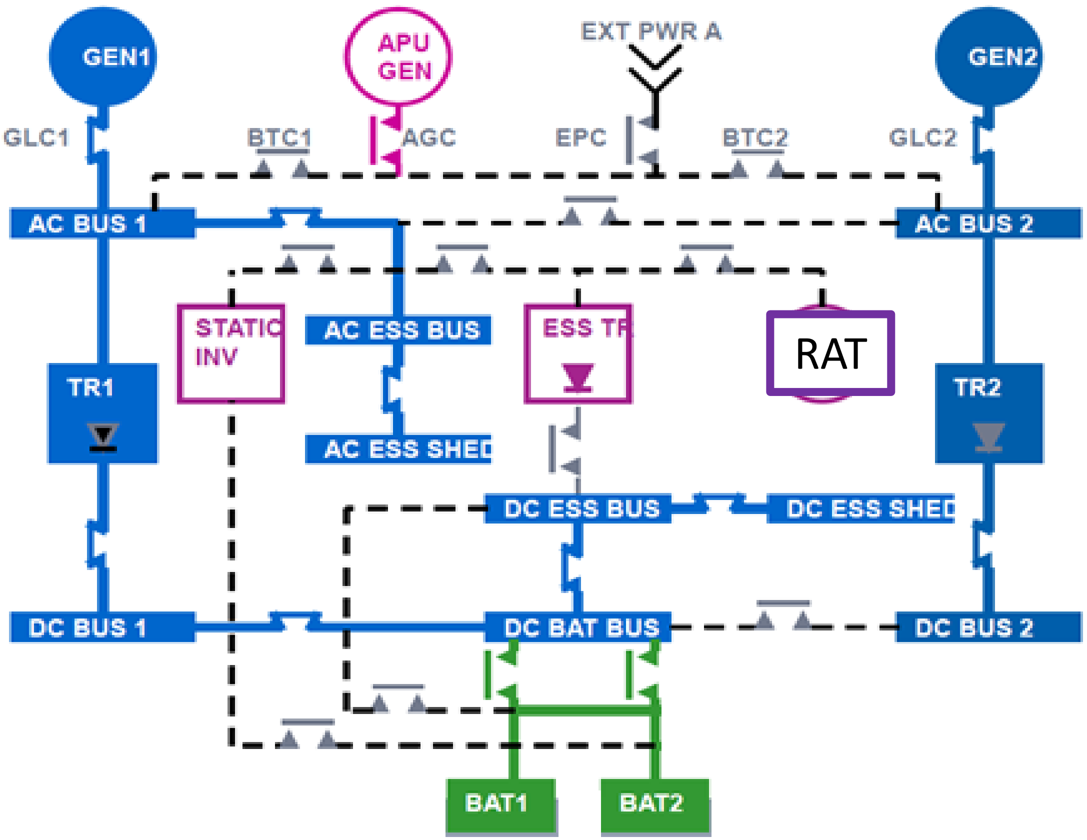
Apparent power during the landing : 77.5 kVA

=> Required energy : $93 * 25 + 77.5 * 5 = 2712.5$ kVA.min

$$: \ 93 * \frac{25}{60} + 77.5 * \frac{5}{60} = 45.2 \ \text{kVAh}$$

=> Battery weight : 150 Kg

Question 4 - RAT



Question 5 - Current in feeder

Power types	kW	kVAR	kVA
230V CF loads	20 KW @ cos φ = 0,9 105 KW @ cos φ = 0,8	Q = Ptanφ = 9.7 kVAR Q = Ptanφ = 78.8 kVAR	
230V VF loads	20 KW @ cos φ = 0,95	Q = Ptanφ = 6.6 kVAR	
Total	145	95.1	$S_{POR}=\sqrt{P_{POR}^2+Q_{POR}^2}$ = 173.4 kVA.

$$I_g=\frac{S_{POR}}{3.V_p} = 173.4/3/230= 251.3\ \mathrm{A}$$