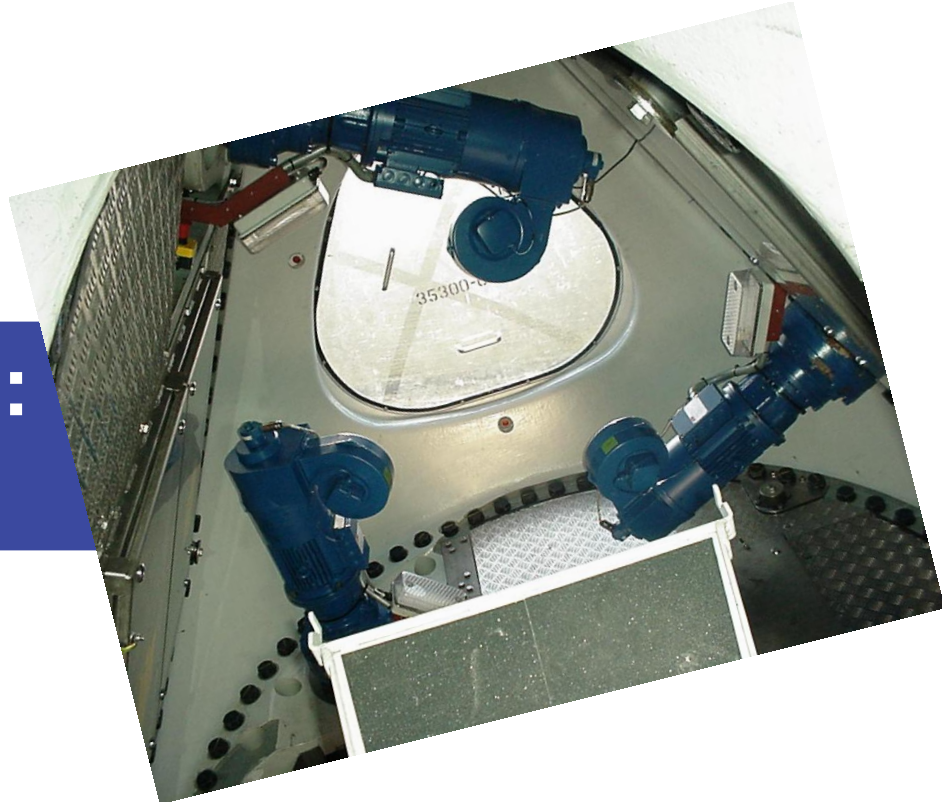
Offshore renewables: Minimising OPEX



Nantes, 21 May 2015

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Managing Director

BVGassociates

Offshore Renewables: Minimising OPEX

Introduction

Contents

- Why focus on turbine reliability
- Reliability centred approach
  - 10 steps to success

Selected clients

BVG Associates

- Market analysis and business development
  - Supply chain development
  - Economic impact assessment
  - Support to industrialisation
- Technical innovation & engineering analysis
  - Support to investment in technology
  - R&D programme management
  - Design and engineering services
- Project implementation
  - FIT project development (UK only)
  - SCADA & condition monitoring
  - O&M technical support

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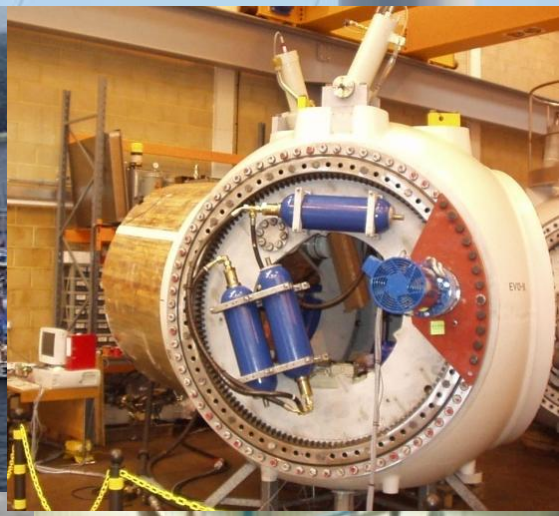
ABUS 25t



Cost of energy

Basics

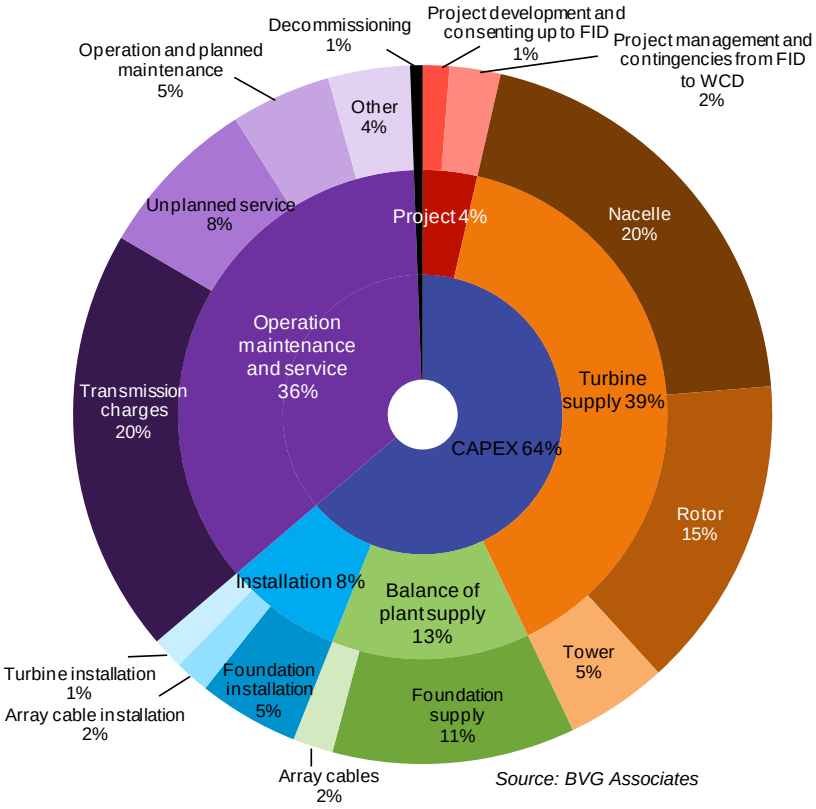
LCOE

$$LCOE = \frac{\sum_{i=-m}^{n} ((C_i + O_i + D_i) \ / (1+W)^i)}{\sum_{i=-m}^{n} (E_i \ / (1+W)^i)}$$

Where:

LCOE	Levelised cost of energy in £/MWh = revenue needed (from whatever source) to obtain rate of return W on investment over life of the wind farm (tax, inflation etc. not modelled)
C_i	Capital expenditure in € in year i
O_i	Operational expenditure in € in year i
D_i	Decommissioning expenditure in € in year i
E_t	Energy production in MWh in year i
W	Weighted average cost of capital in % (real) = (cost of debt x % dept) + (return on equity x equity portion)
n	Operating lifetime of wind farm (baseline 20 years)
m	Years before start of operation when expenditure first incurred
i	i year of lifetime (-m, ..., 1, 2, …n)

LCOE breakdown for project with 6MW turbines

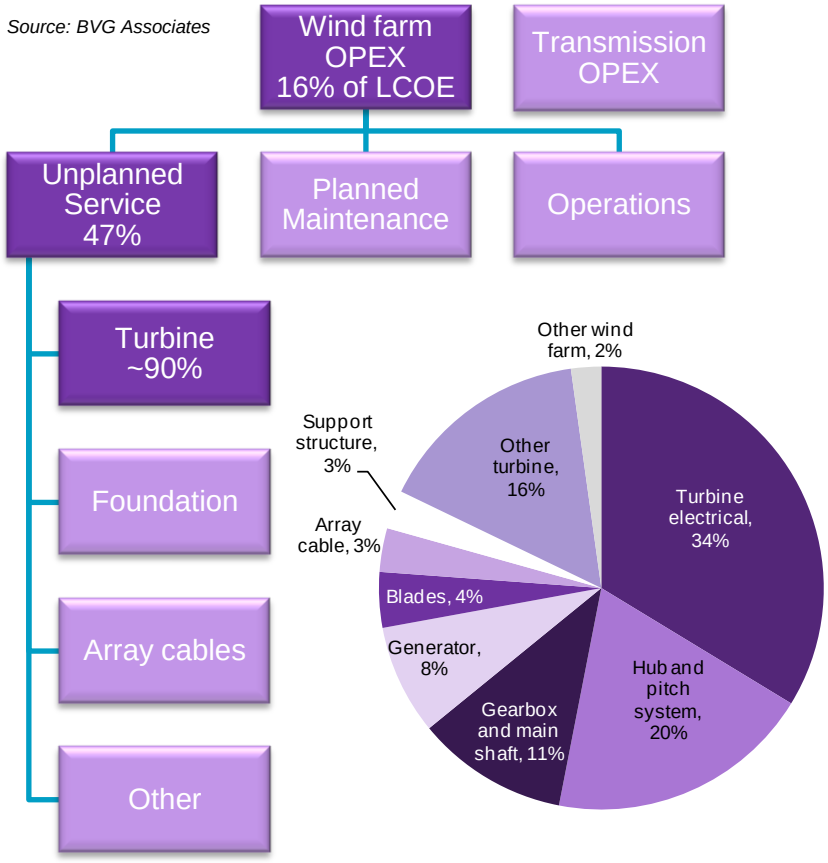


Why focus on reliability

The case for focus on wind turbine reliability

Spend breakdown

Source: BVG Associates

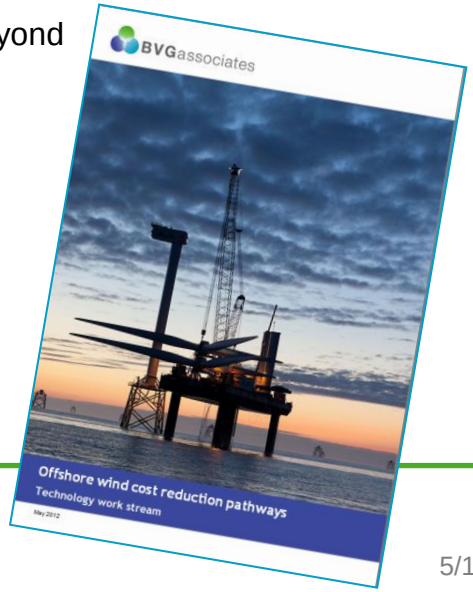


If...

- If turbines were 100% reliable, so just needed visits for planned maintenance...
- Wind farm OPEX reduced by 43%
- Lifetime expenditure reduced by 7%
- Lost energy due to turbine reliability reduced by 90%
- LCOE reduced by 11%

- Visits down 70%
- Accidents down by >80%
- Increased certainty would increase pool of investors and decrease cost of capital

- Many innovations beyond turbines, also…



Why focus on reliability

The case for focus on wind turbine reliability

Due diligence - experience

- ✓ Lots good
- × Few components / systems tested thoroughly
- × Poor justification for component survival (beyond calculations)
- × Main component exchange not designed in / tested
- × Not possible to easily replace wear parts
- × Poor / incomplete manuals and troubleshooting guides
- × Track record of unreliable systems / repeat faults
- × Training strategies not implemented
- × Site work records incomplete
- × SCADA report errors
- × Significant inefficiencies on site
- ✓ Type Certificate (does not consider the above)

Where our experience comes from

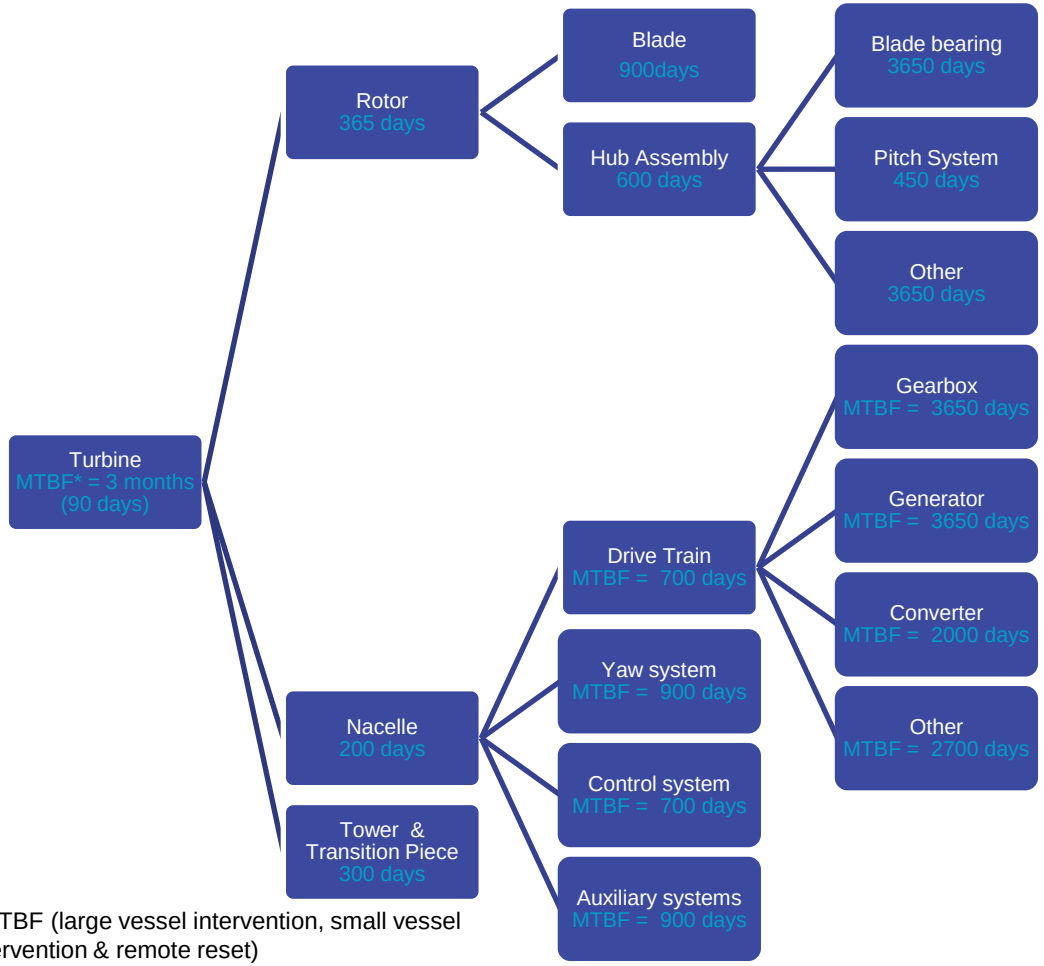
Reliability centred approach

Important ingredients of reliability centred approach

10 Steps to success

1. Reliability and OPEX budgets (and model)

1a. Reliability budget



* MTBF (large vessel intervention, small vessel intervention & remote reset)

Reliability centred approach

Important ingredients of reliability centred approach

10 Steps to success

5. Demonstration of maintenance procedures
4. Test and verification
3. Component reliability reviews
2. ‘Rules of thumb’
1. Reliability and OPEX budgets (and model)

5. Demonstration of maintenance procedures

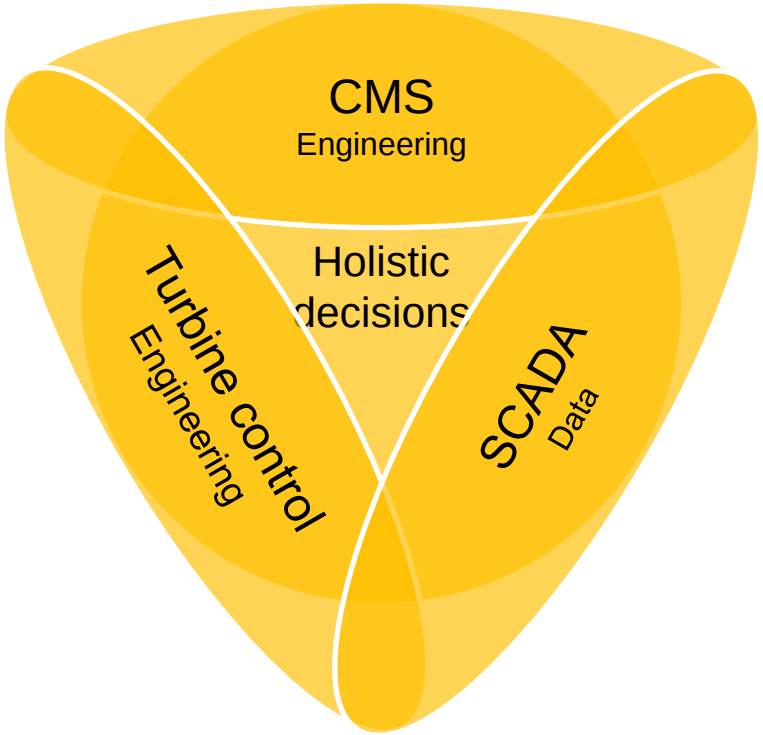
Reliability centred approach

Important ingredients of reliability centred approach

10 Steps to success

6. Joined up SCADA/ control/CM
5. Demonstration of maintenance procedures
4. Test and verification
3. Component reliability reviews
2. ‘Rules of thumb’
1. Reliability and OPEX budgets (and model)

6. Joined up SCADA/control/CM



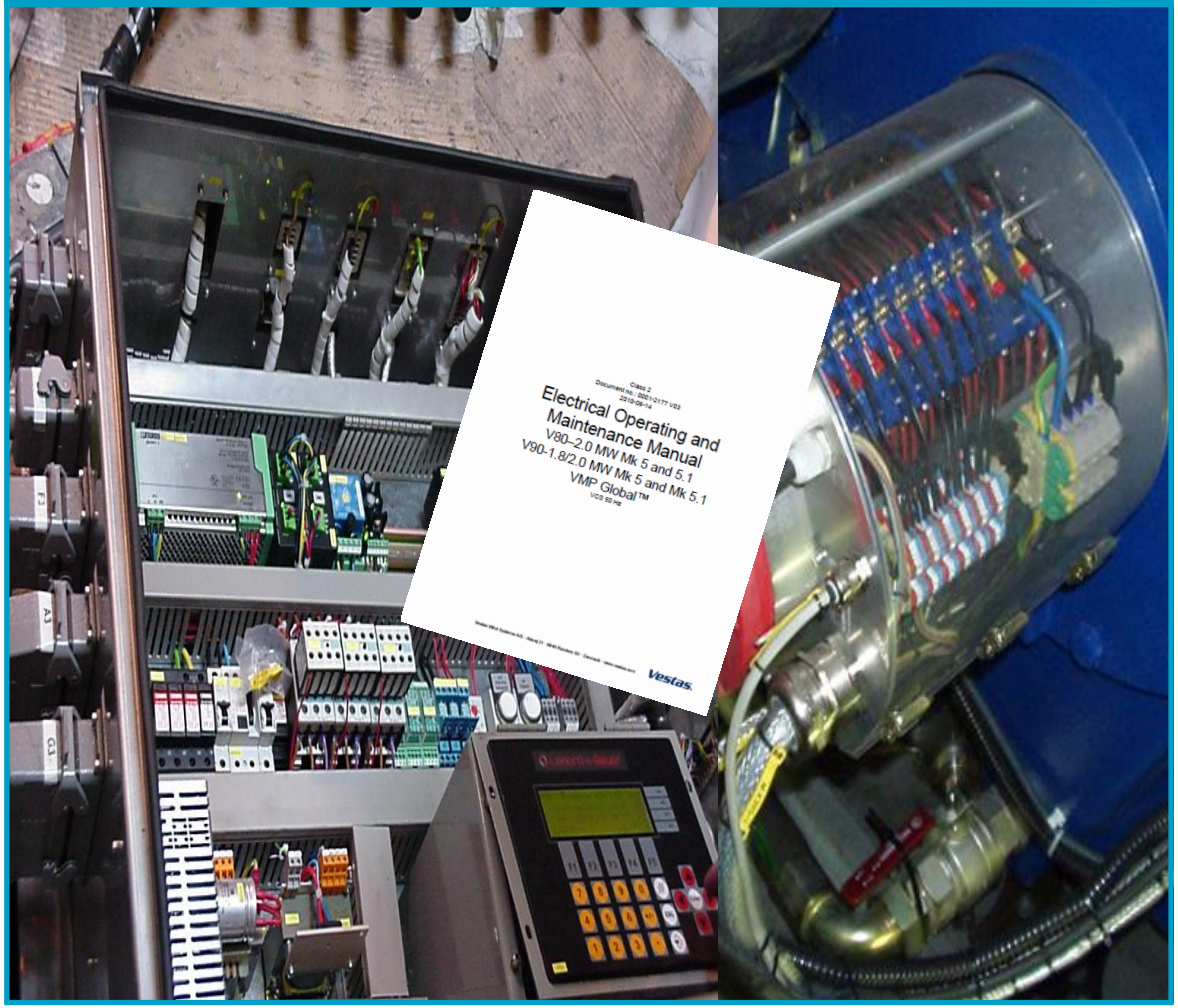
Reliability centred approach

Important ingredients of reliability centred approach

10 Steps to success

9. Fix first time approach
8. Useful, accurate data
7. Feedback from site
6. Joined up SCADA/ control/CM
5. Demonstration of maintenance procedures
4. Test and verification
3. Component reliability reviews
2. ‘Rules of thumb’
1. Reliability and OPEX budgets (and model)

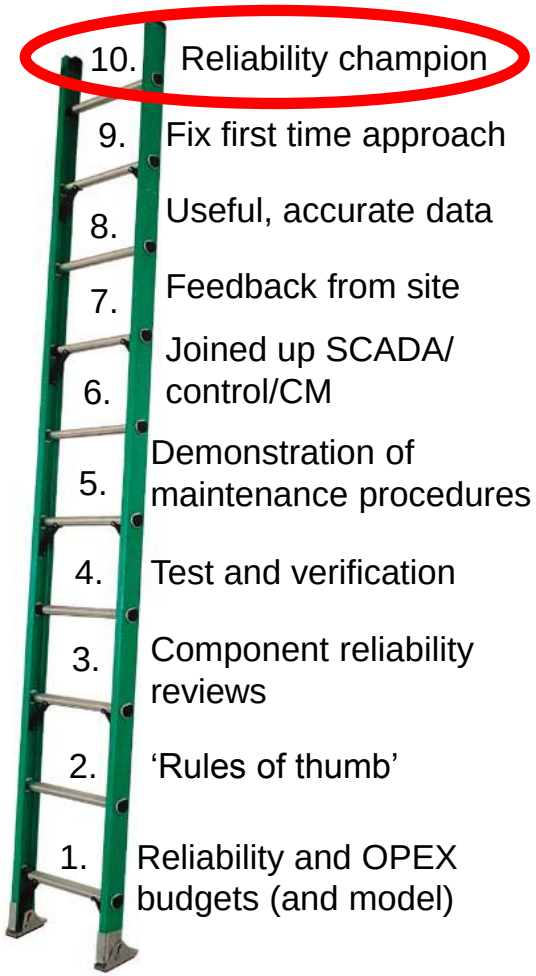
9. Fix first time approach



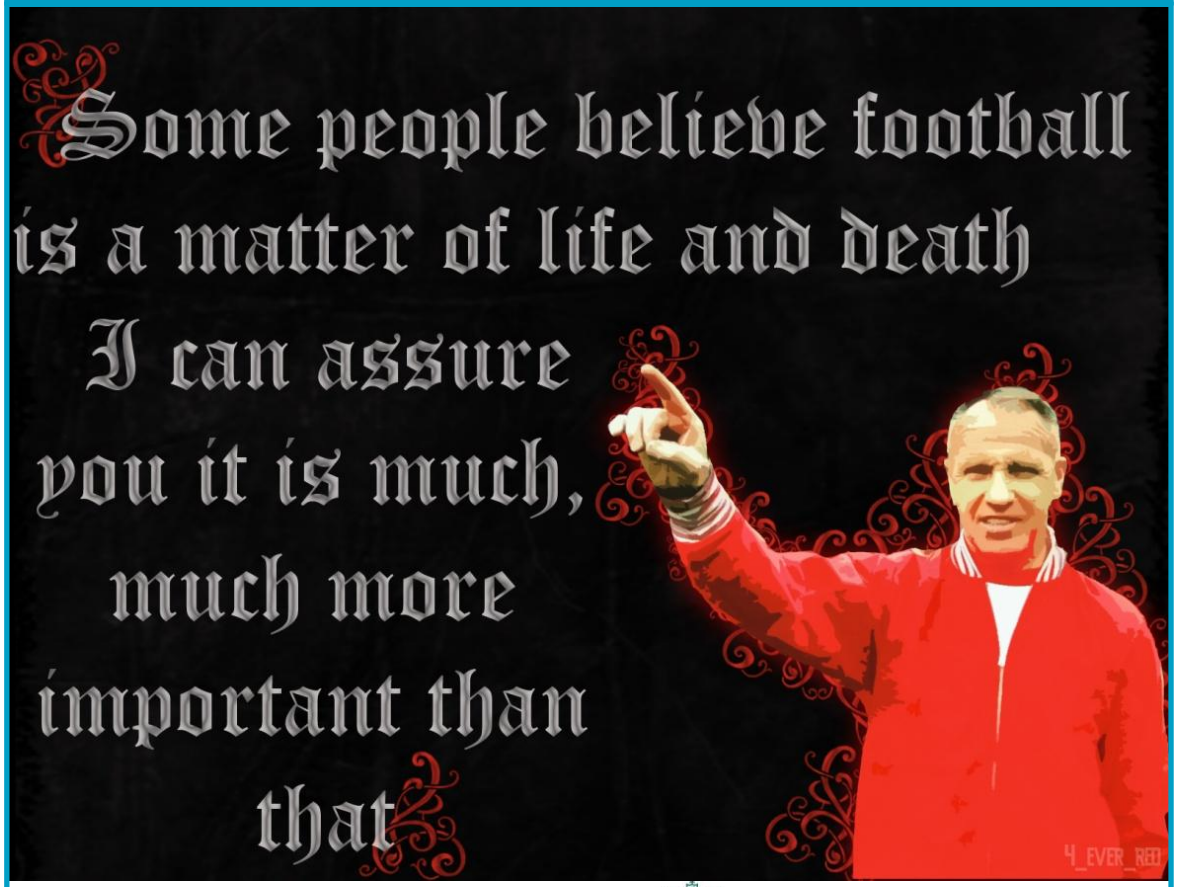
Reliability centred approach

Important ingredients of reliability centred approach

10 Steps to success



10. Reliability champion



Bill Shankly, Liverpool Football Club

Thank you

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