

CREATE Stage 2

Concrete as a Technology Enabler

Introduction

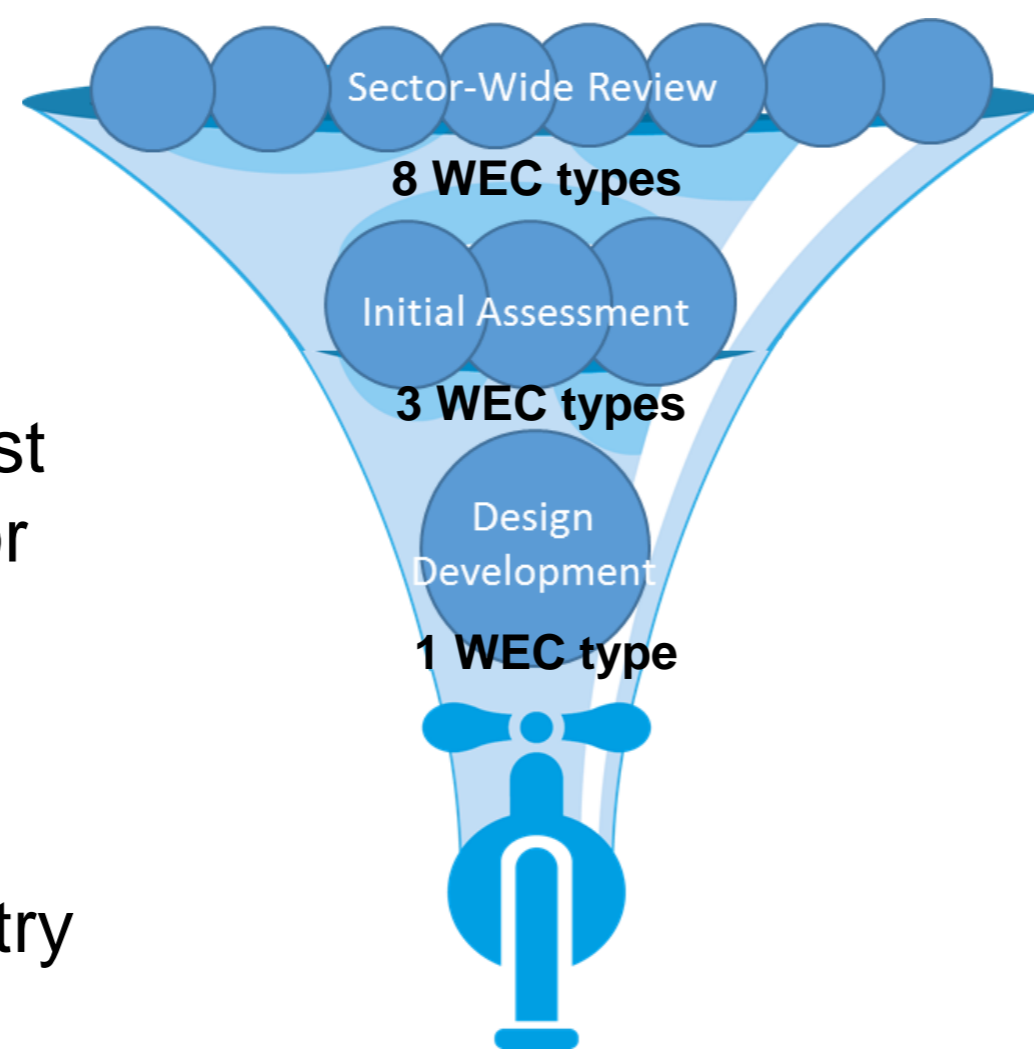
Reinforced concrete has the potential to offer a **low cost solution** for WEC prime movers taking advantage of a **mature supply chain**.

Stage 1 of the CREATE project (2016) took a sector wide approach to identify **where concrete had potential** for structures and developed the most promising option to a **pre-FEED level** with potential for commercialisation.

CREATE Stage 2 (2018/19) aims to mitigate key technical risks identified in Stage 1 and provide confidence that concrete can provide a **step change in LCoE** for WECs.

Stage 1: Engineering Design Study

- A sector wide review identified a range of WECs where concrete represents a feasible structural solution.
- Design, manufacturing and cost assessment was carried out for 3 promising WEC types.
- The buoyant actuator of the Carnegie CETO 6 device was chosen as an example geometry for more detailed assessment.



Stage 2: Risk Reduction Testing

Loads Analysis and Structural Design

The Stage 1 design will be developed to a FEED level with a focus on high risk structural details with broad applicability to the WEC sector, including precast connections and tether attachment points.

Physical Testing

Stage 1 highlighted water-tightness of precast connections under cyclic loading as a key technical risk. Test specimens will be manufactured for cyclic water-tightness testing in representative conditions to mitigate this risk for the sector.

Manufacturing Assessment & Life-Cycle Costing

OPEX and CAPEX will be considered to derive the full lifecycle costs (including LCoE) to illustrate the benefit of concrete over steel. Manufacturing costs will be independently checked by a contractor and a technical roadmap to serial production developed.

A comprehensive risk assessment and mitigation strategy will inform the scope of work for *CREATE Stage 3: Manufacturing Demonstration (anticipated 2019/2020)*.

Stage 1: Engineering Design Study

SeaPower: Concrete Pontoon Generic Point Absorber: Concrete BA

Wello: Concrete Hull Options

Concrete Carnegie CETO Device: Structural Drawings and Analysis

Stage 2: Risk Reduction Testing

Precast Concrete BA Solution: Design for Manufacture

Physical Testing and Independent Cost Assessment

Item	Short Description	Quantity	Unit	Production	Unit rate	Cost per WEC
1.01	CONCRETE BA FACILITY	1.0	item	100%	1	1
1.02	Equipment hire/rental	3.0	month	100%	20,000.00	60,000
Stage 1 Facility Total						
CONCRETE BA FACILITY						
2.01	Rebar preparation for casting	150.0	m ²	100%	3.00	3,000
2.02	Rebar - reinforcement supply	150.0	m ²	100%	60.00	9,000
2.03	Formwork - reinforcement supply	22.0	m ²	100%	628.00	13,816
2.04	Formwork - reinforcement hire	22.0	m ²	17.0	217.00	4,774
2.05	Formwork - concrete supply	81.0	m ²	100%	180.00	14,580
2.06	Formwork - concrete hire	81.0	m ²	1.0	16.00	1,300
2.07	Formwork - seal and temporary bracing, tie rods, stress & seal	2.0	hr	100%	3,000.00	7,000
2.11	Outer Wall - reinforcement supply	40.0	m ²	100%	22.00	2,000
2.12	Outer Wall - reinforcement supply	9.2	m ²	100%	628.00	5,788
2.13	Outer Wall - reinforcement hire	9.2	m ²	8.0	217.00	1,996
2.14	Outer Wall - concrete supply	37.0	m ²	100%	180.00	6,660
2.15	Outer Wall - concrete hire	37.0	m ²	1.0	16.00	592
2.16	Formwork - steel	10.0	m ²	100%	4,000.00	40,000
2.17	Formwork - steel	10.0	m ²	100%	1,000.00	10,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
3.01	Manufacturing and transportation	1.0	item	100%	50,000.00	50,000
3.02	Office equipment & expenses	1.0	item	100%	10,000.00	10,000
3.03	Construction insurance	1.0	item	100%	10,000.00	10,000
3.04	Construction insurance	1.0	item	100%	10,000.00	10,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
4.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
4.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
4.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
5.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
5.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
5.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
6.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
6.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
6.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
7.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
7.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
7.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
8.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
8.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
8.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
9.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
9.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
9.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
10.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
10.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
10.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
11.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
11.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
11.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
12.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
12.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
12.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
13.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
13.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
13.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
14.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
14.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
14.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
15.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
15.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
15.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
16.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
16.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
16.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
17.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
17.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
17.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
18.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
18.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
18.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
19.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
19.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
19.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
20.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
20.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
20.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
21.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
21.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
21.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
22.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
22.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
22.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
23.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
23.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
23.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
24.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
24.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
24.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
25.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
25.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
25.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
26.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
26.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
26.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
27.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
27.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
27.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
28.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
28.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
28.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
29.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
29.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
29.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
30.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
30.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
30.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
31.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
31.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
31.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
32.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
32.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
32.03	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
CONCRETE BA FACILITY TOTAL						
CONCRETE BA FACILITY						
33.01	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
33.02	CONCRETE BA FACILITY	1.0	item	100%	100,000.00	100,000
33.03	CONCRETE BA FACILITY	1.0	item	100%		