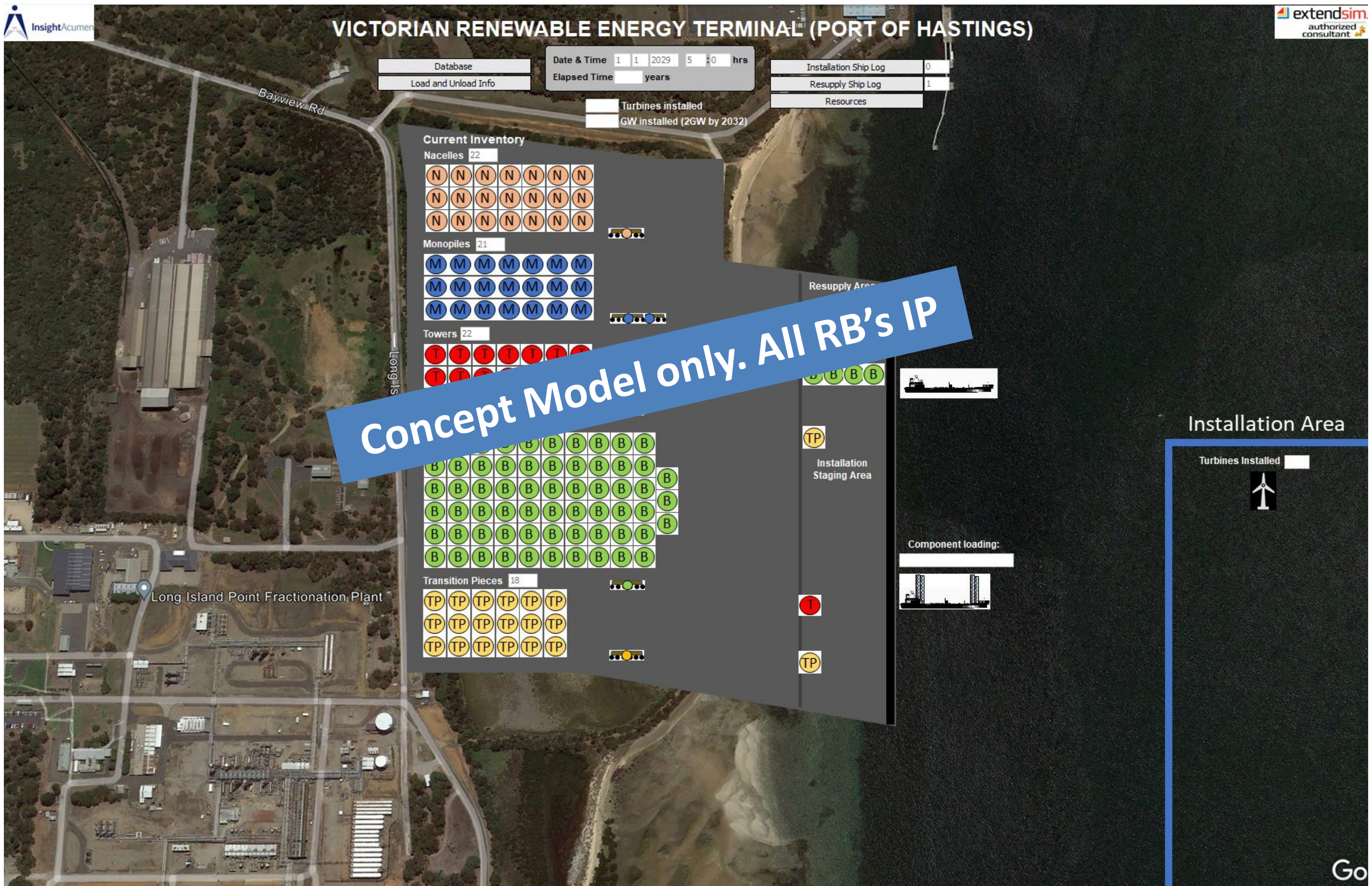
Victorian Renewable Energy Terminal

(Port of Hastings)



Background

Why is VRET required?

- Offshore wind will support Victoria's switch to renewable energy and play a vital role in the state's energy transition. Victoria has set ambitious targets of 2 GW of offshore generation by 2032, 4 GW of offshore wind capacity by 2035 and 9 GW by 2040.
- Developing specialised port infrastructure is critical to achieve these targets and support Victoria's ambitions of establishing a prospering offshore wind sector over the next decade.
- There is no port in Australia that is currently suitable to support offshore wind construction.
- Offshore wind components are very large and heavy, placing unique operational requirement on ports, including the need for heavy duty pavement strength and significant areas of land adjacent to available berths.

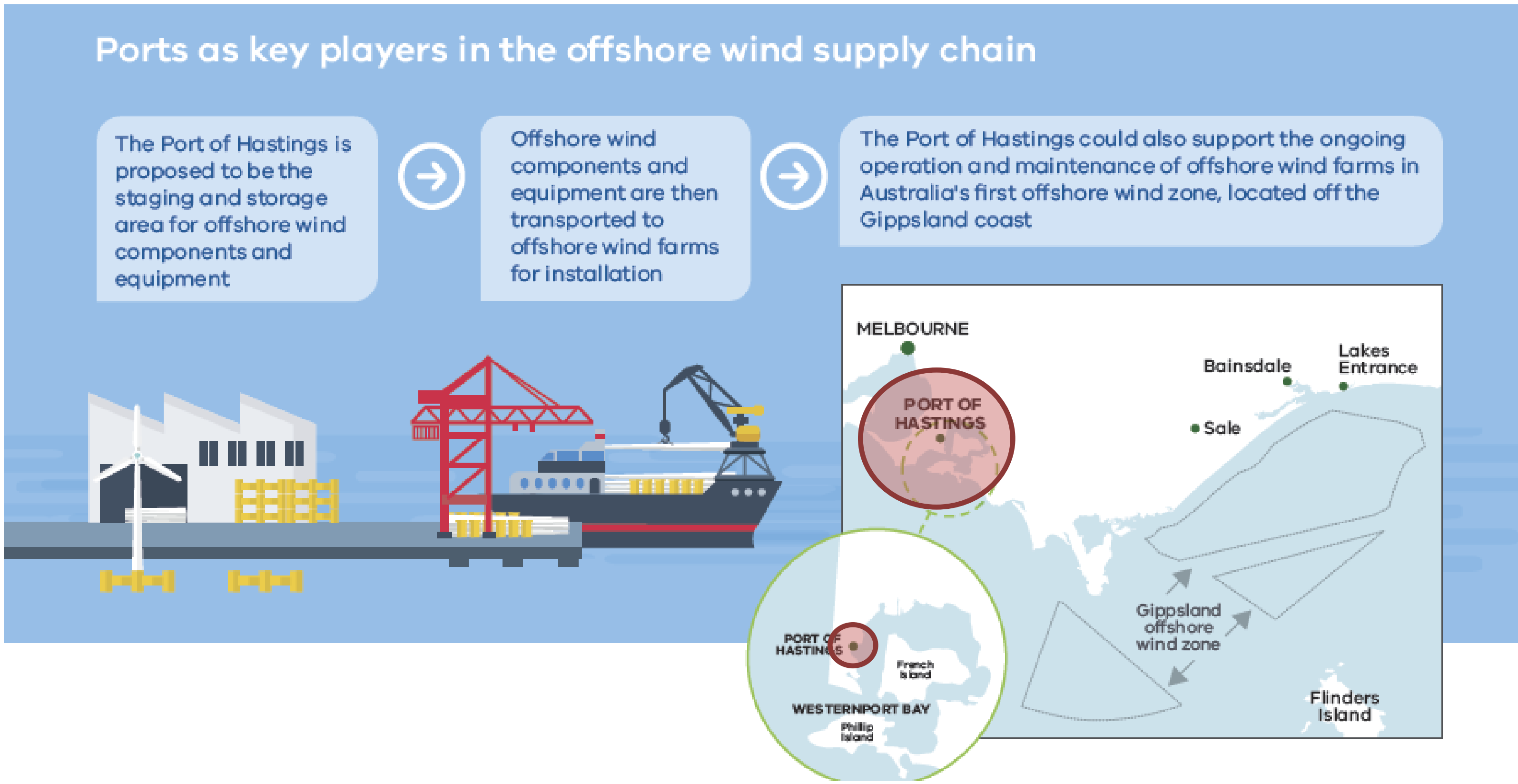
Ref: https://portofhastings.vic.gov.au/supporting-offshore-wind

Port of Hastings

- The Port of Hastings has been confirmed as the most suitable port for the establishment of the Victorian Renewable Energy Terminal following an extensive technical review and engagement with key stakeholders including offshore wind developers and ports.
- The area of the Port of Hastings identified for the establishment of the Victorian Renewable Energy Terminal is the Old Tyabb Reclamation Area (OTRA), located within the port precinct between Esso’s Long Island Point and BlueScope Steel.
- The terminal is expected to include at least 2 berths with a total wharf length of at least 400m, and form up to 35 hectares of heavy-duty hardstand comprised of 10 hectares of reclaimed land connecting the wharf to the existing 25-hectare OTRA land. Construction is schedule to commence in late 2025 subject to obtaining necessary approvals.
- The OTRA site is located within an existing port zone. The development would see the OTRA site transformed into a multiuser facility with new landside infrastructure and berths adjacent to the existing shipping channel.

Ref: https://portofhastings.vic.gov.au/supporting-offshore-wind

Port of Hastings location



Ref: https://portofhastings.vic.gov.au/supporting-offshore-wind.
"LATEST VRET FACT SHEET" downloaded 24 Apr 23

References

- Victorian Government: https://portofhastings.vic.gov.au/supporting-offshore-wind, viewed April 2023
- Other open sources accessed via Google and YouTube, April 2023
- Modeller/developer estimates

Model

Why?

- It's a model applicable to the renewable energy sector – what's not to like?
- It would be a huge opportunity to contract to, and be a supplier for this project.
- And down the line, lessons learned from the PoH modelling experience could greatly assist other states and territories with making more efficient and effective transitions to offshore wind energy generation and their own renewable energy targets.

Disclaimer

- I don’t know “boats”.
- My model of Port of Hastings (PoH) terminal is 100% based on open source references and “guesstimates”.
- I have no SME knowledge of renewable energy terminal processes, configurations, delays, business rules, etc.
- I’ve made many assumptions (most listed later).
- The purpose of the analysis is to show the power of “what if” analysis using a discrete event simulation model.

Software

- ExtendSim by Imagine That (v10.0.9)
- ExtendSim is an easy-to-use yet extremely powerful tool for simulating processes. It helps you understand complex systems and produce better results faster.
- With ExtendSim you can:
  - Predict the course & results of certain actions.
  - Gain insight and stimulate creative thinking.
  - Visualise processes logically or in a virtual environment.
  - Identify problem areas before implementation.
  - Explore potential effects of modifications.
  - Confirm all variables are known.
  - Optimise operations.
  - Evaluate ideas and identify inefficiencies.
  - Understand why observed events occur.
  - Communicate the integrity & feasibility of plans.

Ref: https://extendsim.com/solutions/simulation/why

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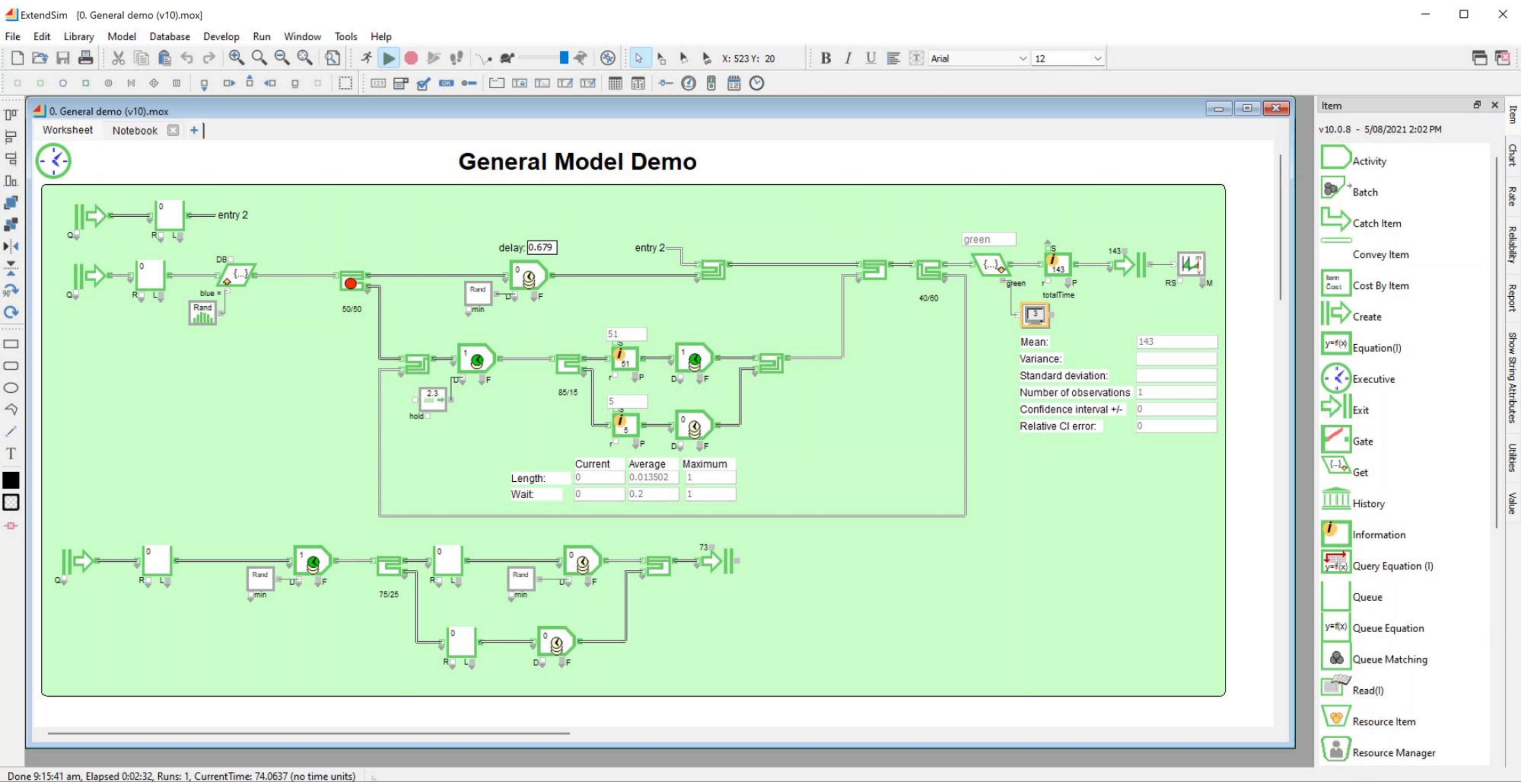
ExtendSim General Demo



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Scope

- Build a representation of PoH terminal for offshore wind installation operations
- 5 major turbine components modelled – monopiles, transition pieces, towers, nacelles/hubs and blades
- Resupply loads and frequency can be tested
- Installation loads and frequency can be tested
- Run long enough to install at least 2GB of turbines offshore
- Ensure model is sufficiently detailed to answer “what if” type questions and conduct sensitivity analysis
- Publish findings on www.insightacumen.com.au and present on YouTube: https://www.youtube.com/channel/UCJOnUkmbvuCqSswHECwrayQ

Animation

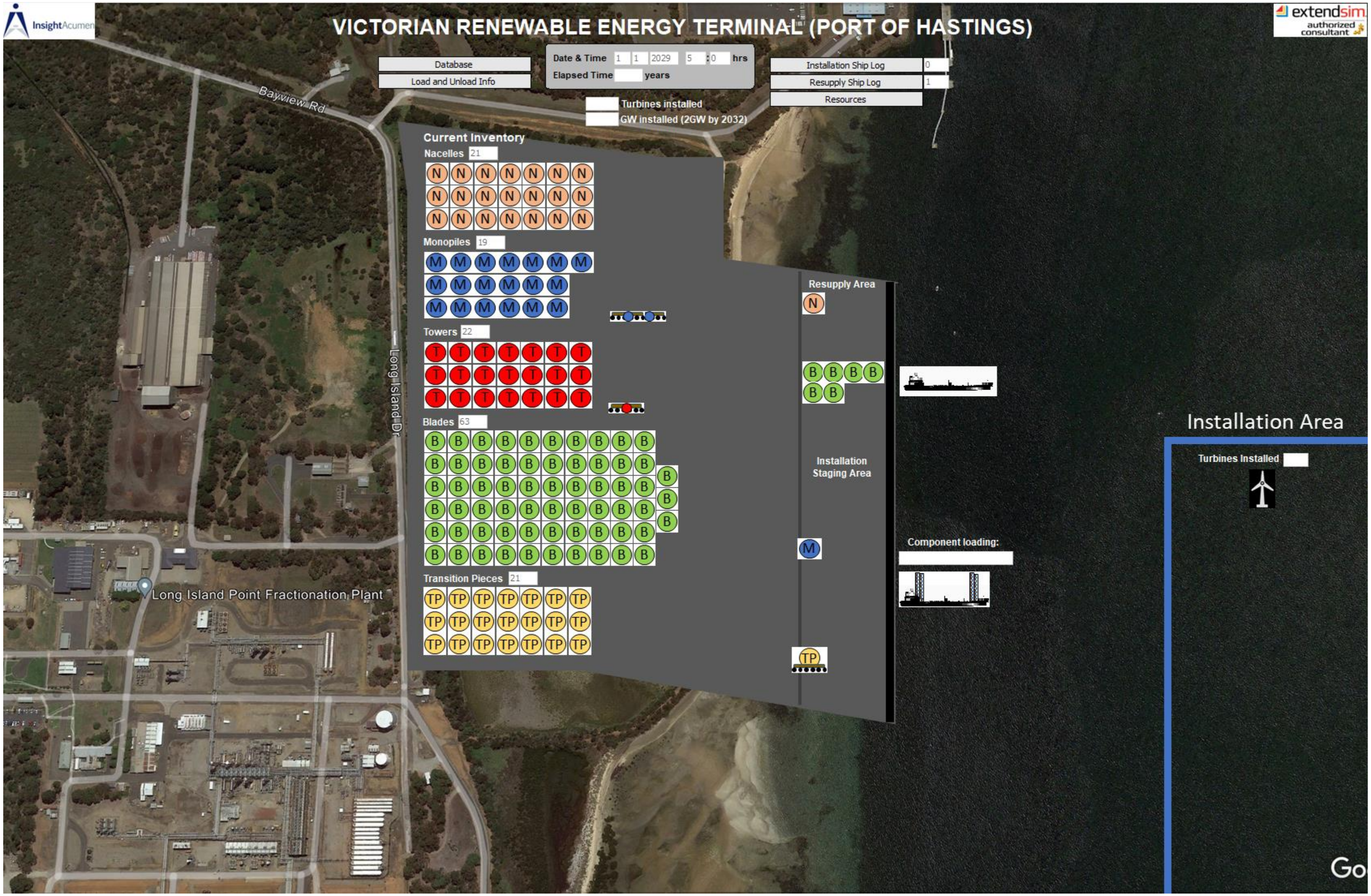
- Simple
- Major components
  - Nacelles
  - Monopiles
  - Towers
  - Blades
  - Transition pieces
- Component unloaded transport
  - Nacelles
  - Monopiles
  - Towers
  - Blades
  - Transition pieces
- Component loaded transport
  - Nacelles
  - Monopiles
  - Towers
  - Blades
  - Transition pieces
- Installation ship unloaded

- Installation ship loaded

- Installation ship jacked

- Resupply ship

Port of Hastings



Assumptions & Constraints

- 1 wind turbine or 1 set = 1 monopile + 1 transition piece + 1 tower + 1 nacelle/hub + 3 blades
- starting inventory at port = 21 sets
- yard capacity = infinite
- 1 resupply ship and 2 installation ships
- separate berths for resupply & installation ships
- separate ground transporter resources / component
- basic business rules for unloading & loading
- resupply ship unloading and installation ship loading operations can occur at the same time at their different berths
- installation ships have same number of components in constant loads for each trip to offshore installation area
- components for installation ship load will start being transported from storage yard as soon as ship arrives

Assumptions & Constraints

- installation ships load in this order: monopiles, transition pieces, towers, nacelles/hubs, then blades
- resupply ships not modelled in significant detail
- resupply ships have constant number of sets for each resupply trip
- resupply ships unload in this order: monopiles, transition pieces, towers, nacelles/hubs, then blades
- 24/7/365 operations
- durations are constant time values, ie no probability distributions
- no planned maintenance, no breakdowns (MTBF/MTTR), no planned shutdowns
- potential impact of maintenance/breakdowns/shutdowns on operations not modelled

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Assumptions & Constraints

- potential impact of weather on operations not modelled
- potential impact of tides on operations not modelled
- potential impact of maritime/port traffic on operations not modelled
- personnel not modelled
- turbines are up to 18 MW with fixed foundations (Ref: https://www.energy.vic.gov.au/renewable-energy/offshore-wind-energy, Statement 2). Model uses 18 MW per turbine.
- duration of model 2 years (2029-2031). Very easy to change and/or increase year range in order to model additional port operations.

Baseline

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Configuration

- Runtime = 2 years
- Resupply ship interarrival time = 10 days
- Ground unload time per component piece (resupply): 20 min
- Ground load time per component piece (installation): 20 min
- Ground transport time per unloaded component piece (resupply): 20 min
- Ground transport time per loaded component piece (installation): 20 min
- Installation ship time on jacks in maritime operations area = 4 days

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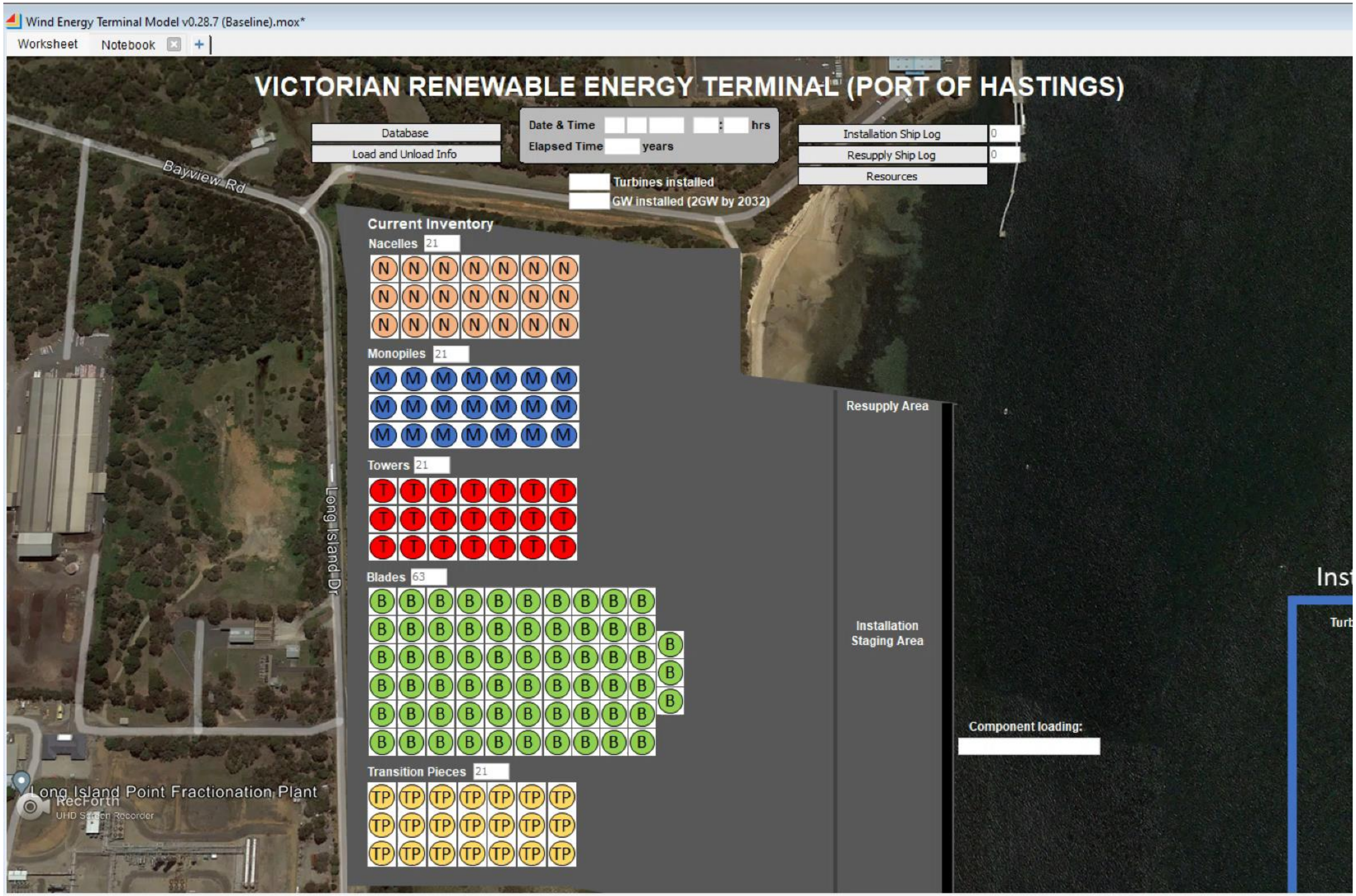
Run-time



Results

Metric	Baseline
No. turbines installed	156
GW installed	2.81
No. installation ship completed events	39
No. resupply ship completed events	69
Berth (Installation) utilisation	5.8%
Berth (Resupply) utilisation	5.5%
Monopile transport utilisation	1.4%
Transition Piece transport utilisation	1.2%
Tower transport utilisation	1.2%
Nacelle Hub transport utilisation	1.2%
Blade transport utilisation	3.9%

- In addition:
  - Resupply ship steady-state unload duration = 9.9-10.8 hrs
  - Resupply ship steady-state time at berth duration = 13.4-14.3 hrs
  - Installation ship steady-state load duration = 23.5 hrs
  - Installation ship steady-state time at berth duration = 26.0 hrs

Analysis Questions

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Analysis Questions

1. In the “baseline” model, resupply ships have an interarrival time of 10 days. If system is left to run without any new constraints, what is the impact on throughput (turbines installed) if the interarrival time is reduced to 8, 6 & 4 days, or increased to 12, 14 & 16 days?
2. What is the impact on throughput (no. of turbines installed) of reducing the ground unload/load time per component piece by 20%?
3. What is the impact on throughput (no. of turbines installed) of reducing the ground transport time per component piece by 20%?
4. The “baseline” model currently uses a 4-day interval for time spent jacked up in the maritime operations area undertaking turbine installation. What would be the impact on throughput if the installation crews were able to complete their operations per trip more efficiently, by spending 3.5 days jacked instead of 4 days? Would it impact on key metrics if time in operations area increased?

Let’s test and analyse one question at a time …

Analysis Question 1

In the "baseline" model, resupply ships have an interarrival time of 10 days.

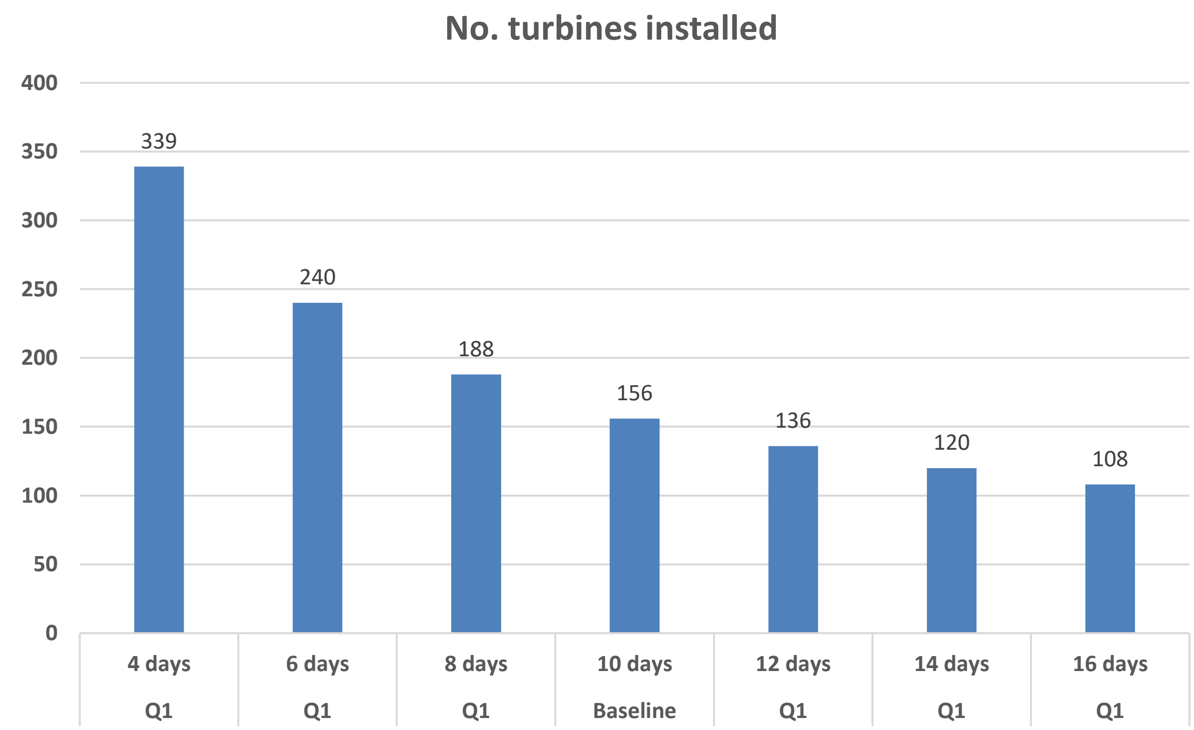
If system is left to run without any new constraints, what is the impact on throughput (turbines installed) if the interarrival time is reduced to 8, 6 & 4 days, or increased to 12, 14 & 16 days?

Configuration

- Runtime = 2 years
- Resupply ship interarrival time = 10 days. Test 4, 6, 8, 12, 14 & 16 days.
- Ground unload time per component piece (resupply): 20 min
- Ground load time per component piece (installation): 20 min
- Ground transport time per unloaded component piece (resupply): 20 min
- Ground transport time per loaded component piece (installation): 20 min
- Installation ship time on jacks in maritime operations area = 4 days

Results & Analysis

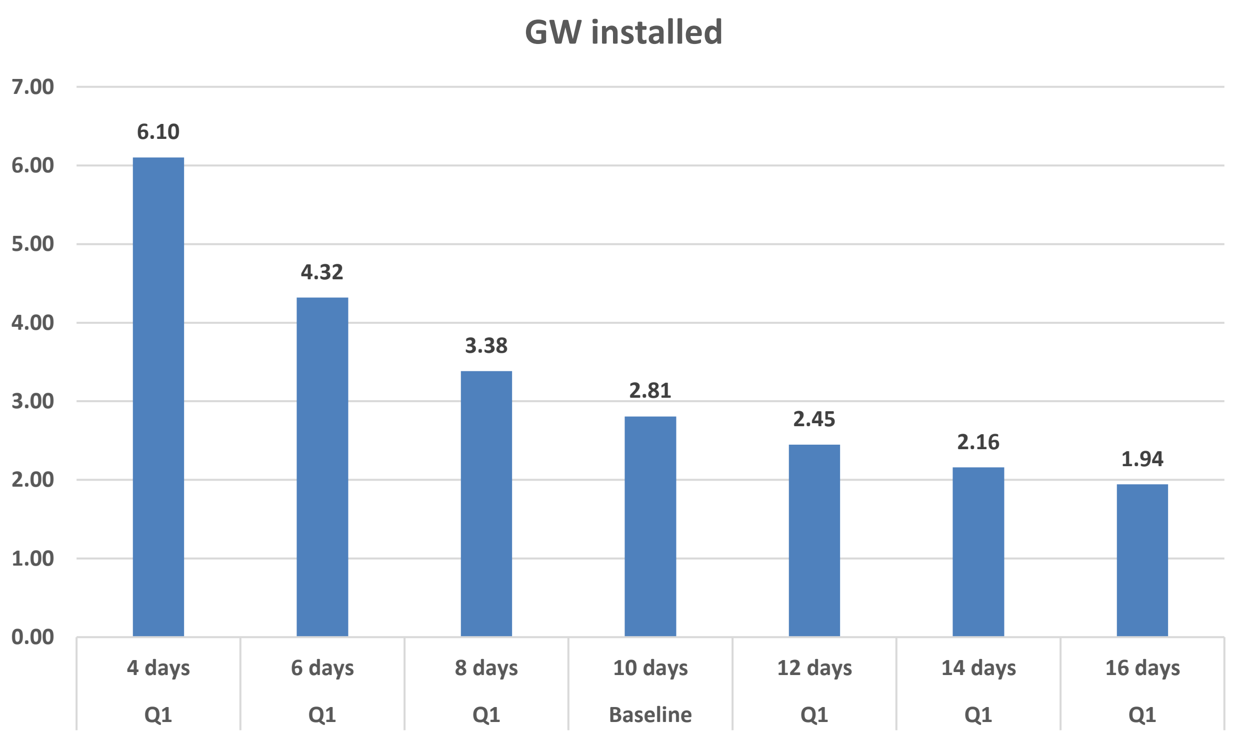
- No. turbines installed



The non-linear relationship between resupply ship interarrival time and number of turbines installed is noteworthy.

Results & Analysis

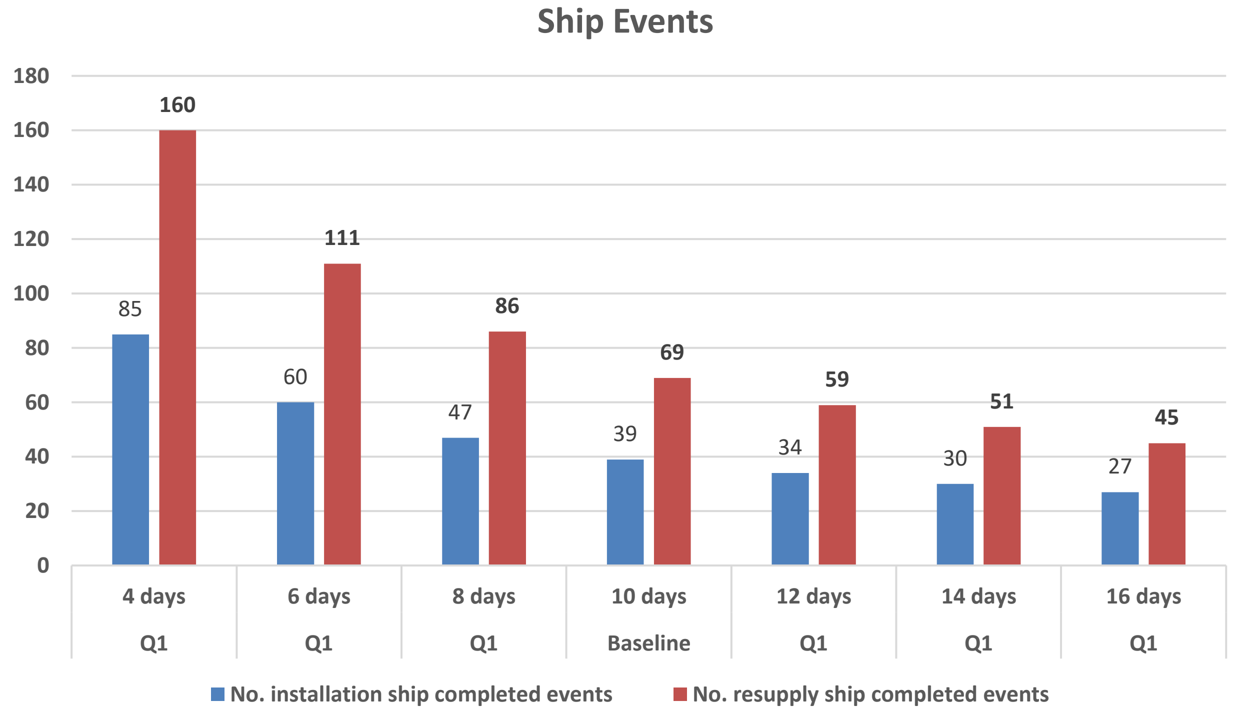
- GW installed



Same observation as for turbines installed, ie the non-linear relationship between resupply ship interarrival time and GW installed is noteworthy.

Results & Analysis

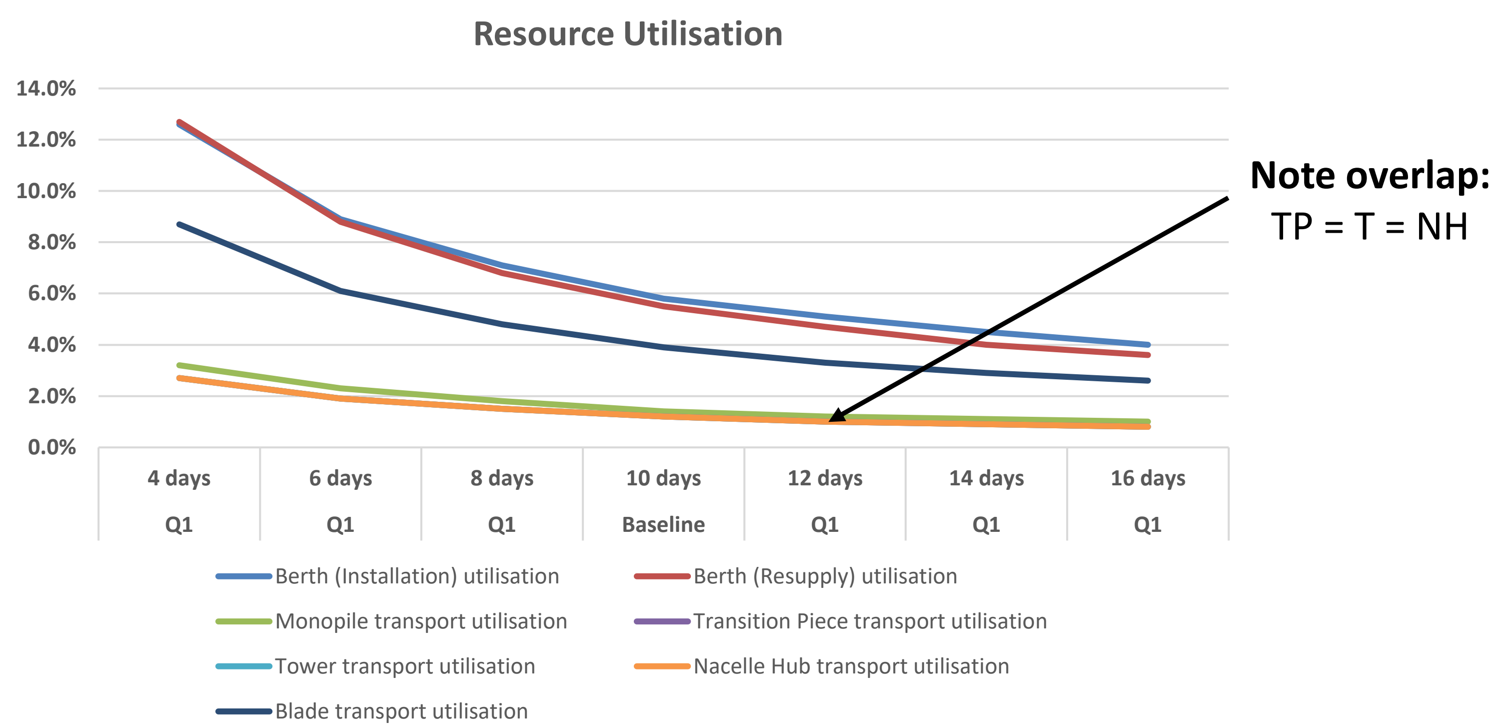
- No. installation ship completed events
- No. resupply ship completed events



More resupply ship events allows for greater numbers of components in inventory and more installation ships to be loaded and events completed.

Results & Analysis

- Ship Berth and Ground Transport Utilisation



As expected, both resupply and installation berths are busier when resupply interarrival time reduces. And with corresponding unloading and loading events, transport resource utilisations follow a similar pattern.

Next: Q2

Analysis Question 2

What is the impact on throughput (no. of turbines installed) of reducing the ground unload/load time per component piece by 20%?

Configuration

- Runtime = 2 years
- Resupply ship interarrival time = 10 days
- Ground unload time per component piece (resupply): 20 min. Test impact of efficiency gain by 20% (4 min) to 16 min.
- Ground load time per component piece (installation): 20 min. Test impact of efficiency gain by 20% (4 min) to 16 min.
- Ground transport time per unloaded component piece (resupply): 20 min
- Ground transport time per loaded component piece (installation): 20 min
- Installation ship time on jacks in maritime operations area = 4 days

Results & Analysis

Metric	Baseline	Q2 20% unload/load
No. turbines installed	156	156
GW installed	2.81	2.81
No. installation ship completed events	39	39
No. resupply ship completed events	69	69
Berth (Installation) utilisation	5.8%	5.6%
Berth (Resupply) utilisation	5.5%	5.5%
Monopile transport utilisation	1.4%	1.4%
Transition Piece transport utilisation	1.2%	1.2%
Tower transport utilisation	1.2%	1.2%
Nacelle Hub transport utilisation	1.2%	1.2%
Blade transport utilisation	3.9%	3.8%

Summary: minor insignificant changes to some metrics.

Next: Q3

Analysis Question 3

What is the impact on throughput (no. of turbines installed) of reducing the ground transport time per component piece by 20%?

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Configuration

- Runtime = 2 years
- Resupply ship interarrival time = 10 days
- Ground unload time per component piece (resupply): 20 min
- Ground load time per component piece (installation): 20 min
- Ground transport time per unloaded component piece (resupply): 20 min. Test impact of reduction by 20% (4 min) to 16 min.
- Ground transport time per loaded component piece (installation): 20 min. Test impact of reduction by 20% (4 min) to 16 min.
- Installation ship time on jacks in maritime operations area = 4 days

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Results & Analysis

Metric	Baseline	Q3 20% transport
No. turbines installed	156	156
GW installed	2.81	2.81
No. installation ship completed events	39	39
No. resupply ship completed events	69	70
Berth (Installation) utilisation	5.8%	5.7%
Berth (Resupply) utilisation	5.5%	5.4%
Monopile transport utilisation	1.4%	1.4%
Transition Piece transport utilisation	1.2%	1.1%
Tower transport utilisation	1.2%	1.2%
Nacelle Hub transport utilisation	1.2%	1.1%
Blade transport utilisation	3.9%	3.8%

Summary: minor insignificant changes to some metrics.

Next: Q4

Analysis Question 4

The “baseline” model currently uses a 4-day interval for time spent jacked up in the maritime operations area undertaking turbine installation.

What would be the impact on throughput if the installation crews were able to complete their operations per trip more efficiently, by spending 3.5 days jacked instead of 4 days?

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Configuration

- Runtime = 2 years
- Resupply ship interarrival time = 10 days
- Ground unload time per component piece (resupply): 20 min
- Ground load time per component piece (installation): 20 min
- Ground transport time per unloaded component piece (resupply): 20 min
- Ground transport time per loaded component piece (installation): 20 min
- Installation time on jacks in installation operations area = 4 days. Test impact of reduction in event time to 3.5 days. Would it impact on key metrics if time in operations area increased?

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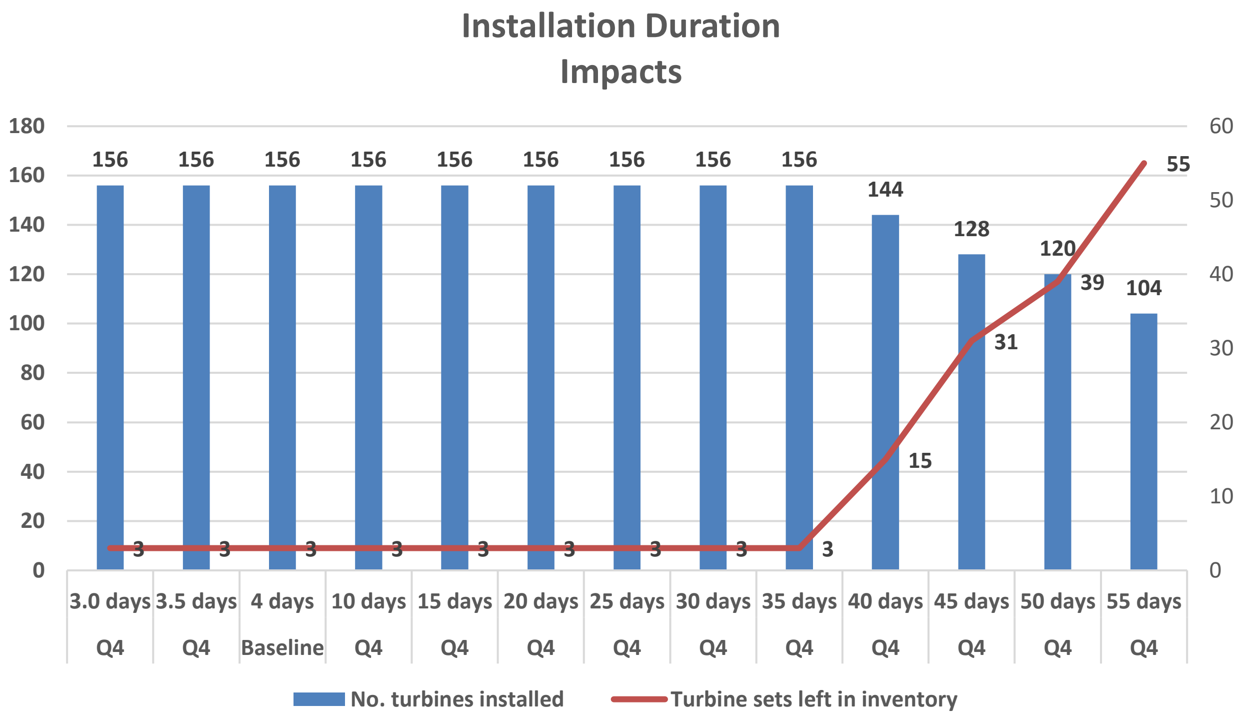
Results & Analysis



Y1 axis = *number of turbines installed*, Y2 axis = *number of turbine sets remaining in inventory*. The test value of 3.5 days matches baseline output option (4 days).

Note the system output doesn't change significantly until installation time has increased past 35 days! Output changes significantly after 35 days.

Next steps

- Keep informed by further Implementation Statements and remain engaged with Engagement Team.
- If engaged by SMEs or PoH, many of the assumptions made could be modelled robustly using known values, probability distributions or by professional judgement.
- SME advice would be needed in order to make a model that is fit for purpose for PoH or any other renewable energy terminal … PTO

SME Advice / Professional Judgement

- Physical layout – preferences, configurations
- Build and installation schedule
- Ship – numbers, requirements, limitations
- Infrastructure – numbers, deconfliction, staging points, business rules
- Personnel – numbers, attributes, shifts, business rules
- Processing – queues, buffers, durations, probability distributions
- Equipment – reliability and maintainability
- Capacity – inventory, storage, bottlenecks
- Weather – probability, likelihood, severity, impacts
- Tides – schedule, ship requirements, impacts
- Model validation – methodology, similar builds, historical data

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