BOXBAY's Revolutionary Impacts on Modern Container Terminals

Presented by BOXBAY's
Peter Slootweg, Managing Director Americas

AAPA Webinar, September 10, 2024

BOXBAY HIGH BAY STORE (HBS) - 11 HIGH IN DUBAI

TABLE OF CONTENTS

The future is vertical

WHAT IS BOXBAY?

ROOTS & PROOF OF CONCEPT

The future is vertical

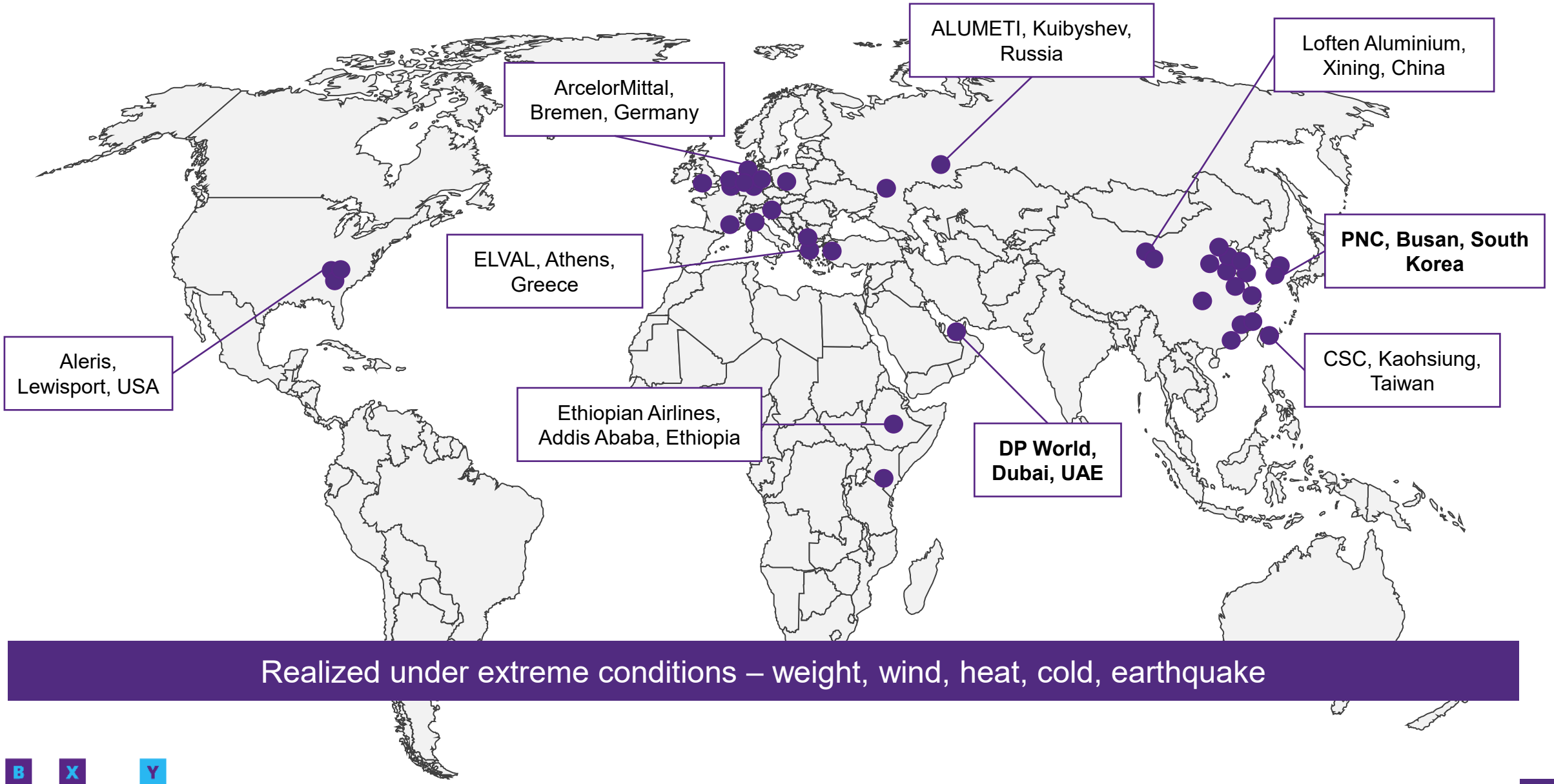
AMOVA HEAVY-LOAD TECHNOLOGY IN METALS INDUSTRY

Conveying & handling systems

High-bay storage systems

Reliable & proven technology meeting highest customer demands for decades

30+ HIGH BAY STORE REFERENCES OVER THE LAST 30 YEARS



Realized under extreme conditions – weight, wind, heat, cold, earthquake

The future is vertical

PHASE 1 BOXBAY HBS AT JEBEL ALI T4 (PROOF OF CONCEPT)

- Dimensions: 230 x 26 m
- 11 Stories
- 792 container slots 20’ & 40’
- 92,000 TEU/a capacity
- 2 stacker cranes
- 1 conveyor + shifting cars
- 1 truck crane
- 1 shuttle carrier
- Automation + warehouse management system (WMS)

BOXBAY DUBAI POC

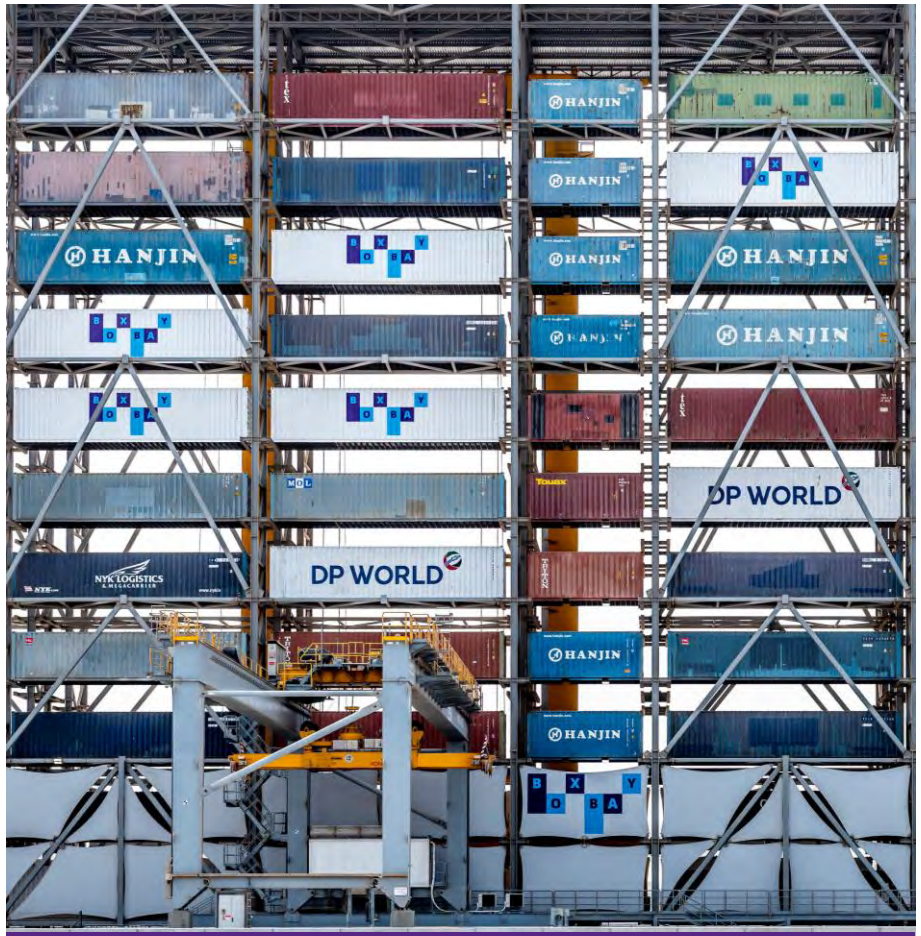
500,000+ moves handled since opening October 2020

POC IS PART OF FUTURE BUILD OUT TO 3,300,000 TEU HBS

BUILD OUT DIMENSIONS

- 637 x 234 m
- 11 Stories
- Capacity 45,925 TEU
- 25 HBS aisles
- 50 stacker cranes
- 6 conveyors + 12 shifting cars
- 12 truck cranes
- Automation + WMS

HBS RACK STRUCTURE AND EQUIPMENT



HBS rack structure

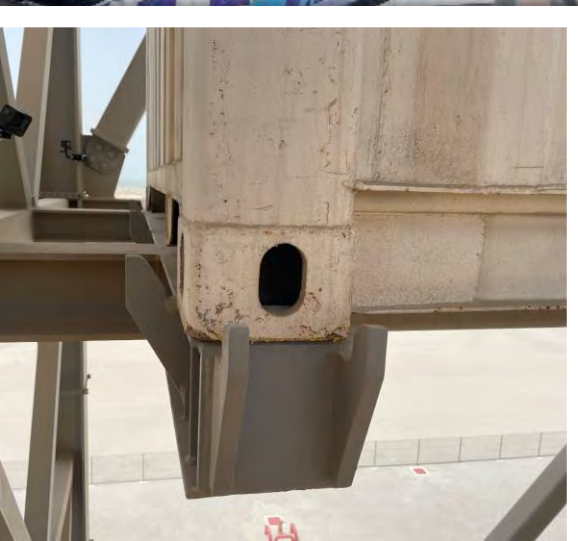
Stacker crane

Cross pallet conveyor loops

Truck crane interface

Straddle carrier interface

SIMPLE DESIGN WITHOUT MOVING PARTS

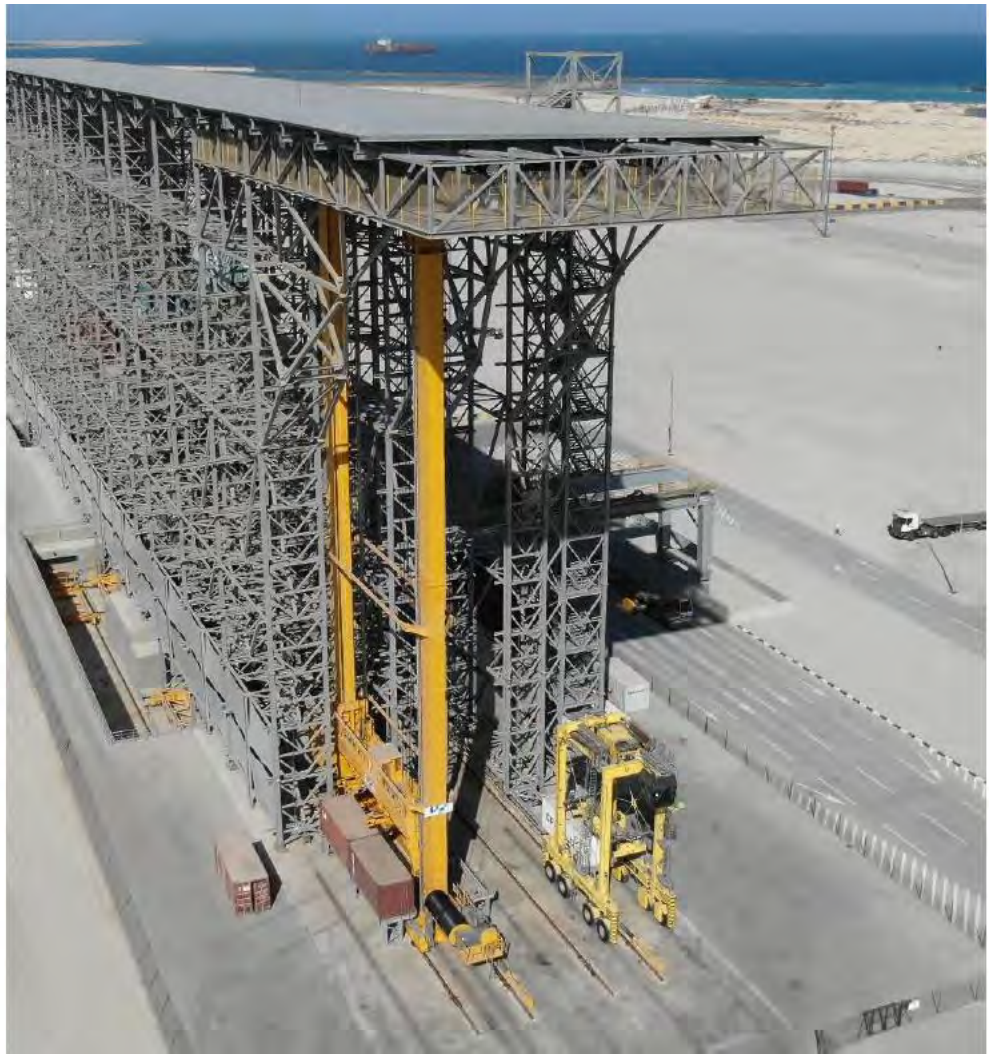


PALLET CIRCULATION - CROSS PALLET CONVEYOR (CPC)

LANDSIDE INTERFACE - AUTOMATED TRUCK LOADING CRANE

The future is vertical

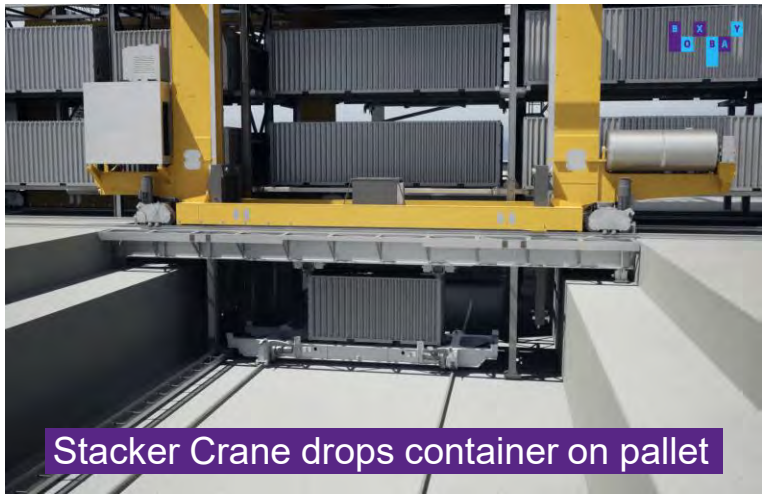
WATERSIDE INTERFACE FOR STRADDLE CARRIERS



The future is vertical

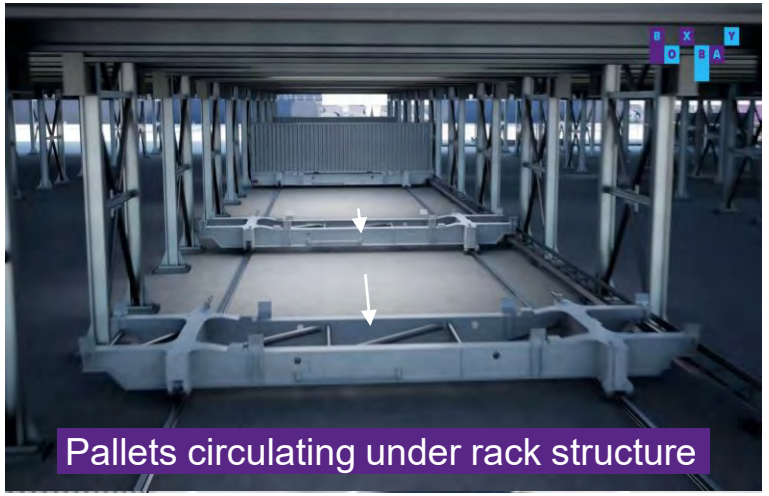
OPERATIONAL PROCESS ILLUSTRATED THROUGH SOME EXAMPLES


Stacker crane drives over CPC runway


Stacker Crane drops container on pallet

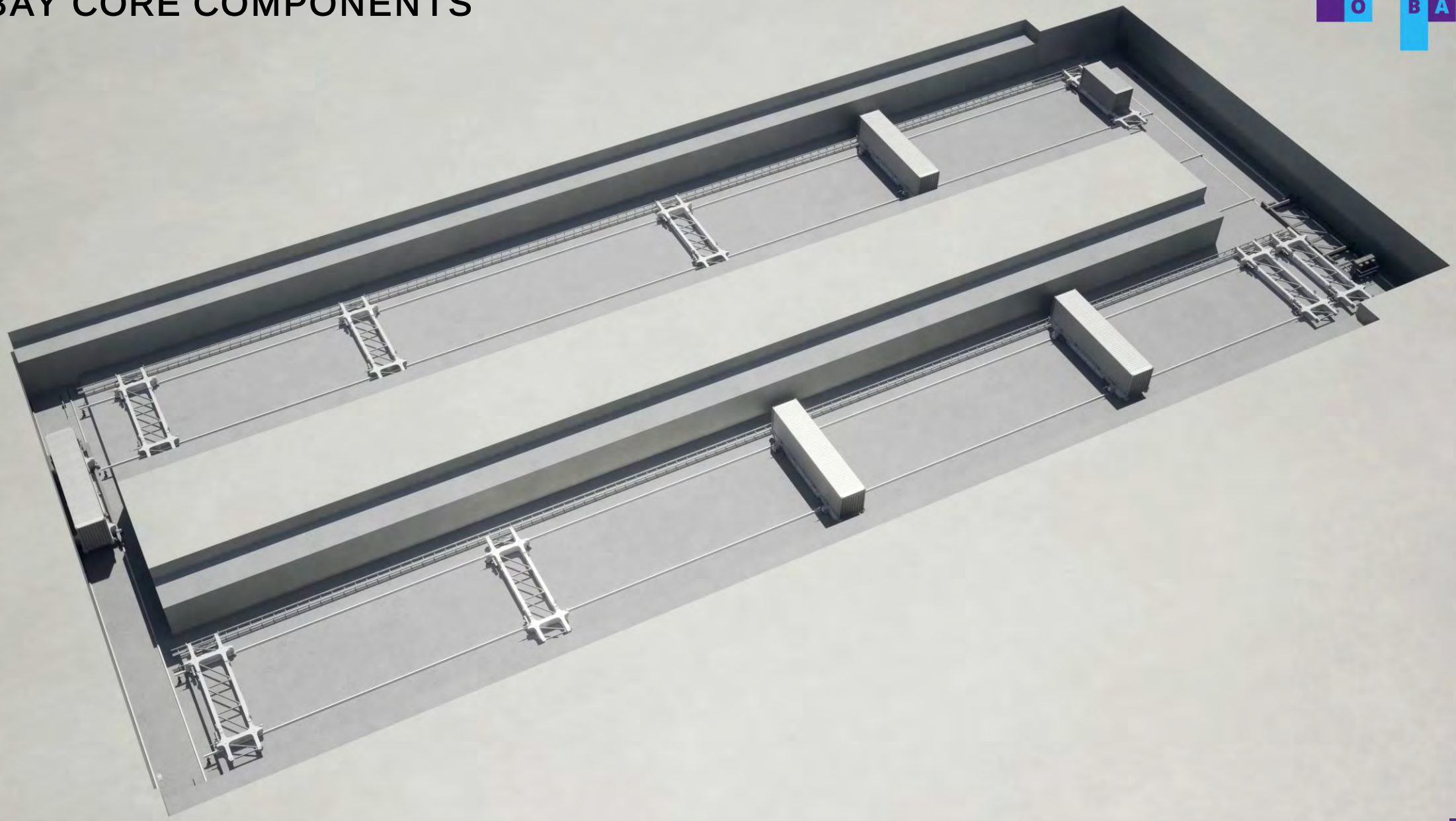

SC in aisle - direct access to both sides


Extended spreader sets box in the bay


Pallets circulating under rack structure

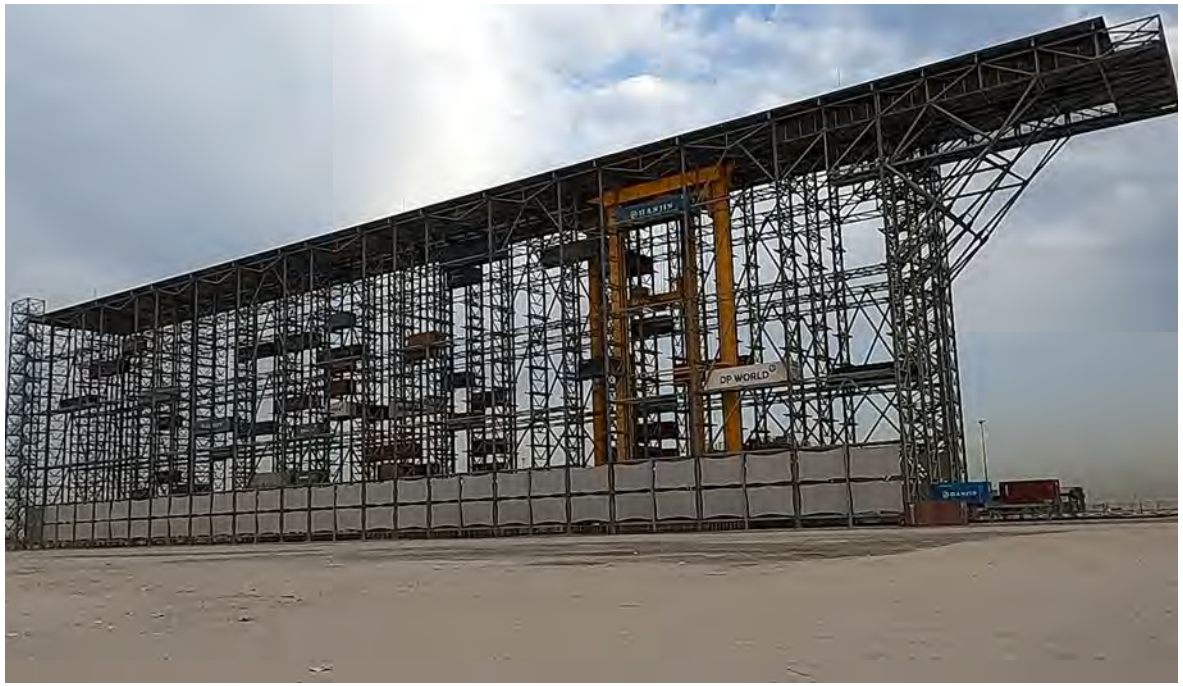

Truck crane places container onto truck

BOXBAY CORE COMPONENTS



FULLY AUTOMATED AND DIGITAL READY

- Highly reliable automation system comprising automation levels 0 – 3
- HBS digitalization package consists of:
  - Energy distribution and management systems
  - Highly efficient drive systems
  - Control and visualization tools
  - **Warehouse management system** (HBS TOS)
  - Business intelligence (BI) module
- Works with connects to any TOS



WAREHOUSE MANAGEMENT SYSTEM (HBS TOS)

- Container tracking and tracing
- Inventory management and equipment control
- Real time data exchange with any TOS
- Web-based interface for pc, tablets, mobile, etc.
- Live 3D-visualization of HBS including equipment and inventory (digital twin)
- Logistic planning – in advance optimization / POW check
- Dynamic material flow control
- System feedback for maintenance planning and ordering of spare parts

CHALLENGES FACING

CONTAINER TERMINALS

MULTIPLE & INCREASING PRESSURES ON CONTAINER TERMINALS

Volume of container traffic

Size of container ships & call size

Unexpected interruptions
(blockade of shipping routes, delays in the supply of raw materials/vendor parts to many industries due to pandemics, port closures)

Wars and sanctions

Reorientation global flow of goods
(Ukraine war, reducing dependence on China through global diversification

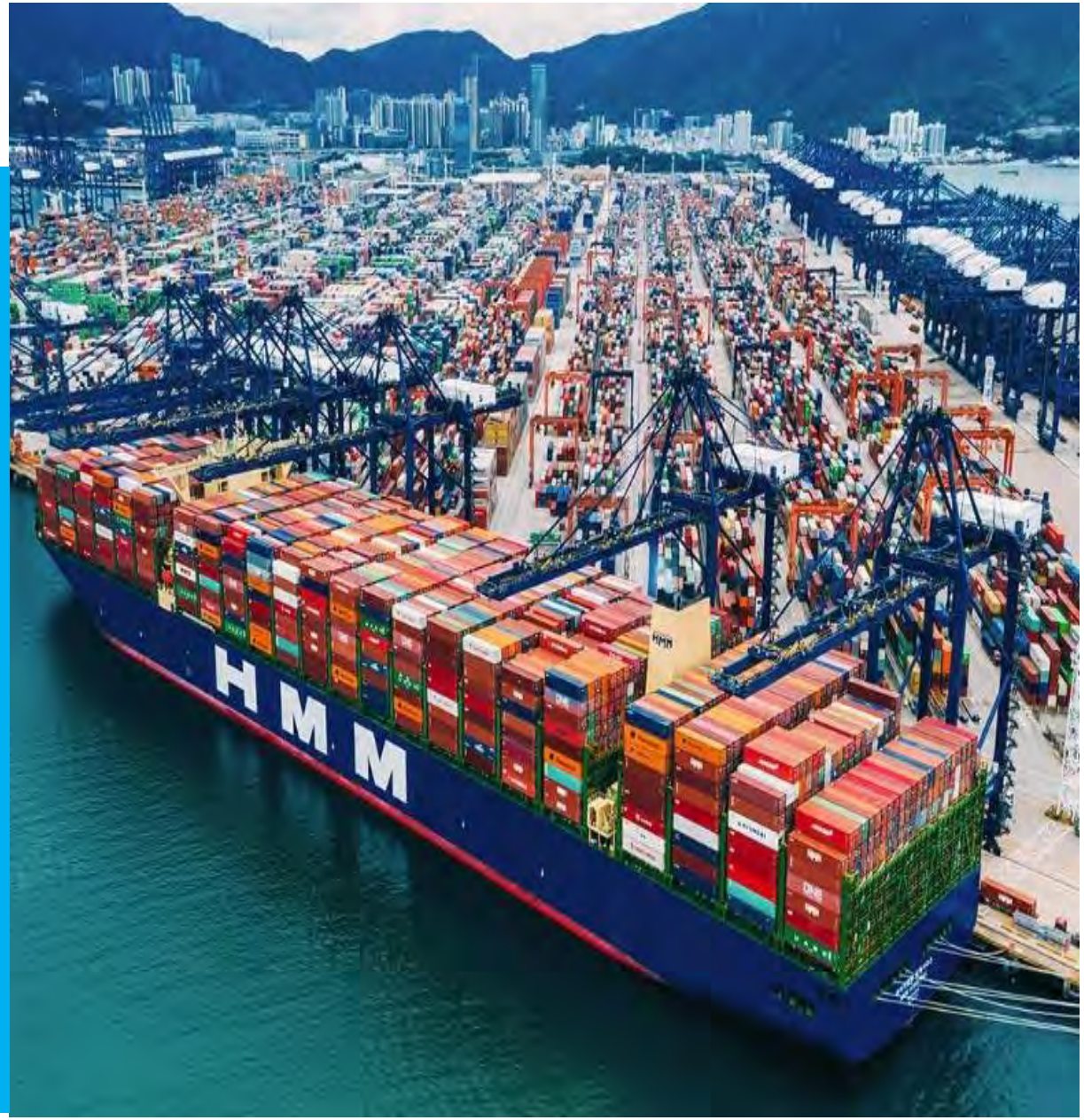
Lack of qualified personnel

LIMITED OPTIONS FOR ACTION

- **Lack of expansion space**
- **Change of operating mode difficult**
  - Pressure to continue ops
  - Resistance to change
- **More & stricter environmental regulation**
- **Sustainability Becoming a Higher Priority**

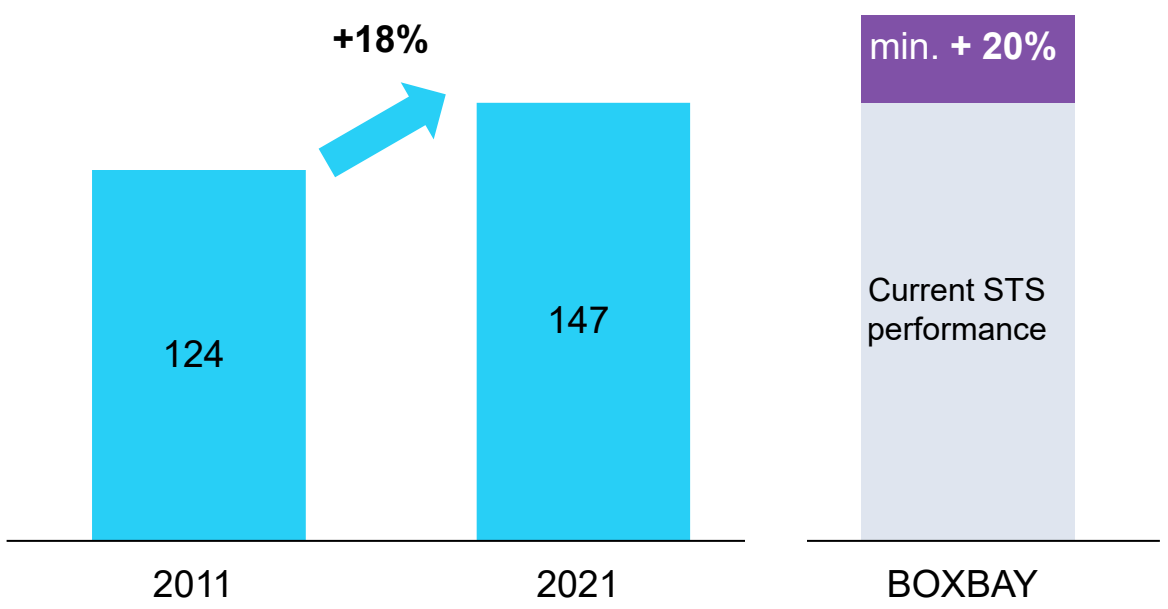
RESULTING IN COMMON OPERATOR CHALLENGES

- Yard is terminal constraint to capacity & performance:
  - Many container yards congested,
  - Highly utilized
  - There is a shortage of empties storage space
  - Complexity of yard strategy, planning and equipment dispatch
  - Yards contribute to terminals Carbon footprint
  - Yard crane performance can often not keep up with WS requirements, large call sizes (ULCS)
  - Unproductive moves/ yard shuffles in ASC yards reaching 60% of total moves is not unusual

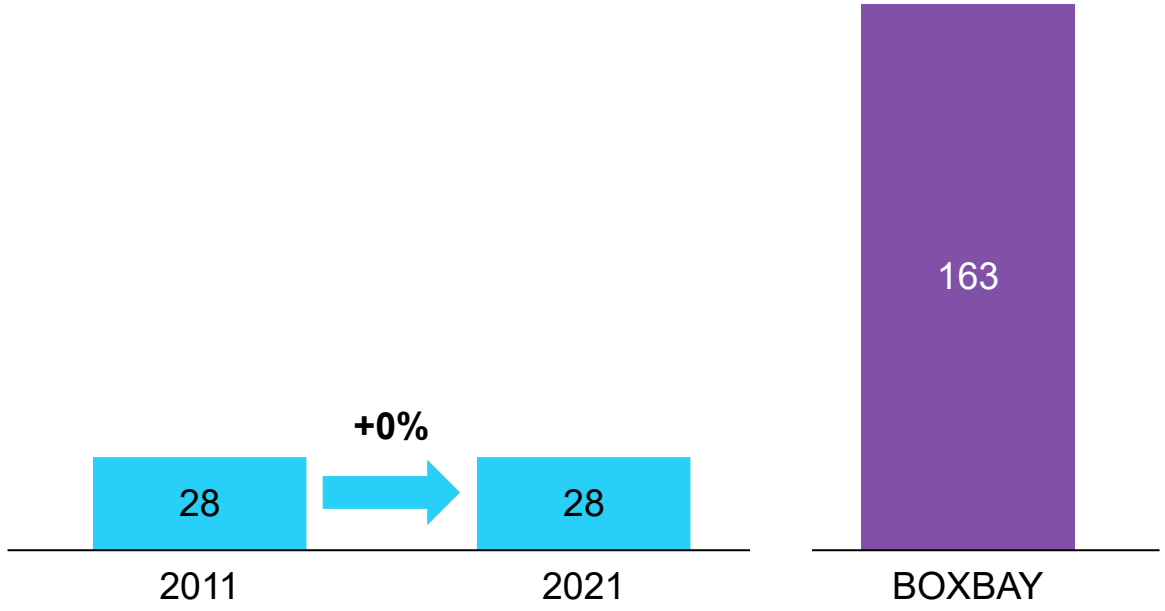


BERTH PERFORMANCE INCREASES BUT THE YARD FAILS TO KEEP UP

**QUAY CRANE PERFORMANCE GLOBAL AVERAGE*
('000 TEU PER STS CRANE)**



**YARD PERFORMANCE GLOBAL AVERAGE*
('000 TEU PER HECTARE)**



BOXBAY is designed to support massively higher throughput scenarios with unmatched yard performance

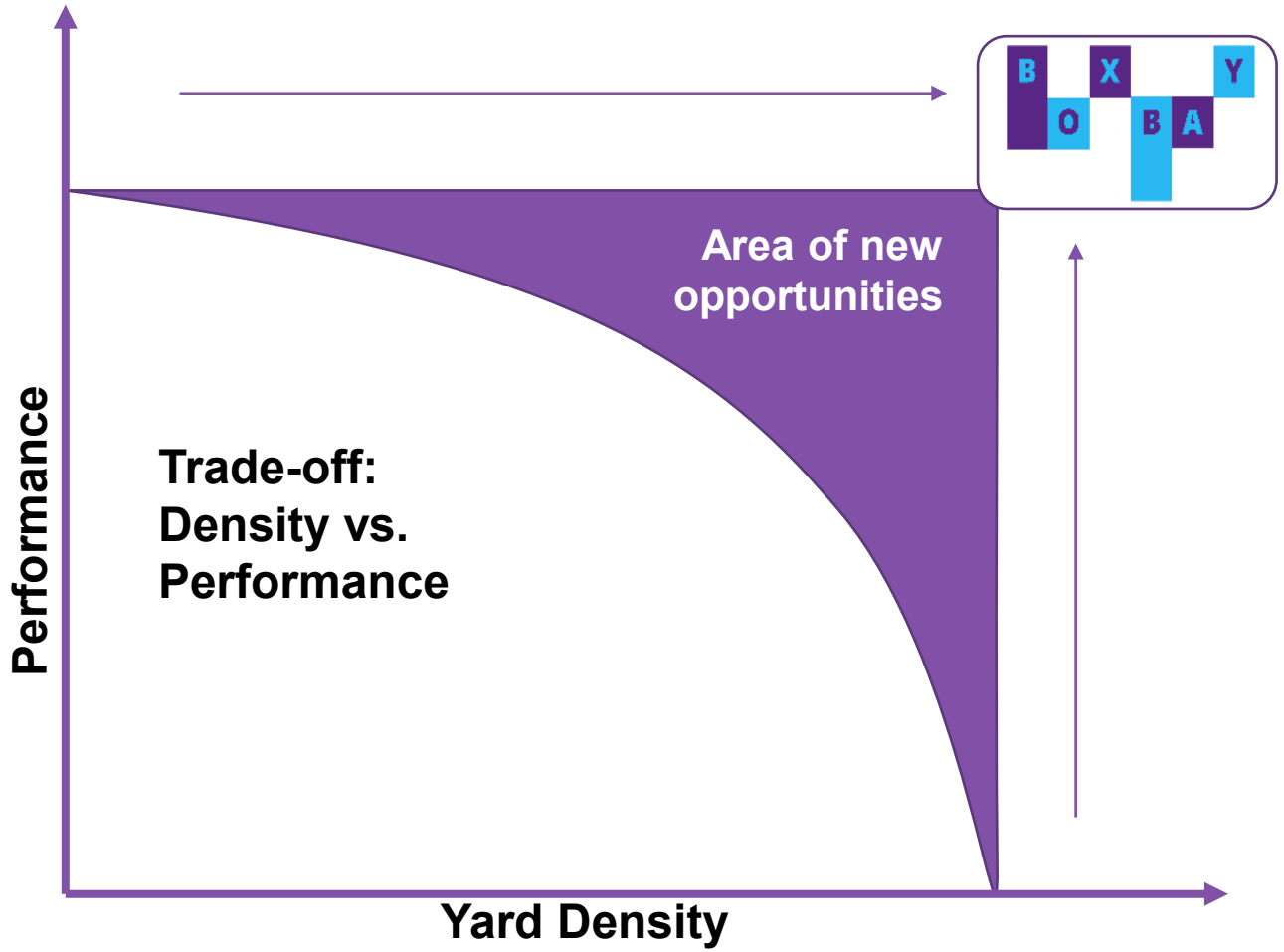
* Source: Drewry Maritime Research, BOXBAY analysis

The future is vertical

BOXBAY'S REVOLUTIONARY IMPACT ON MODERN TERMINALS

The future is vertical

BOXBAY IS MORE THAN A YARD SOLUTION – BOXBAY CREATES OPPORTUNITIES FOR THE ENTIRE TERMINAL



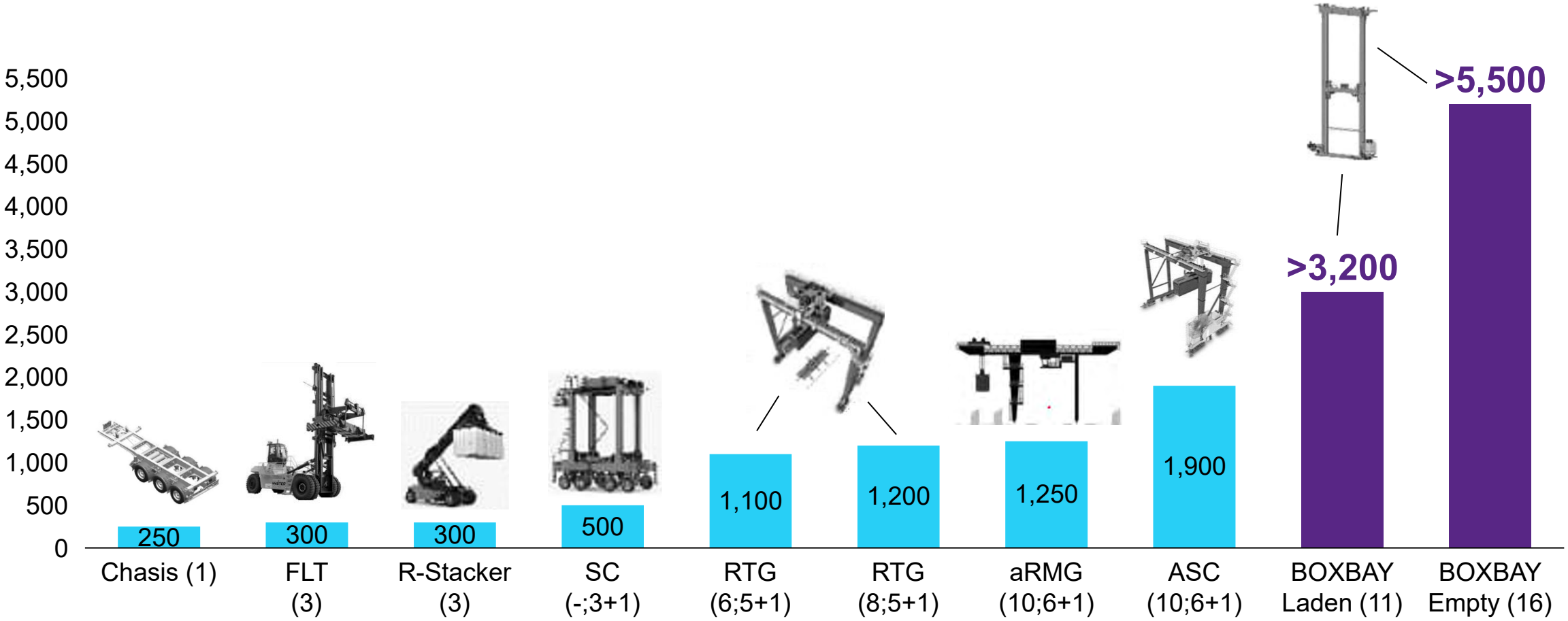
BOXBAY'S REVOLUTIONARY IMPACT

- Massively Saves Space & Increases Capacity
- Boosts Terminal Productivity & Service Levels
- Reduces Operating & Maintenance Cost
- Champions Sustainability

The future is vertical

The future is vertical

YARD EQUIPMENT COMPARISON: STATIC STORAGE CAPACITY IN TEU/HA

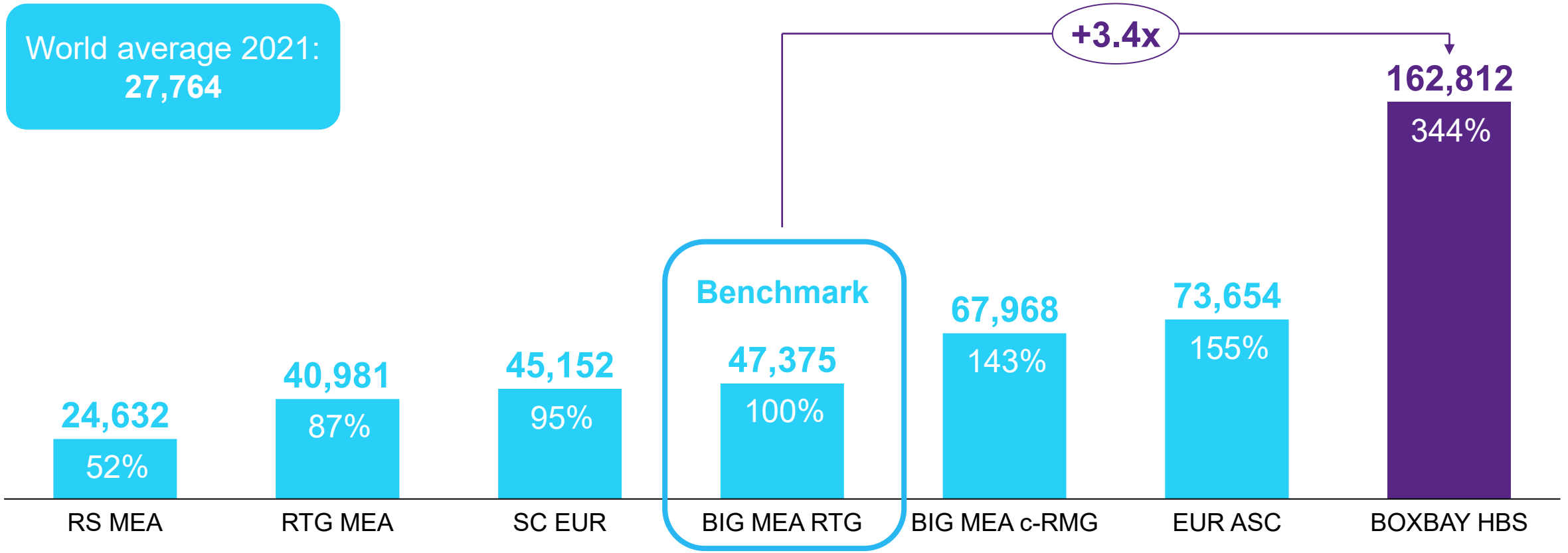


UP TO 300% STORAGE CAPACITY VS. MOST ADVANCED CONVENTIONAL SYSTEM

BOXBAY

The future is vertical

THROUGHPUT COMPARISON: TEU PER ANNUM PER HECTARE



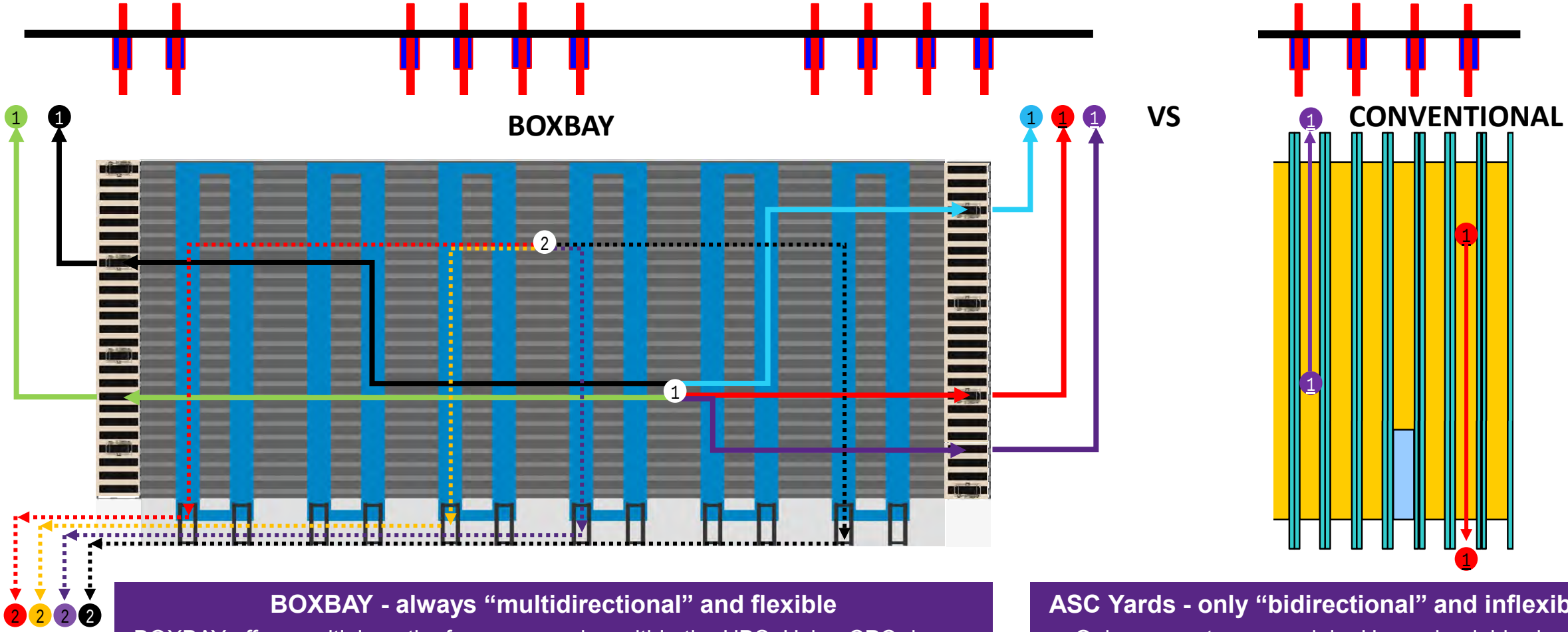
More than 3x throughput per hectare

Source: DPW Terminal Simulations

The future is vertical


REVOLUTIONARY IMPACT
BOOSTS TERMINAL PRODUCTIVITY & SERVICE LEVELS

ROUTING FLEXIBILITY UNLOCKS ROVOLUTIONARY NEW BENFITS



BOXBAY - always “multidirectional” and flexible

BOXBAY offers multiple paths for maneuvering within the HBS. Using CPC- loops, containers distribute across aisles, while stacker cranes distribute across loops.

ASC Yards - only “bidirectional” and inflexible

Only one route per module. Unused neighboring Stacker Cranes can not be used as alternatives.

The future is vertical

BOXBAY IS FAST, INCREASES PERFORMANCE OF CONNECTING EQUIPMENT

- Each container stored in individual compartment; direct access at any time
- Performance is independent from utilization and thus deterministic and predictable
- 100 % utilization is possible
  (vs. max. 80 % in conventional yards)
- Late arrivals, roll overs, sequence changes all have no performance impact
- **Results in 100% predicable performance**
- **Results in 20% productivity increase of connecting equipment/processes (STS cranes, etc.)**

Source: DPW simulations

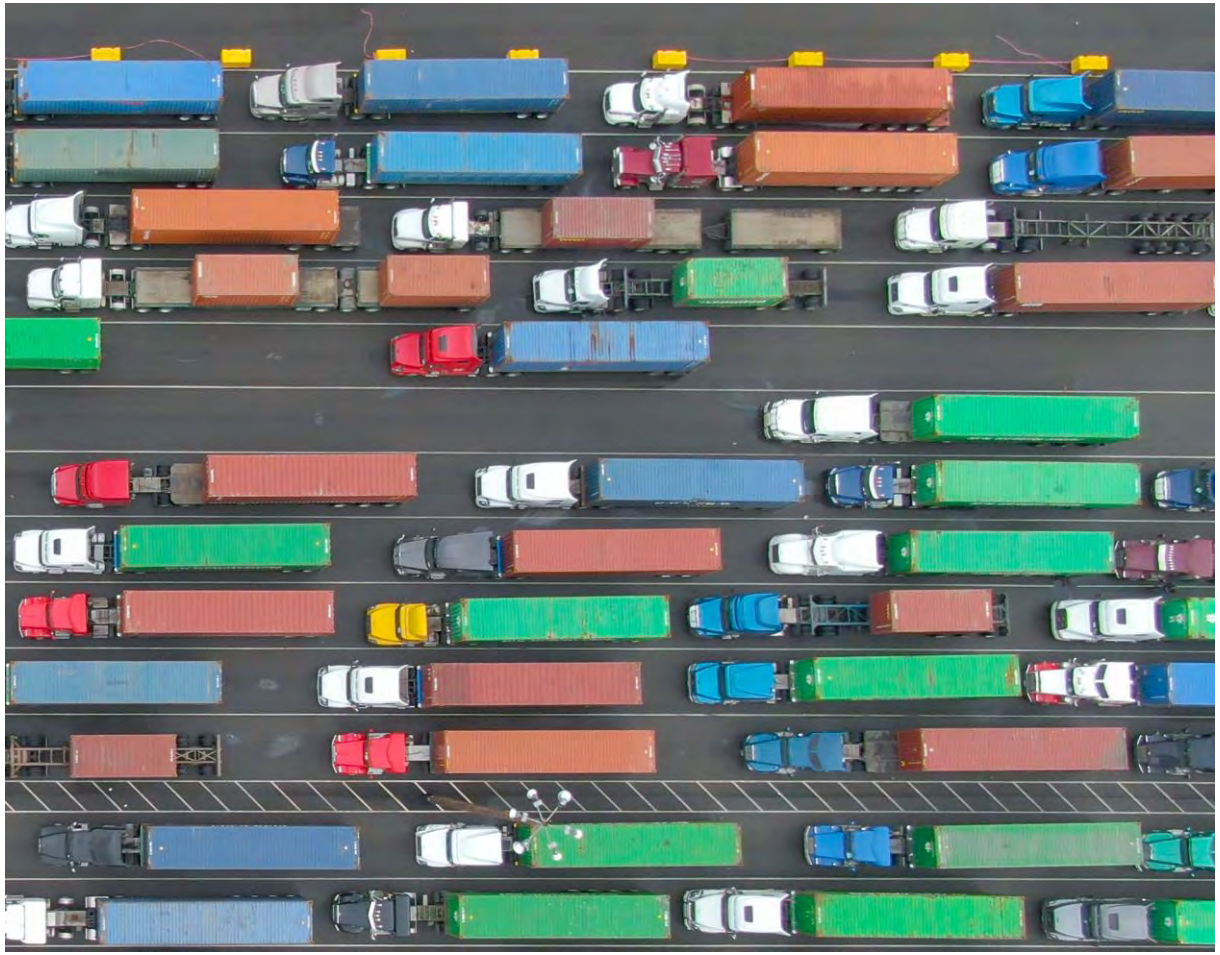
The future is vertical

PERPETUAL YARD CONTROL DRIVES GAME-CHANGING SERVICE LEVELS & EFFICIENCY

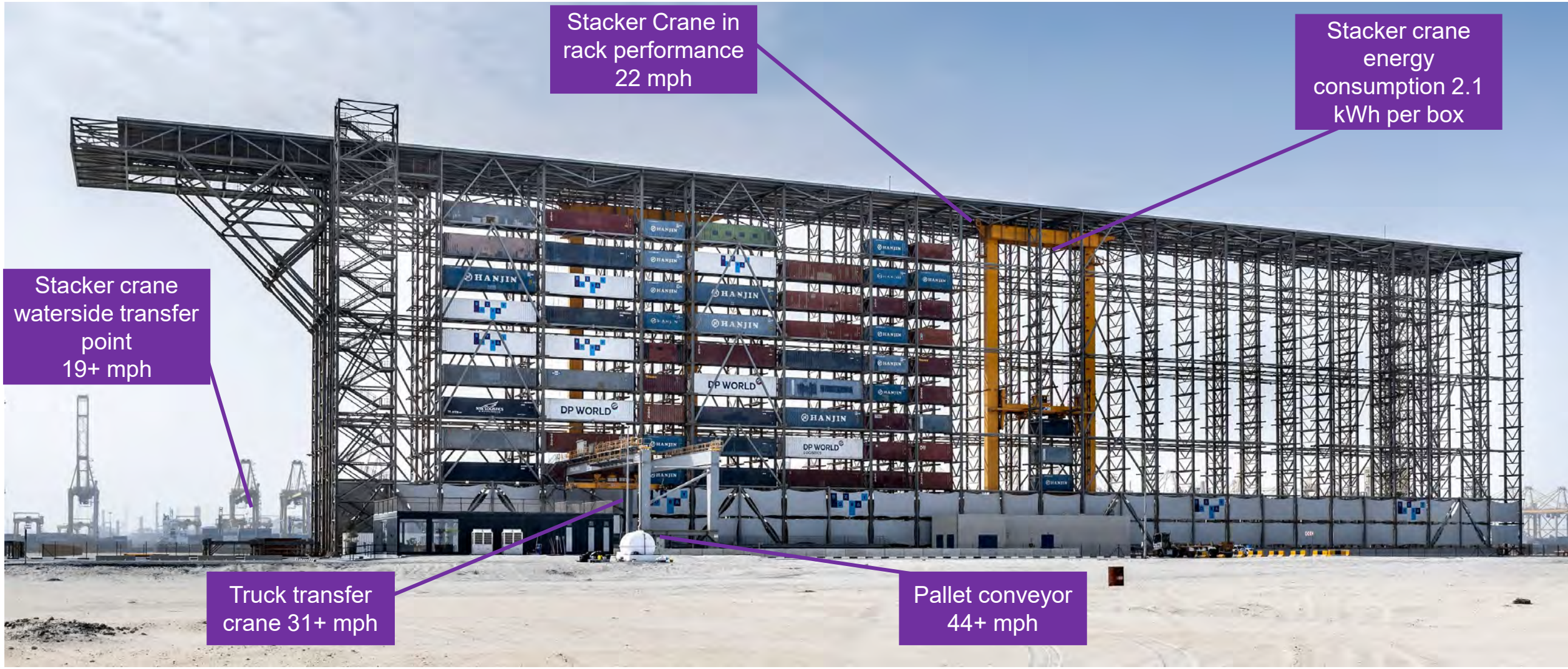
- No yard planning needed (no planners needed)
  - BOXBAY adapts instantly to re-assigned QC
  - COD/COV or cargo re-nominations don’t trigger relocation (but you can continue to charge for COD/COV ☺)
  - Customs inspection requests have no impact
- Smaller control team needed
- WMS focused on workload distribution, not storage location
- Dual cycle with ITV/AGV easy, import and export full & empty are mixed
- Always ULCS Waterside & Landside peak performance ready

SMOOTH HANDLING OF EXTERNAL TRUCKS – REDUCE TURN TIMES

- Yard assignments no longer needed
- No more trucks waiting/ going to wrong block
- Proven chassis alignment & anti-lifting scanners
- No reversing of truck chassis needed
- Easy use of multi trailers
- Easy, flexible routing to nearby truck cranes



PROVEN 100% PREDICTABLE PERFORMANCE VALUES OF POC



The future is vertical

POC IS PART OF FUTURE BUILD OUT TO 3,300,000 TEU HBS

BUILD OUT DIMENSIONS

- 637 x 234 m
- 11 Stories
- Capacity 45,925 TEU
- 25 HBS aisles
- 50 stacker cranes
- 6 conveyors + 12 shifting cars
- 12 truck cranes
- Automation + WMS

Capable of 500 waterside and 370 landside moves simultaneously & reliably per hour


REVOLUTIONARY IMPACT
HUGE REDUCTION IN OPERATING & MAINTENANCE COST

LOWER OPERATING & MAINTAINANCE COST

- Elimination of unproductive moves means…
  - 30-60% wasted moves disappear (vs conventional ASC yards)
  - Less energy required
  - Less wear & tear on equipment
- Steel structure is almost completely maintenance free
- Equipment is covered/protected from elements, snow, wind, rain,
- No need for planning means greatly reduced planning team
- Because of solar panels BOXBAY can run on its own green energy and be energy positive !

The future is vertical


REVOLUTIONARY IMPACT
CHAMPIONS SUSTAINABILITY

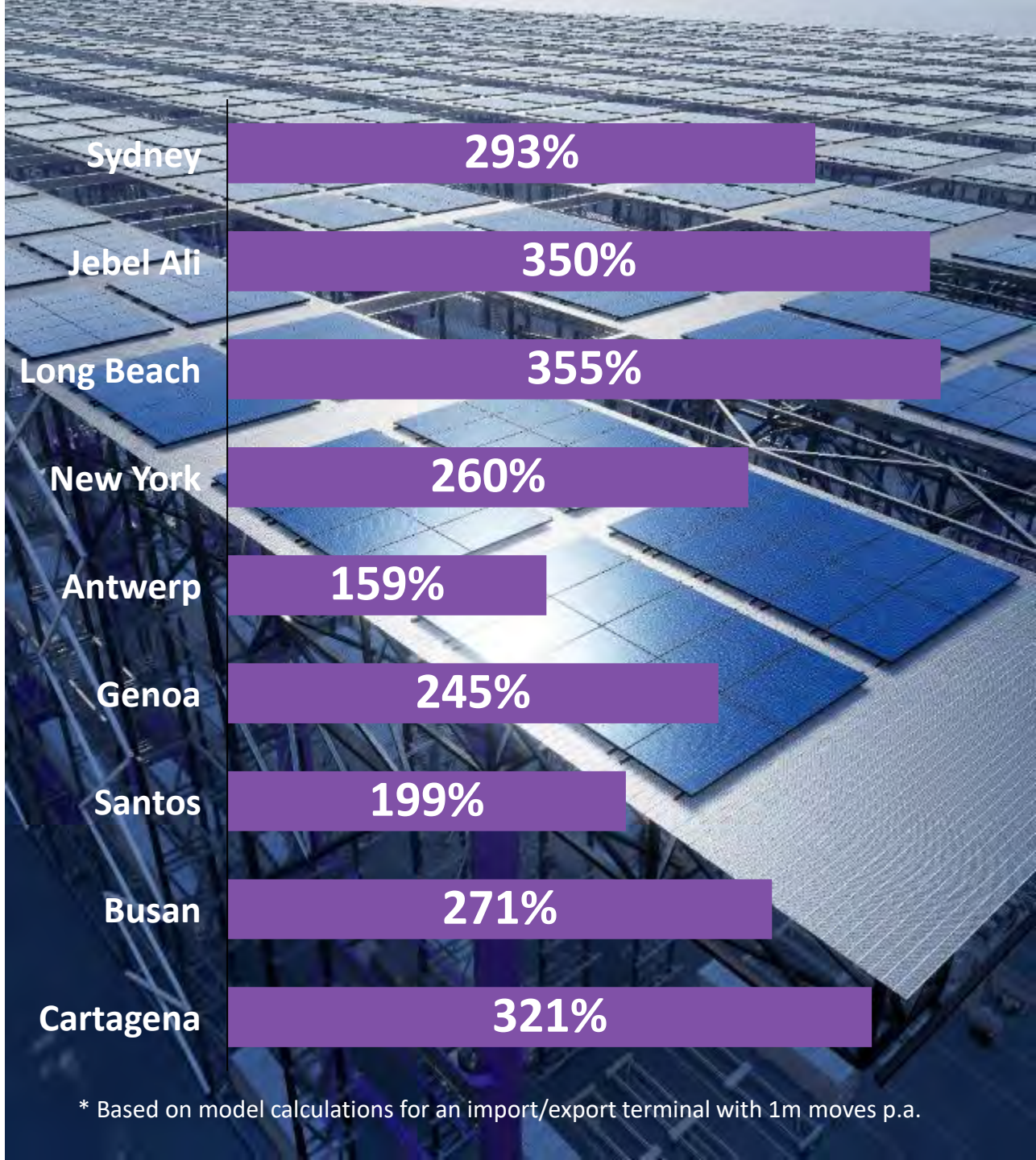
BOXBAY IS GREEN – CLEAN AND HIGHLY SUSTAINABLE

- BOXBAY Completely **closed** system
- Fully electrical with power regeneration/recapture
- Noise suppressed operation
- Very safe
- Very secure, protected, cannot get into BOXBAY
- Lack of light pollution
- Green wall cladding possible

The future is vertical

OPTION: **SOLAR ROOF, ENERGY POSITIVE**

- **Produced energy significantly higher than consumed** by HBS system
- **Power surplus between 150% and 350%**
  - Feed back into local grid = compensation
  - Use for reefer cooling
  - Power other equipment or installations
  - Store energy for night operations
- **Zero local emissions, positive energy balance**
- **Lowest power consumption in class**
- **Opportunity charging inside HBS**



* Based on model calculations for an import/export terminal with 1m moves p.a.

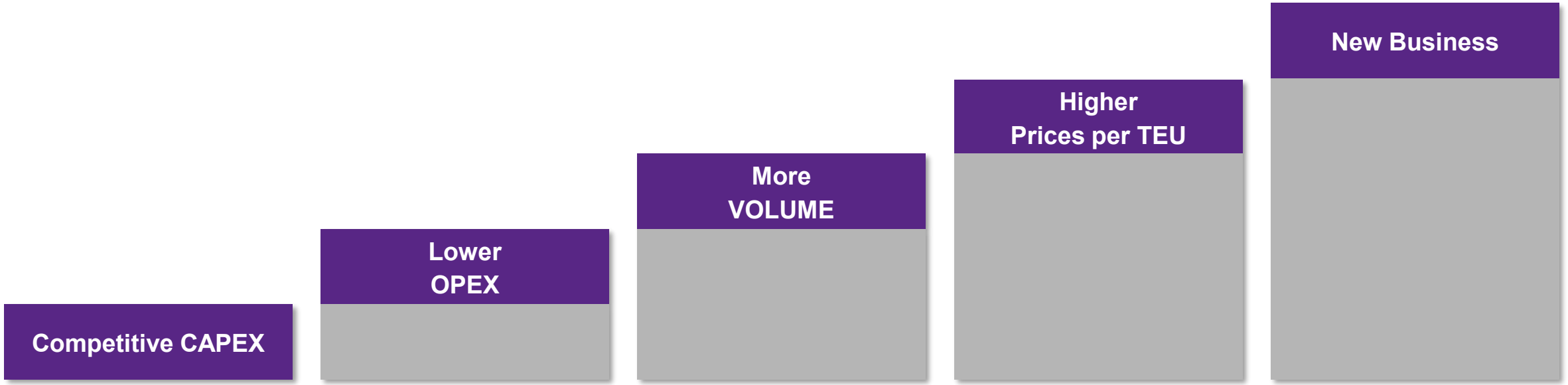
BOXBAY

The future is vertical

ECONOMICS OF BOXBAY ADD UP

LOWER LIFE CYCLE COSTS

HIGHER RECURRING REVENUES



- Comparable to modern ASC / aRMG systems
- Less land, reclamation
- Less equipment

- No unproductive moves
- Minimal labor costs
- Less energy/energy +
- Lower maintenance
- Longer life

- More TEU per yard space & quay meter
- More TEU from-to landside
- More TEU from offsite locations

- Higher performance, reliability, and service levels
- Up-sell opportunities at price premiums

- Integration of additional value chain activities
- Off site empties to BOXBAY
- Use space for something else

= MORE PROFIT FOR TERMINALS

BOXBAY

The future is vertical

Q&A

FLEXIBLE & MODULAR NATURE OF BOXBAY

EXAMPLES

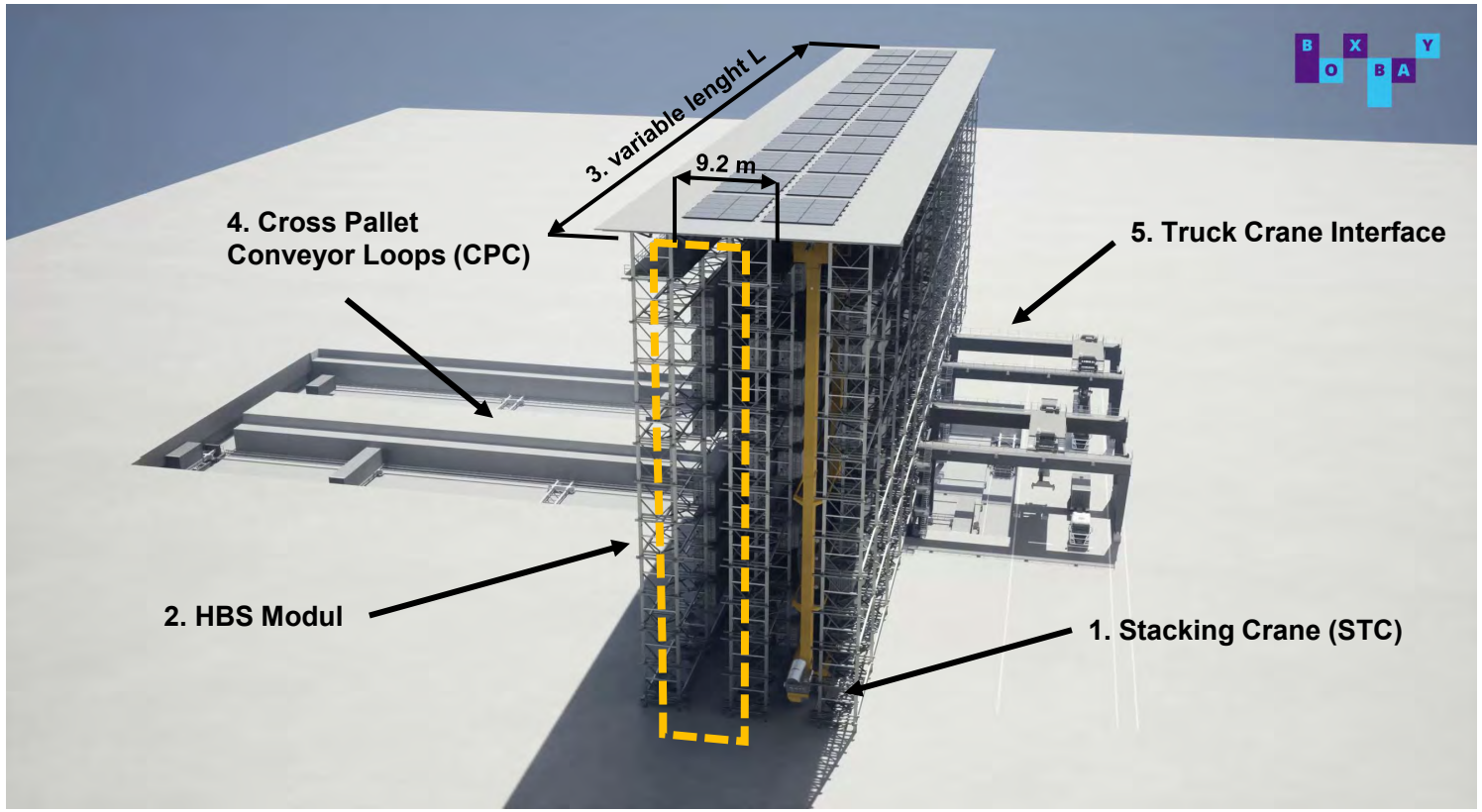
The future is vertical

HBS AISLE – BASIC ELEMENT OF SCALABLE AND MODULAR CONCEPT

FULL HBS SCALABILITY

- HBS basic element: Aisle
- Aisle width: approx. 9.1 m
- Aisle length: 200 – 800 m
- 1 or 2 stacker cranes per aisle
- #aisles per HBS: 4 – 30
- Multiple HBS buildings per container terminal possible

BUILDING DIMENSIONS, NUMBER & TYPE OF EQUIPMENT INTERFACES ARE FLEXIBLE BASED ON TERMINAL NEEDS



BOXBAY does not always come looking the same. The shown main components must be configured to a first layout to define the major dimensions:

- number of stacking cranes.
  - two per aisle for longer aisles
  - one per aisle for shorter aisles
- resulting in the number of HBS modules
- Setting the length of the rack:
  - consideration to manage with one single rack
  - or if you need several blocks
- Number of CPC-loops
- Number truck crane and final configuration of all interfaces

INTERFACES FOR ALL HORIZONTAL TRANSPORT SYSTEMS

Manual operated TTs

Straddle carrier (manual/automated)

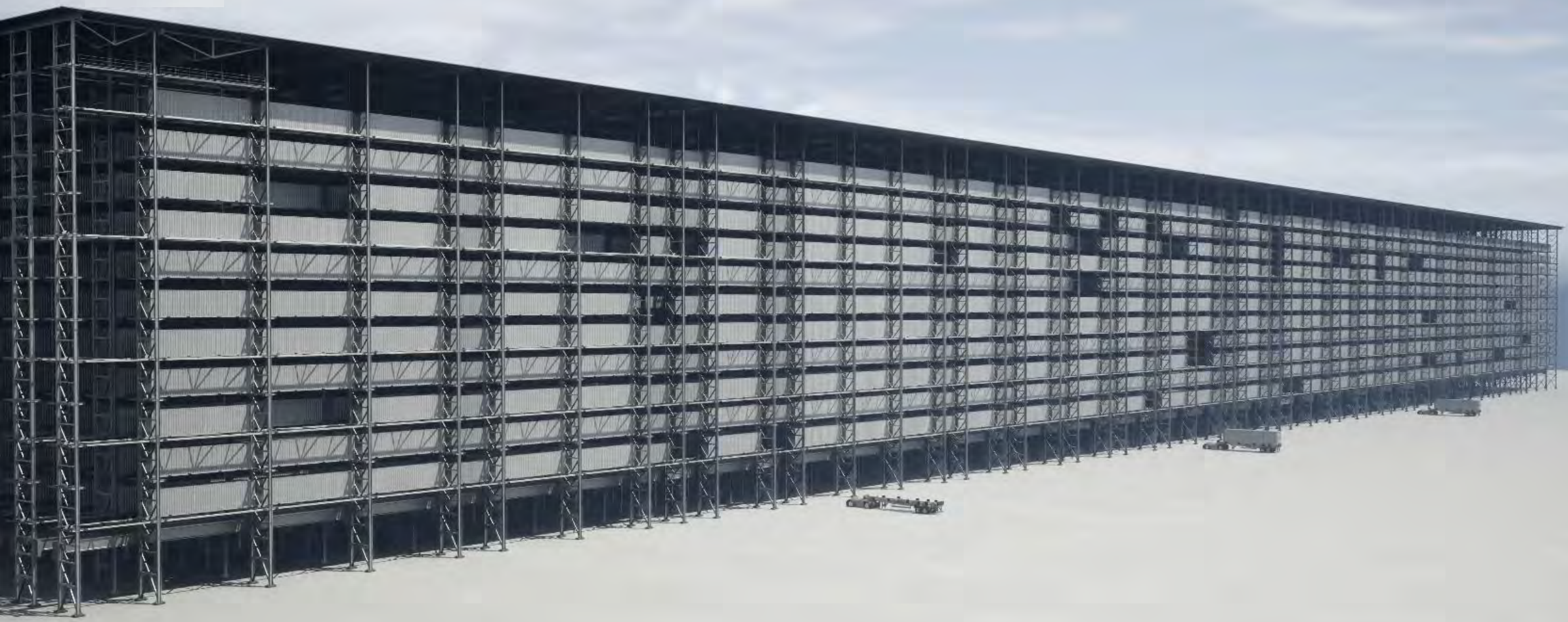
Autonomous TTs

AGVs

SIDE-GRID®

The Side-Grid has interfaces on both end faces and longitudinal sides. Because trucks are serviced via CPC loops and Truck Transfer Cranes are on the longitudinal sides, it is called the Side-Grid.

TOP-GRID®



In the Top-Grid, the warehouse is elevated and accessible from **all** sides from below. AGVs or automated trucks operate at ground level beneath the aisles and are serviced directly by the Stacker Cranes from above

TOP-GRID WITH **AGV'S**

HYBRID-GRID®

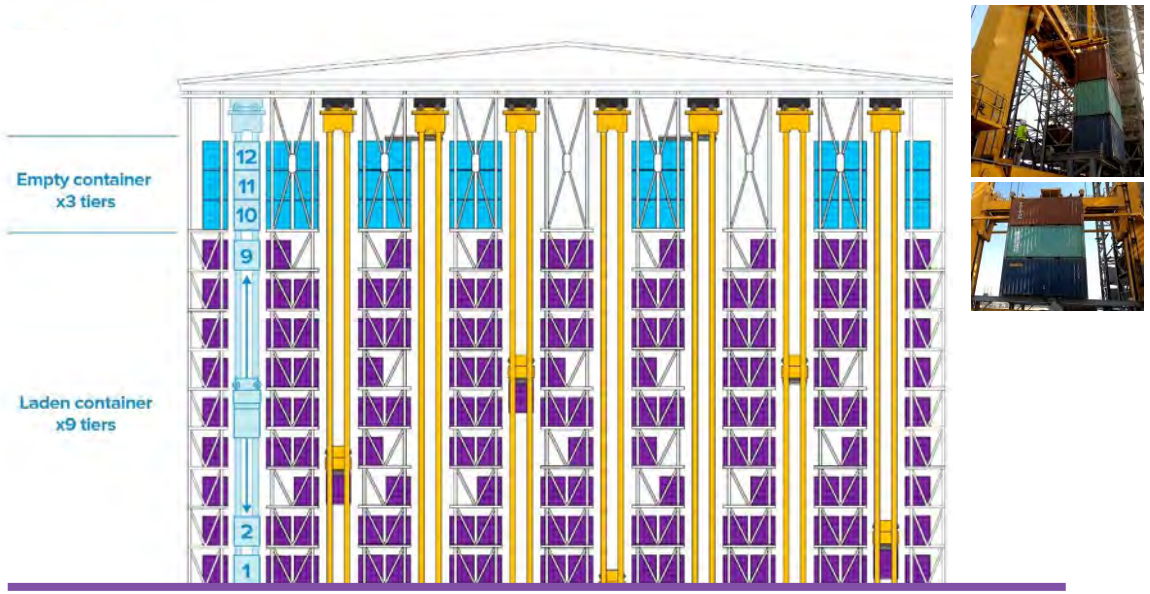
The Hybrid-Grid combines features of both the Top-Grid and Side-Grid. AGVs or automated terminal trucks are serviced direct under the HBS, landside truck traffic is handled using CPC loops and truck cranes.

BOXBAY FOR PUSAN NEWPORT, KOREA

HYBRID-GRID (COMBINATION SIDE-GRID AND TOP-GRID)

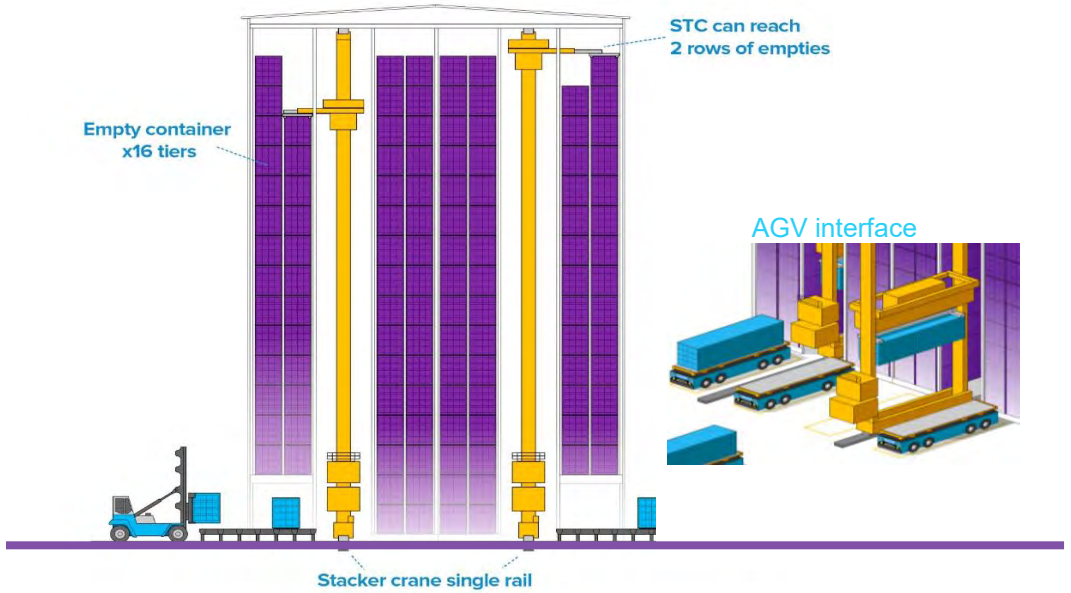
TWO TYPES OF DESIGNS FOR HANDLING OF EMPTY CONTAINERS

1. MIXED STORAGE OF LADEN AND EMPTIES



- Empty stacks on highest tiers
- 12 tiers for container storage
  within same height for laden 11 tiers
- Works with TOP-GRID and SIDE-GRID

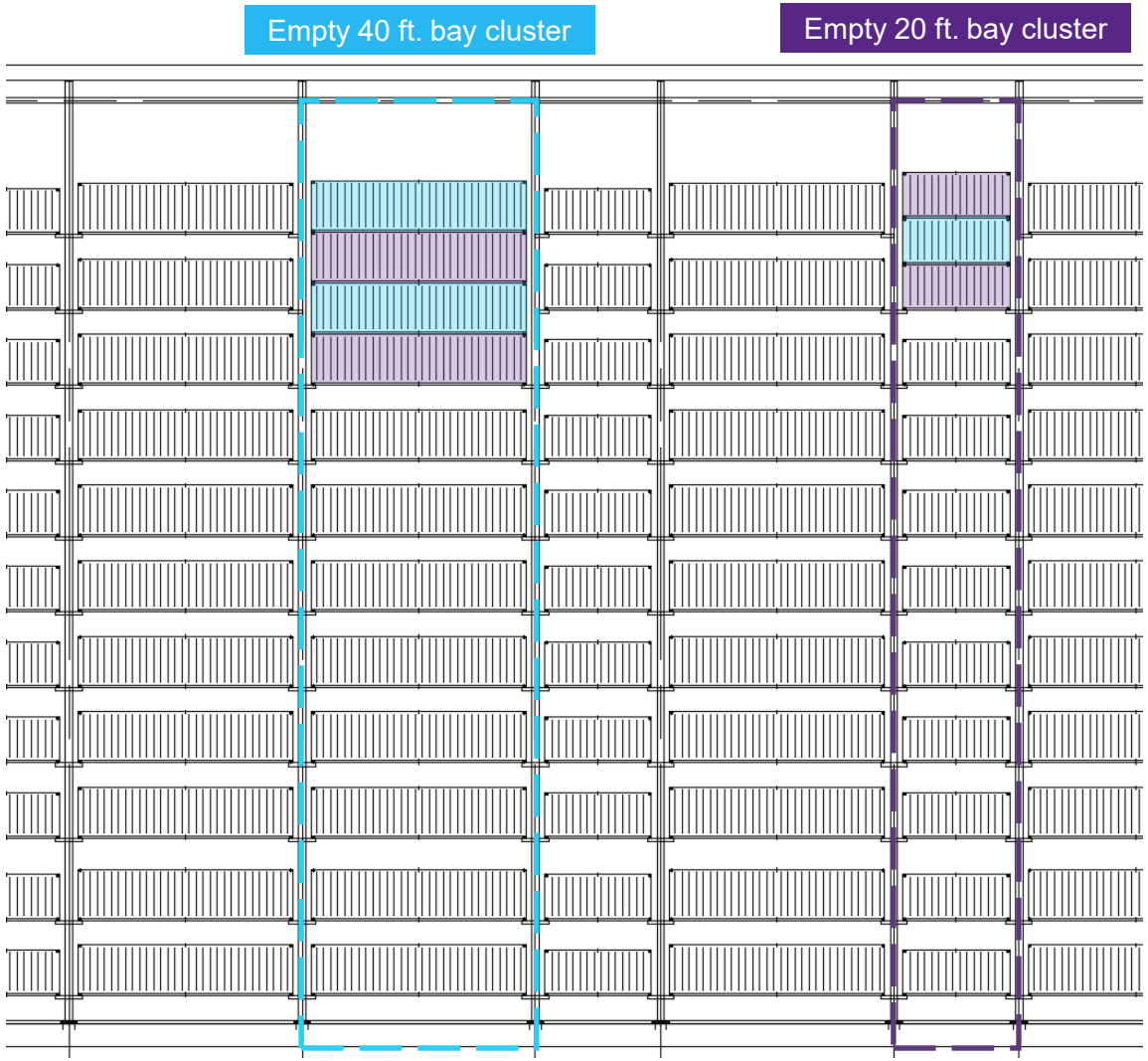
2. PURE EMPTY STORAGE



- Empty stacking on 16 tiers, double-deep, lighter crane
- Various interfaces at each aisle end (possible for all ITVs)
- Integration of manual or automated equipment

DESIGN FOR MIXED LADEN & EMPTY CONTAINERS

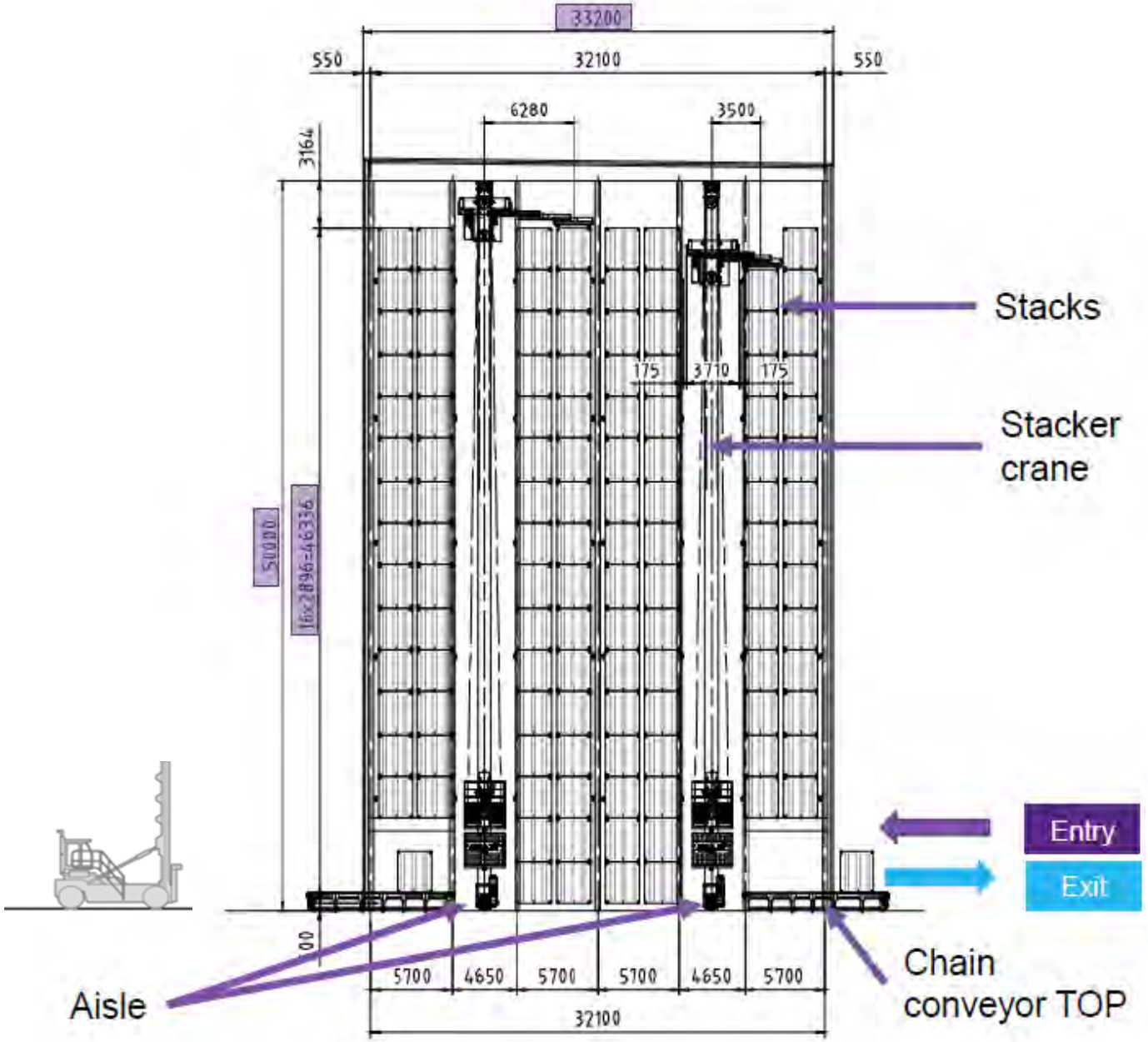
- Empties can be stored in clusters at the upper levels of the BOXBAY
- The number of columns that store empties is flexible
- This results in 12 or 13 containers high (instead of 11 for laden) being stored in one column



DESIGN FOR 100% EMPTIES –

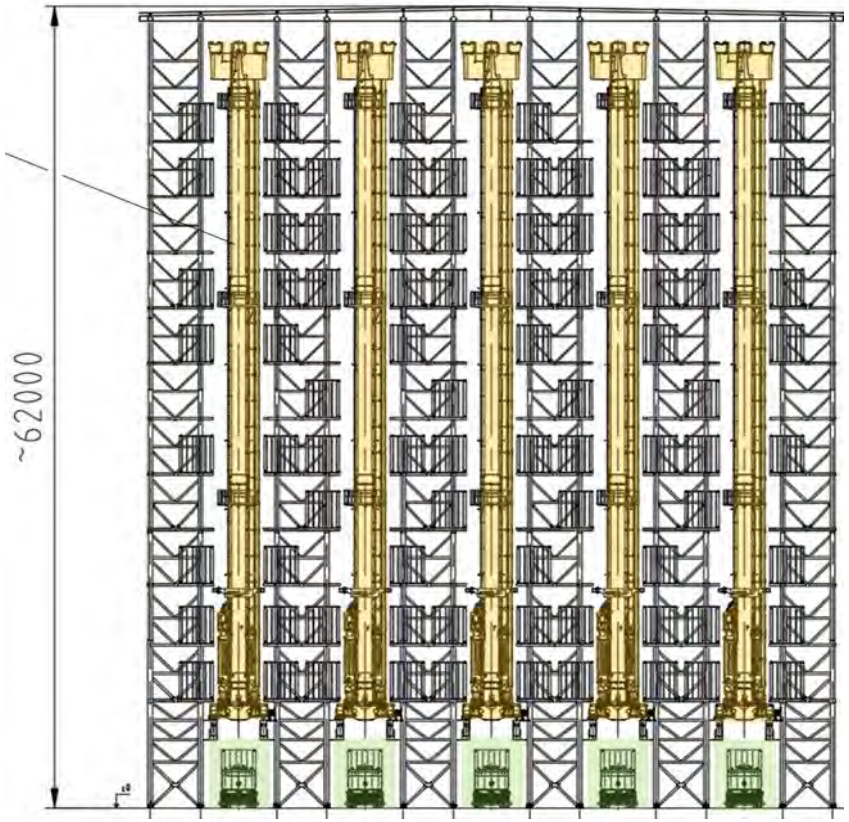
THE EMPTY SUPERSTACK

- Up to 16 stories of empties, 2 rows each side
- Fall arrest with boundary steel structure
- Stacker cranes reach double deep
- Empty interchange with Chain conveyor
- Transfer point to SC possible by end loading
- Truck handling at HBS TOPs can either happen by standard empty handlers or automated truck cranes



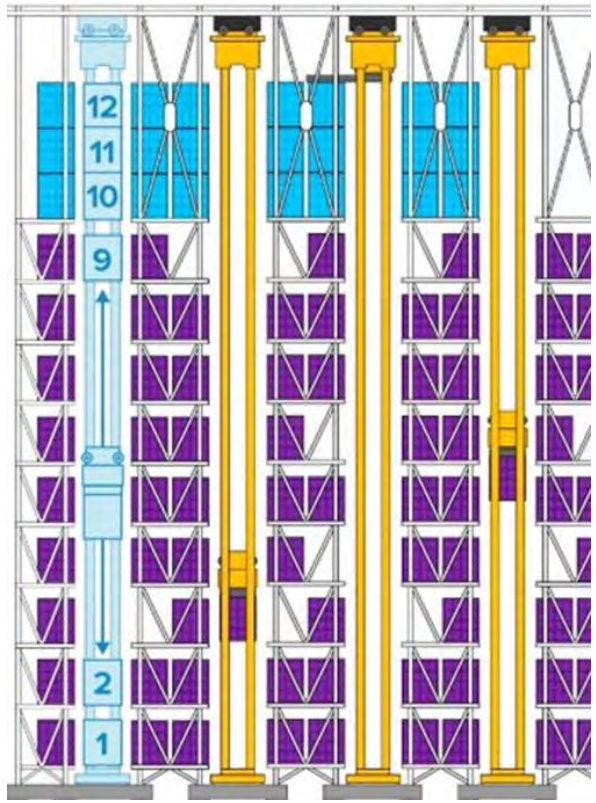
LADEN - MIXED - EMPTY STORAGE DENSITY

Laden 11 tiers



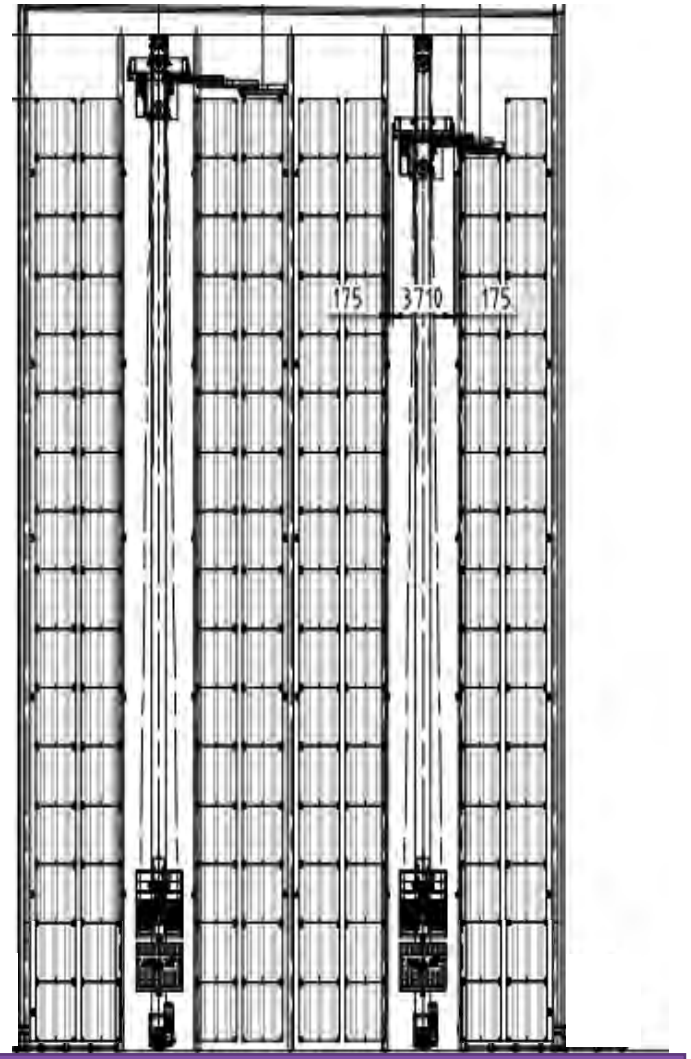
Laden 3,200 TEU/ha

Mix Laden/Empty 9+3



Mixed laden/Empty 3,800 TEU/ha

Empty Superstack 16 tiers



Empty Superstack 5,200 TEU/ha

The future is vertical

GREENFIELD APPLICATION

BOXBAY ideal for greenfield projects when:

- **High throughput or storage capacity needed.**
- **Conventional yard space limited or unavailable.**
- **Land acquisition is costly due to reclamation or earthworks.**
- **Strict environmental regulations are in place.**
- **Energy supply is unreliable**

The future is vertical

TRANSSHIPMENT PROPOSAL WITH TRUCK INTERFACES ON BOTH LONG SIDES

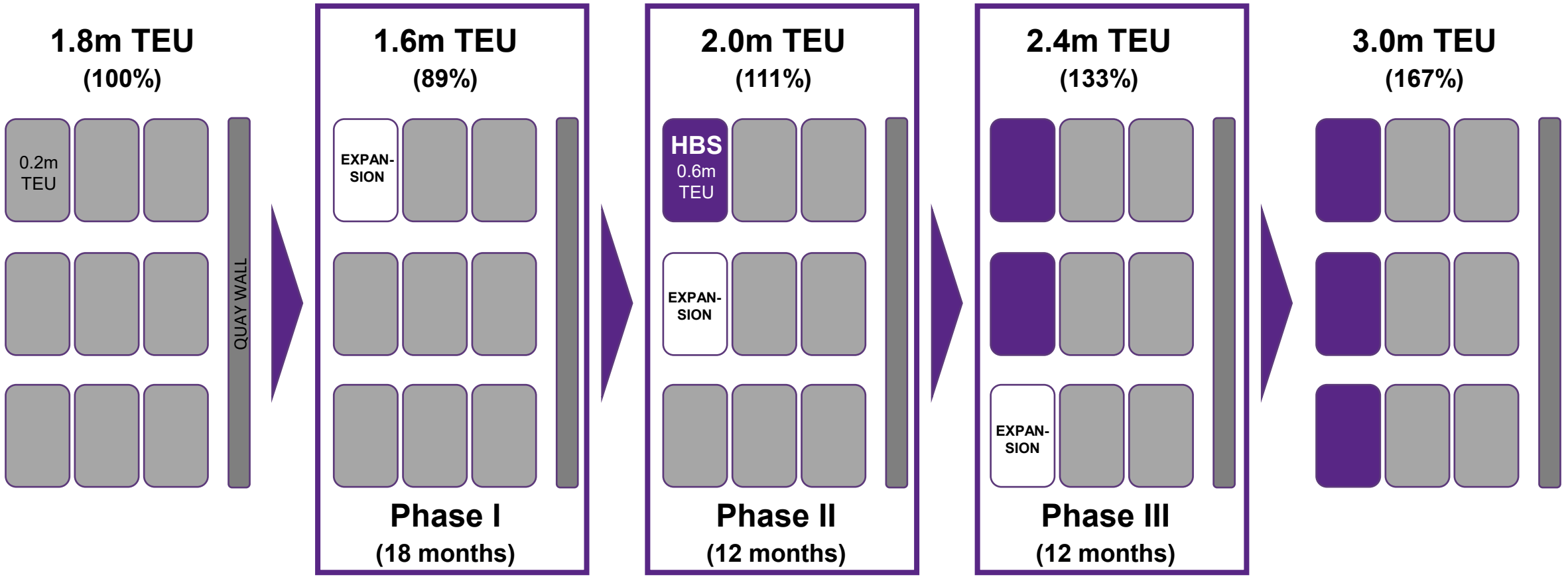
The future is vertical

BROWNFIELD APPLICATION – RTG TO BOXBAY CONVERSION

- **BOXBAY ideal for brownfield projects when:**
  - Existing terminal reaches its limit
  - No further expansion areas are available,
  - No further land can be filled or reclaimed
  - Neighboring city or surrounding landscape hinder further expansion

3 X YARD CAPACITY AND 3-4 X THROUGHPUT PER HECTARE VS RTG YARD

EXAMPLE: CAPACITY EXPANSION OF A BROWNFIELD TERMINAL



Capacity expansion on existing footprint with limited capacity reduction during expansion phase

PETER SLOOTWEG: MANAGING DIRECTOR AMERICAS

EMAIL: Peter.Slootweg@Boxbay.com
MOBILE: +1 412 277 1476

Q&A, THANK YOU,

STAY IN TOUCH,
SEE YOU AT AAPA EXPO

The future is vertical