



OVERVIEW

Technology for Sustainable Operations

Avid Boustani
VP, Product, Turntide Technologies
July 2021

AVID'S JOURNEY



Track Record

De novo companies	Corporate / university spin-outs	Private equity investments	Capital raised and invested in sustainability
9	3	15	> \$3B

Software & Internet

Energy & Water

Our Partners



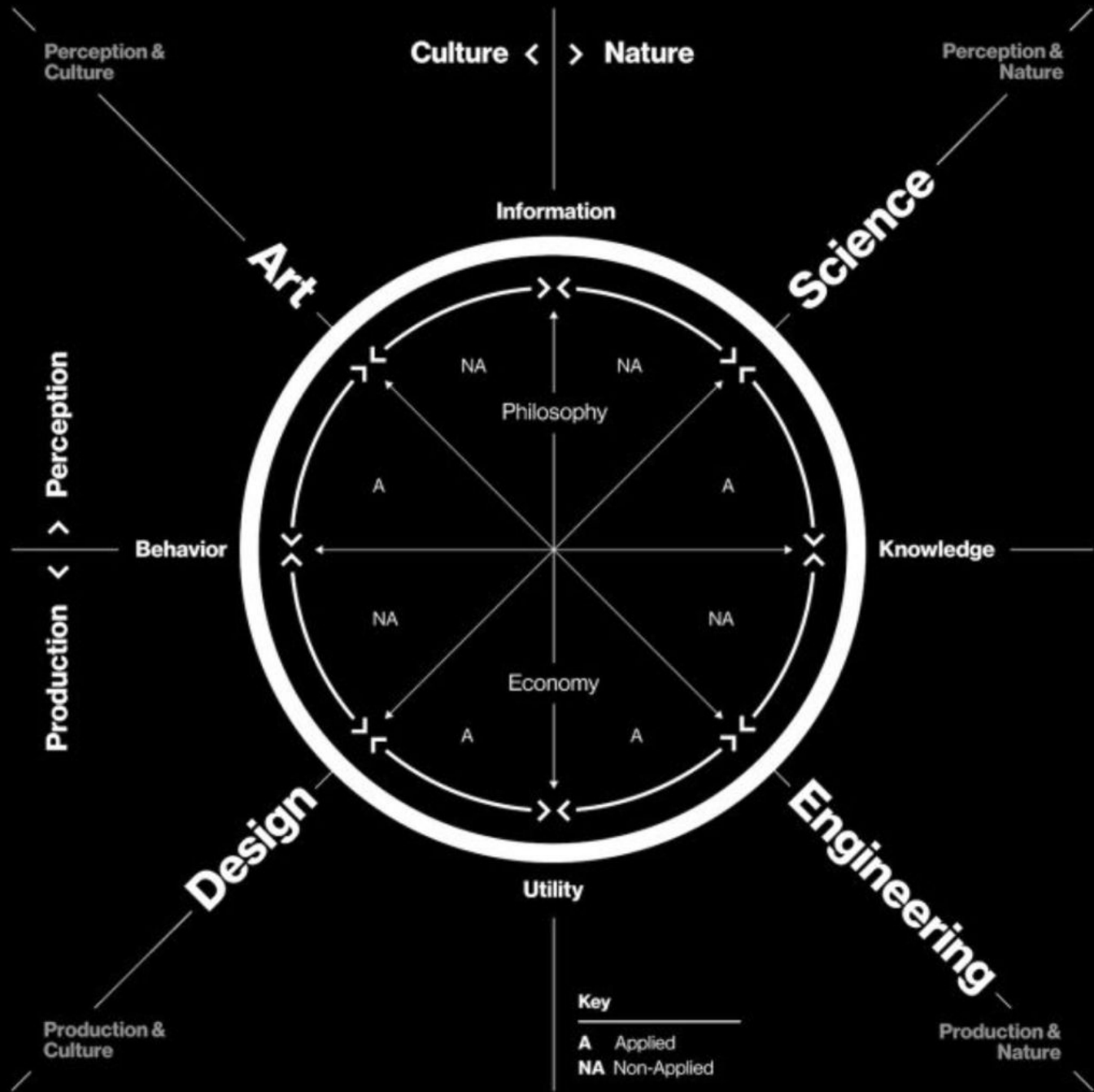
Aluminum Can

Disposal of
1000-1098 1st Ave
Seattle, WA 98104

Transported
2.5 Miles,
1 Day and 18 Hours

Category
Metals

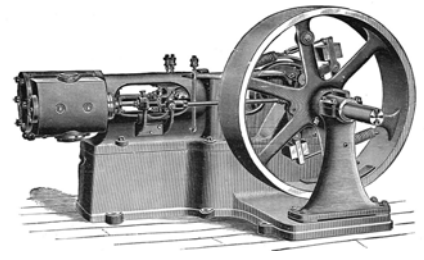
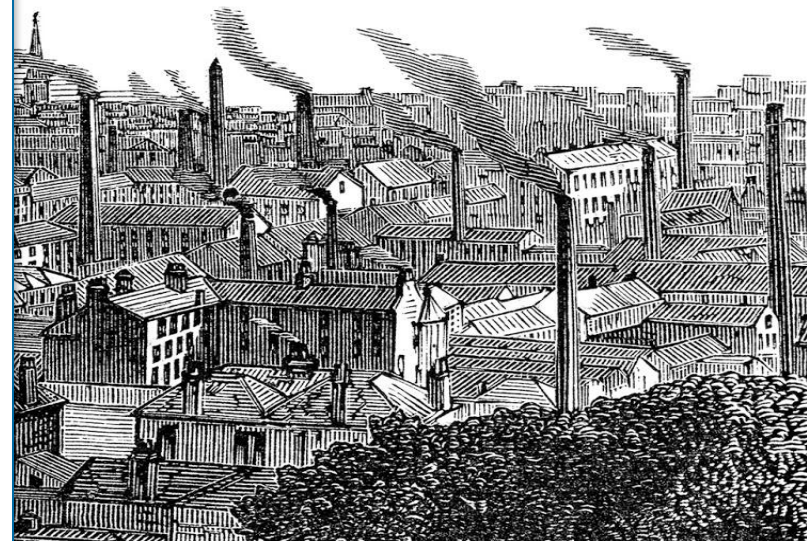




THE MOTOR WAS THE CATALYST TO THE INDUSTRIAL REVOLUTION

BILLION METRIC TONS OF CO2

And Drastically Drove Climate Change



Industrial 1.0



ELECTRIC
MOTOR

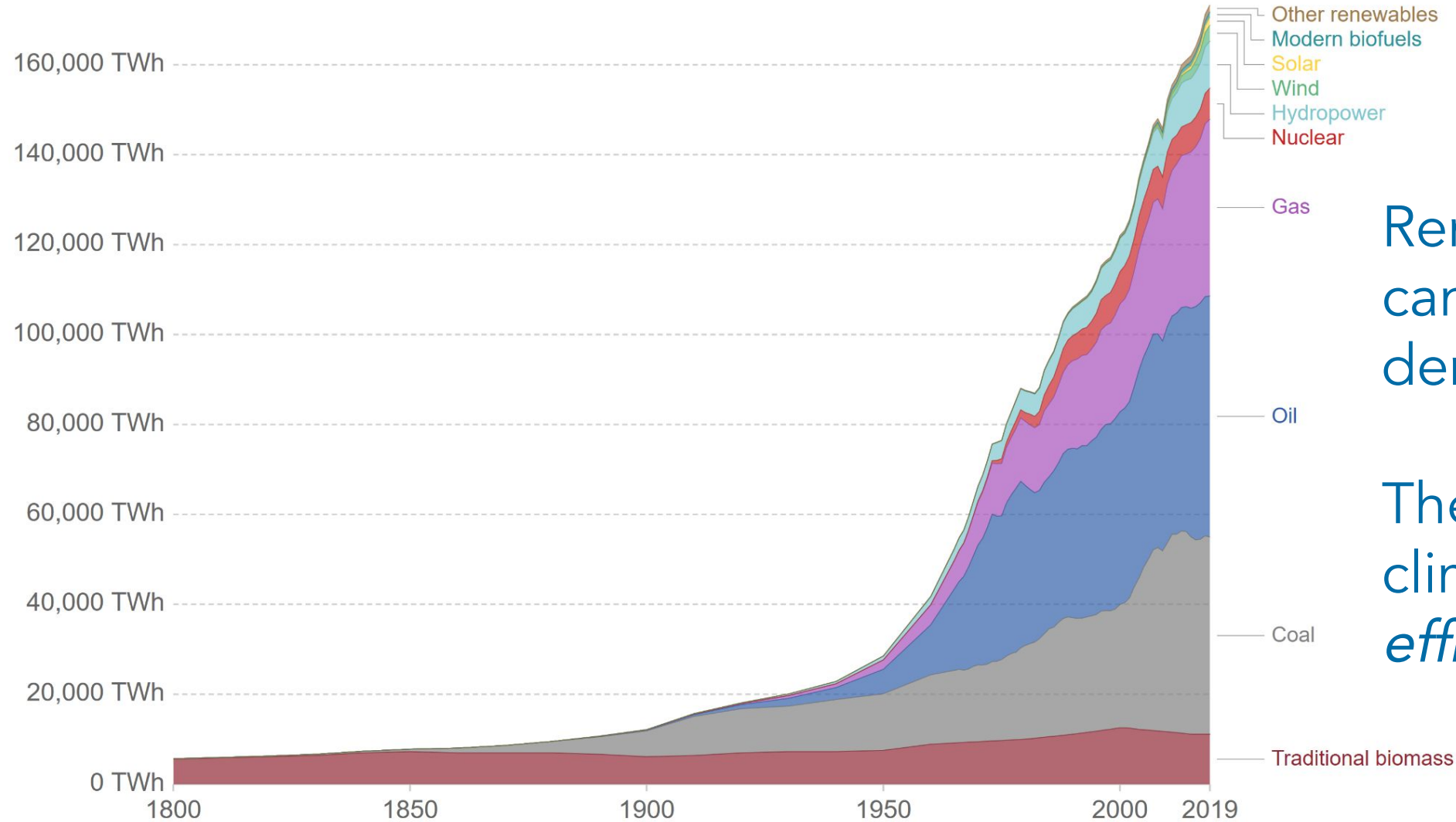
Industrial 2.0



Industrial 3.0

Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.



Renewable supplies
can't keep up with
demand

The most important
climate solution is
efficiency

Today, electric motors consume over half the world's electricity

There is no path to 100% clean energy without modernizing the world's motors

WHY WE START WITH THE BUILT ENVIRONMENT

Buildings and construction drive:

33%

of global energy consumption

40%

of global carbon emissions





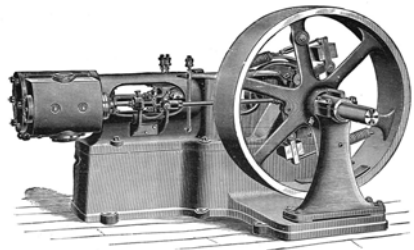
BOOMING DEMAND FOR HVAC

"Growing demand for air conditioners is one of the most critical blind spots in today's energy debate. Setting higher efficiency standards for cooling is one of the easiest steps governments can take to reduce the need for new power plants, cut emissions and reduce costs at the same time."

Fatih Birol, IEA Executive Director

source: IEA, *Future of Cooling* [report](#).

The Software-Driven Motor Will Make the 4th Industrial Revolution *Sustainable*



Industrial 1.0

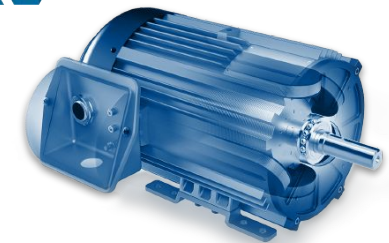


**ELECTRIC
MOTOR**

Industrial 2.0



Industrial 3.0



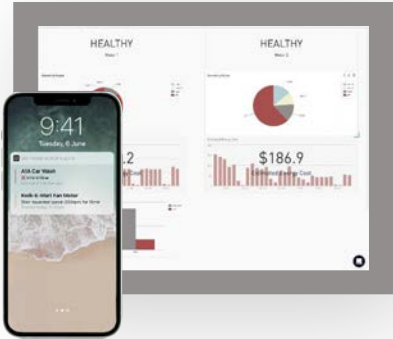
2019

Industrial 4.0

OUR TECH FOR SUSTAINABLE OPERATIONS

CLOUD INSIGHT

IOT & ANALYTICS
PLATFORM



EDGE AUTOMATION

BUILDING OPERATING
SYSTEM / CONTROLS



ELECTRIC MACHINES

MOTOR

MOTOR DRIVE



KEY FACTS ABOUT TURNTIDE



Founded in 2013 by purchasing IP assets in development since 2007



Headquartered in Sunnyvale, CA. Offices in US (5 locations), Canada, UK, India



500+ employees



150+ patents and 50+ registered trademarks

INVESTORS:
**OUR COALITION TO TURN
THE TIDE ON CLIMATE CHANGE**

\$400M+

RAISED SINCE 2013

Bloomberg Green

Energy & Science

Robert Downey Jr. and Bill Gates Bet On Electric Motor Startup

California-based Turntide Technologies raised \$80 million for its motors that reduce electricity use

By Akshat Rathi

March 3, 2021, 3:00 AM PST



FUTURESHAPE



EVOLUTION OF THE ELECTRIC MOTOR

MOTOR TYPE

1832



Direct Current Motor

1888



Alternating Current Induction

1980



AC Motor & Variable Frequency Drive

1990



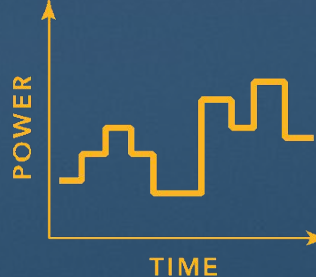
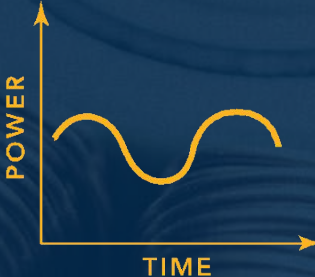
Switched Reluctance

2016



Turntide High Rotor Pole Switched Reluctance

CONTROL SYSTEM



BREAKTHROUGH

DISCOVERY OF ELECTRICITY

NIKOLA TESLA

MICROCHIP & POWER SEMICONDUCTORS

CUSTOM POWER SEMICONDUCTORS

SOFTWARE + COMPUTER + SIMULATION BASED DESIGN

COMPARISON

DIFFERENT MOTOR ARCHITECTURES



AC INDUCTION

- Very mature design—invented 130+ years ago by Nikola Tesla
- Extremely iterated upon, now at physical limits of performance
- Low cost, scalable to large size
- Inefficient outside narrow range
- Vast majority of market share in industrial motors



PERMANENT MAGNET

- Can be more efficient than AC
- Best performance requires rare earth magnets—China controls 95% global supply of rare earth materials
- Much higher cost
- Do not scale easily to larger sizes



SWITCHED RELUCTANCE

- Have been theorized as a next-gen solution for decades
- Simplest and lowest cost motor possible, no magnets, no rare earths
- Fundamentally different engineering challenges than other motors: electronics and software control

Five key technical hurdles blocked SRM from the mass market

Until Turntide took them on

By taking a novel, software-first design approach, Turntide has overcome these fundamental challenges as of 2019 to produce commercially available products



DISRUPTION: SOFTWARE WRAPPED IN METAL™

“Software eats the world” comes to electric motors as Moore’s Law drives exponential improvement in enabling technologies.



NEW POWER SEMICONDUCTORS ENABLE ULTRA-EFFICIENT CUSTOM INVERTER DESIGNS



HIGH PERFORMANCE & LOW POWER MOBILE COMPUTING ALLOWS MORE COMPLEX STRATEGIES TO CONTROL ALGORITHMS



SIMULATION BASED DESIGN PERMITS HARDWARE DEVELOPMENT AT THE SPEED OF SOFTWARE

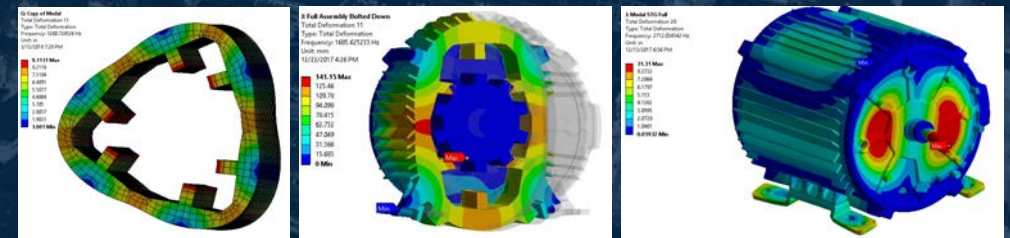


IOT CONNECTIVITY ENABLES DIGITAL TRANSFORMATION OF BUSINESS MODELS

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UNIQUE PARTNERSHIP ENABLES US TO DESIGN MOTOR SYSTEMS WITH THE WORLD’S MOST ADVANCED SIMULATION TOOLS



TESTED AND VALIDATED



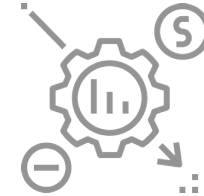
ENERGY SAVINGS

The patented switched reluctance motor from Turntide is proven to be 40-60% more efficient



INCREASED UPTIME

Real-time alerts allow an HVAC service technician to be dispatched immediately



LABOR REDUCTION

Costly overtime pay is avoided by understanding the precise mechanical issue



EXTENDED LIFESPAN

Machine learning prescribes proactive maintenance to prevent catastrophic failures



71% Energy savings in condenser fan applications



Energy for What's Ahead®
57% Energy savings in RTU fan applications



31% Energy savings in evaporation fan applications

MOMENTUM

More than
6,000
motors in the field
across NA and UK



THE POTENTIAL IMPACT

Our HVAC customers
see average energy
savings of

64%



THE POTENTIAL IMPACT

If we could replace every motor in every building, and see half that performance improvement, it would be like adding

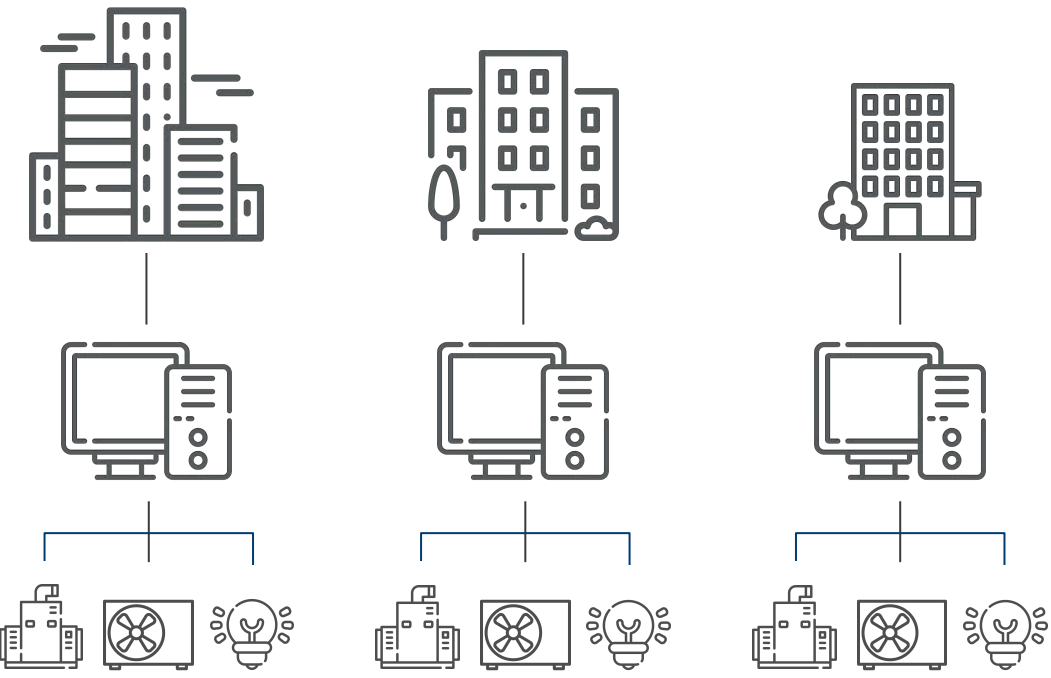
7 new
Amazon
rainforests



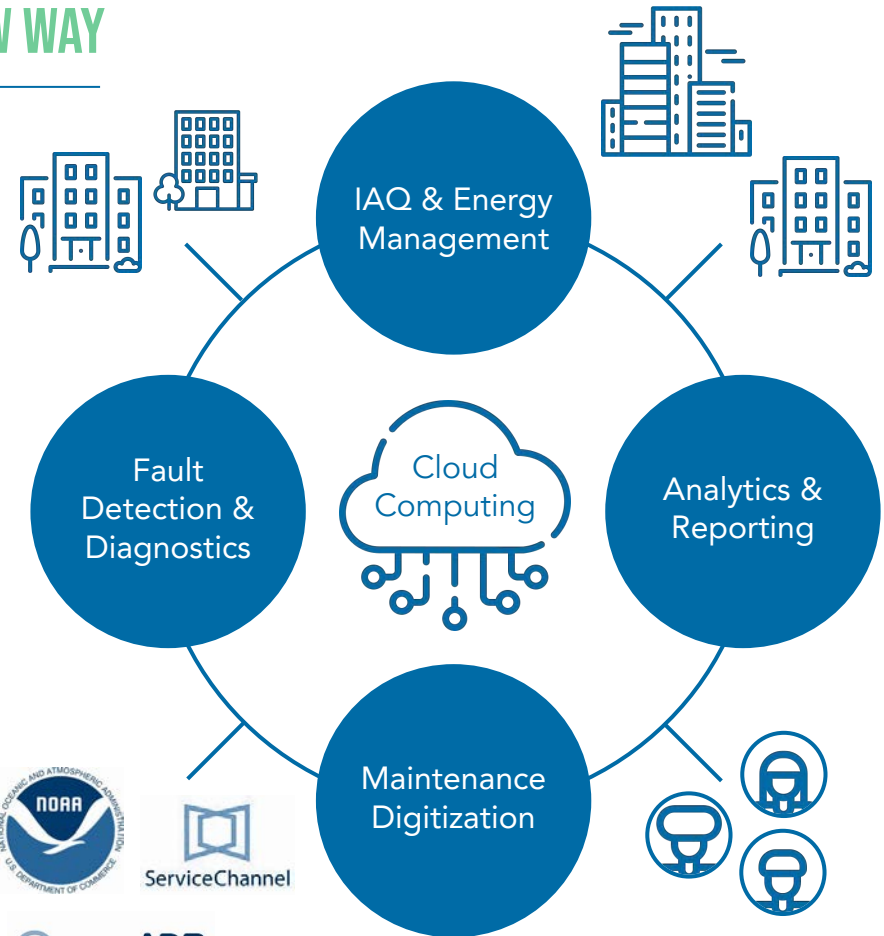
Connected, software-driven motors
enable connected, intelligent systems

FROM SILOED SYSTEMS TO CONNECTED, INTELLIGENT, OPTIMIZED PLATFORM FOR SUSTAINABLE OPERATIONS

OLD WAY

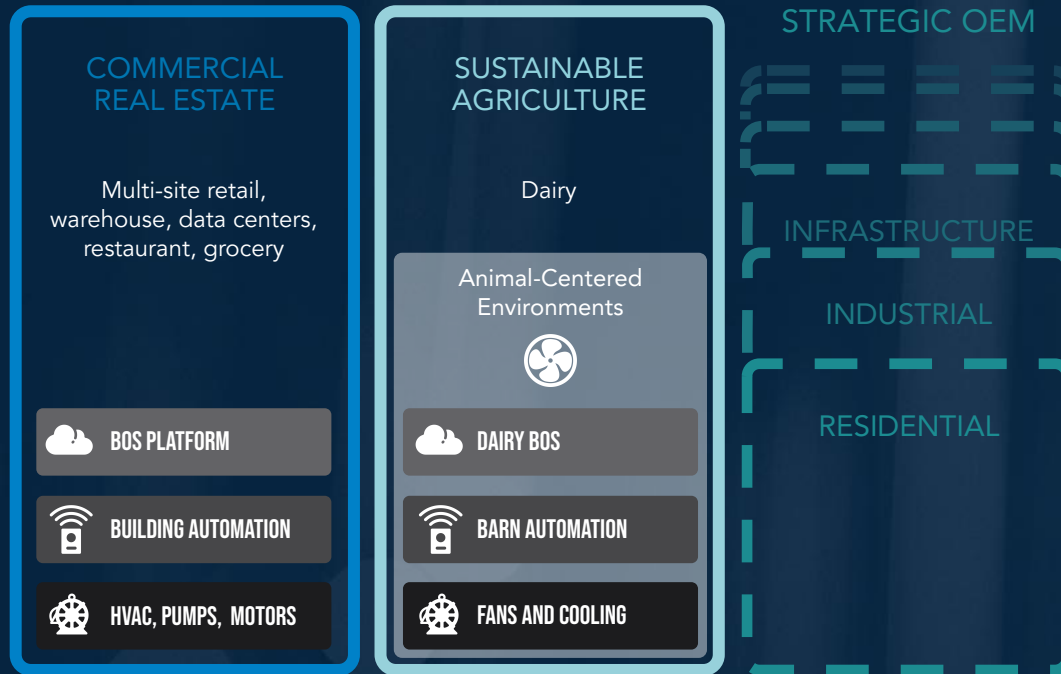


NEW WAY

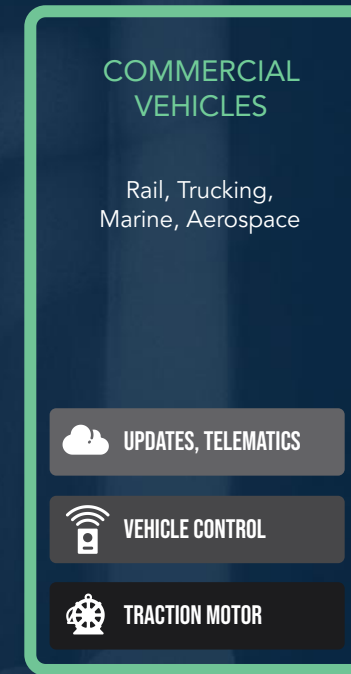


TURNTIDE INDUSTRIES

TURNTIDE BUILT ENVIRONMENT



TURNTIDE TRANSPORT



TURNTIDE TECHNOLOGIES

TECHNOLOGY STACK:

 CLOUD INSIGHT

 EDGE AUTOMATION

 ELECTRIC MACHINES

TURNTIDE INDUSTRIES EXAMPLES

TURNTIDE BUILT ENVIRONMENT

TURNTIDE TRANSPORT

CUSTOMIZATION



COMMON PLATFORM



COMMERCIAL REAL ESTATE RETROFIT

Multi-site retail, warehouse, data centers, restaurant, grocery



SUSTAINABLE AGRICULTURE

Dairy



COMMERCIAL VEHICLES

Rail, Trucking, Marine, Aerospace



TURNTIDE TECHNOLOGIES

TECHNOLOGY STACK:



CLOUD INSIGHT



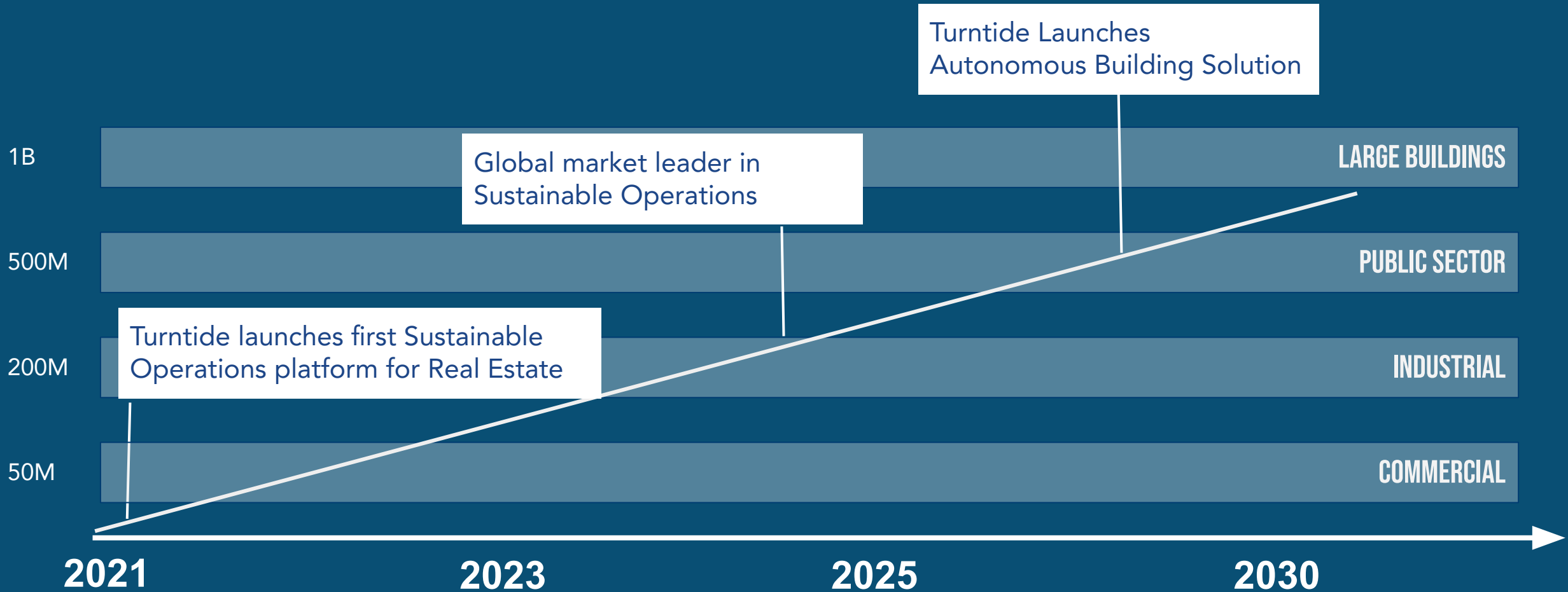
EDGE AUTOMATION



ELECTRIC MACHINES

OUR ASPIRATION

Transform real estate to be connected, intelligent, automated



NEW VISIBILITY INTO ENERGY USE

Dashboards show a facility manager their current conditions and their energy use/savings



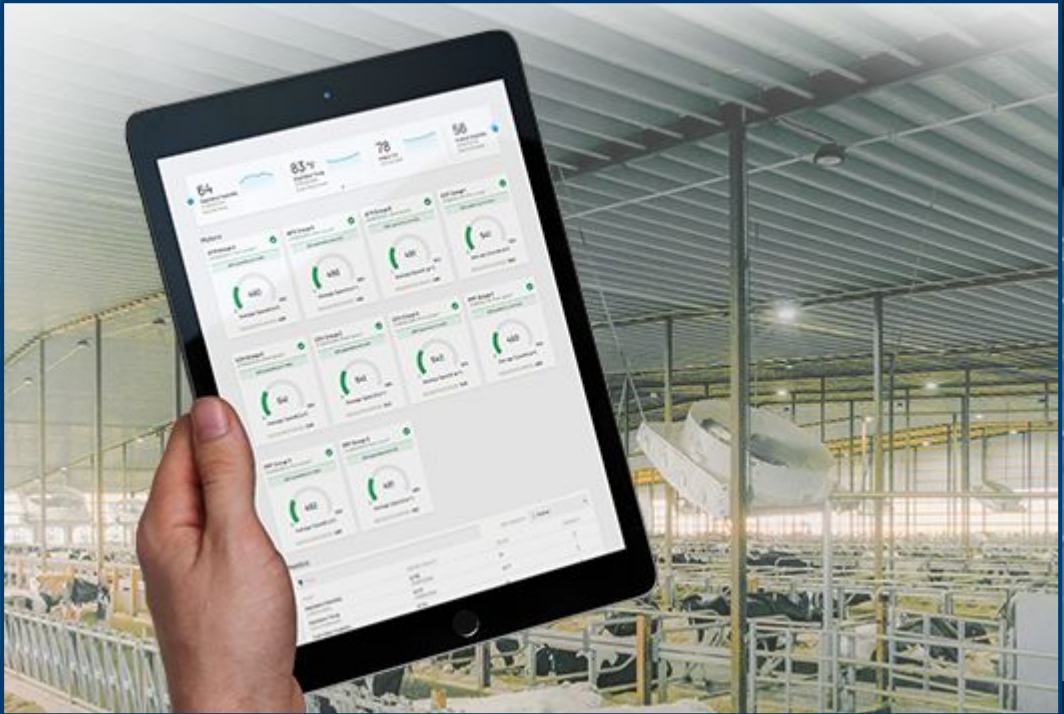
Memphis TN - Energy Savings
SISENSE

RTU	OPERATING MODE	MOTOR SPEED IN RPM	POWER DRAW IN WATTS
RTU-1 Motor 3HP (see details)		0	11
RTU-2 Motor 3HP (see details)		1433	872
RTU-3 Motor 3HP (see details)		0	12
RTU-4 Motor 3HP (see details)		0	12

Weekly Total Energy Consumption

All Motors - Projected Annual Savings	11383 kWh (71%) <small>Energy Saved</small>	\$1,479.79 <small>Est. Yearly Savings</small>
All Motors - Savings Since 01/04/20	5094 kWh (73%) <small>Energy Saved</small>	\$662.22 <small>Est. Total Savings</small>

TURNTIDE AGRICULTURE: TRANSFORM AG TO BE CONNECTED, INTELLIGENT, OPTIMIZED



TURNTIDE AG ASPIRATION: HELP PRODUCE MORE FOOD WITH FEWER RESOURCES

FEED 10B PEOPLE SUSTAINABLY

SOURCES OF PROTEIN

1/3 OF WORLD'S PROTEIN OPTIMIZED BY BOS

GLOBAL MARKET LEADER IN DAIRY

2021

2025

2030

2050

RECENT TRANSPORT ACQUISITIONS EXPAND TURNTIDE OFFERING ACROSS EV VALUE CHAIN

HYBRID COMMERCIAL TRUCK



WAREHOUSE ROBOT



HYBRID-EV HYPERCAR



RECENT ACQUISITIONS





Our mission:
Upgrade all the world's motors to
intelligent systems so every watt is
worthwhile for humanity

Avid Boustani
avid@turntide.com

