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| Date | 27.01.2019 |
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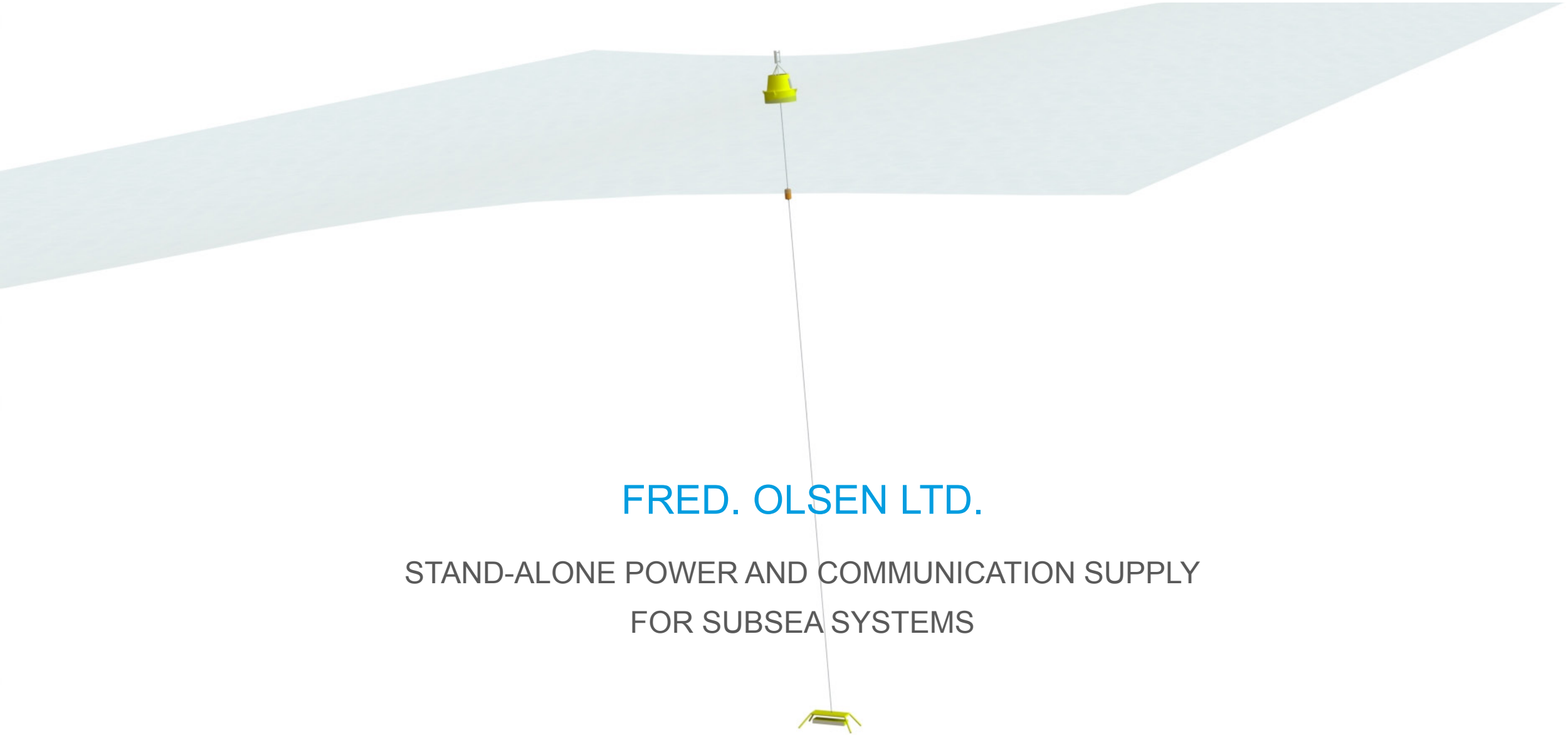
| Author | E. Hjetland |



# FRED. OLSEN LTD.

## STAND-ALONE POWER AND COMMUNICATION SUPPLY FOR SUBSEA SYSTEMS

# BOLT SEA POWER PROGRAM

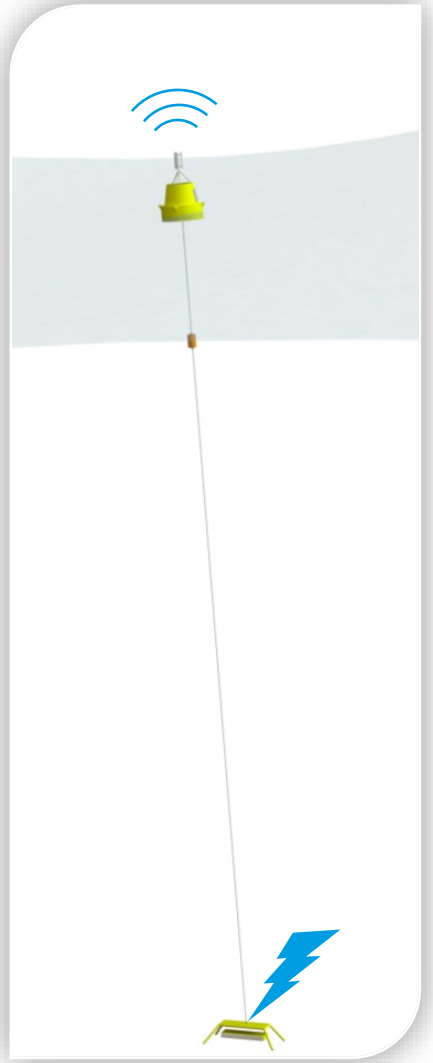
## NEXT STEP: PRODUCT DEVELOPMENT

- FRED. OLSEN HAS DEVELOPED STAND-ALONE, AUTONOMOUS OFFSHORE POWER GENERATOR TECHNOLOGY SINCE 2007

- TECHNOLOGY DEVELOPMENT COMPLETE ✓
  - **RELIABILITY** THOROUGHLY VALIDATED AND DEMONSTRATED DURING US NAVY TRIALS 2015-2019

**NEXT STEP**

- COMMERCIALLY AVAILABLE PRODUCT:
  - ADAPT DESIGN TO COMMERCIAL PRODUCT AS **STAND-ALONE POWER SUPPLY** FOR SUBSEA OIL & GAS
  - TO ENABLE DEPLOYMENT OF SUBSEA EQUIPMENT **INDEPENDENT OF AVAILABILITY OF POWER AND COMMUNICATION INFRASTRUCTURE**
- DEVELOPMENT PROCESS
  - IDENTIFY POTENTIAL **CUSTOMERS** FOR PRODUCT
  - IDENTIFY PILOT DEMONSTRATION PROJECT PARTNERS
  - IDENTIFY INDUSTRIAL **INVESTOR** FOR JOINT VENTURE



# FRED. OLSEN GROUP OF BUSINESSES

## 170 YEARS OF INDUSTRIAL EXPERIENCE

**SHIPPING:**

CRUISE LINE, TANKERS, SHIP YARDS




**OIL & GAS:**

EXPLORATION AND PRODUCTION

**RENEWABLE ENERGY**

ONSHORE WIND FARMS

WIND TURBINE INSTALLATION VESSELS

WAVE AND TIDAL TECHNOLOGY

# BOLT SEA POWER

## AUTONOMOUS, STAND-ALONE POWER UNIT DEVELOPMENT

| 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOLT 33  | BOLT 22  | BOLT 1@ NORWAY |  | | BOLT LIFESAVER @ UK |  | | BOLT LIFESAVER @ US NAVY, HAWAII 1 |  | | BOLT LIFESAVER @ US NAVY, HAWAII 2 |  |

### SCALE TESTING

- TEST SITE IN NORWAY
- EUROPEAN COMMISSION FUNDED
- TESTING POWER TAKE-OFF PRINCIPLE

### FULL SCALE TESTING

- TEST SITE OUTSIDE FALMOUTH, UK
- UK GOV. FUNDED
- JOINT ENGINEERING WITH SUPACAT LTD.
- TEST FULL SCALE POWER TAKE-OFF DESIGN

### FULL SCALE DEMONSTRATION

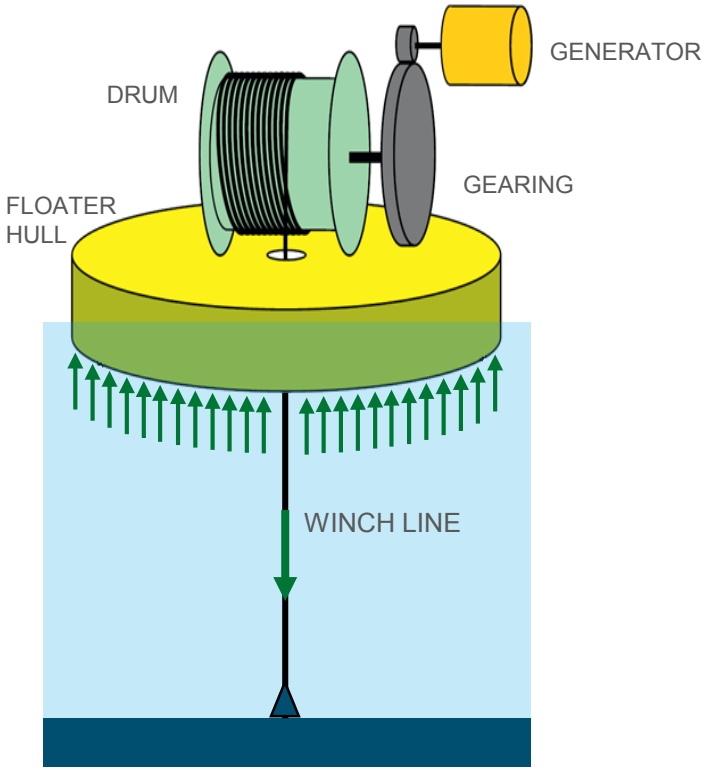
- TEST SITE OUTSIDE HAWAII, USA
- US NAVY FUNDED
- DEMONSTRATE RELIABLE POWER PRODUCTION
- POWER EXPORT TO OBOARD SENSOR PACKAGE
- POWER TRANSPORT SUBSEA

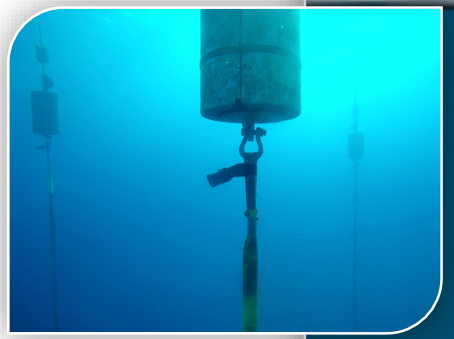
LINK TO VIDEO

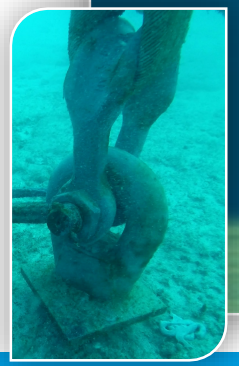
# CURRENT TECHNOLOGY

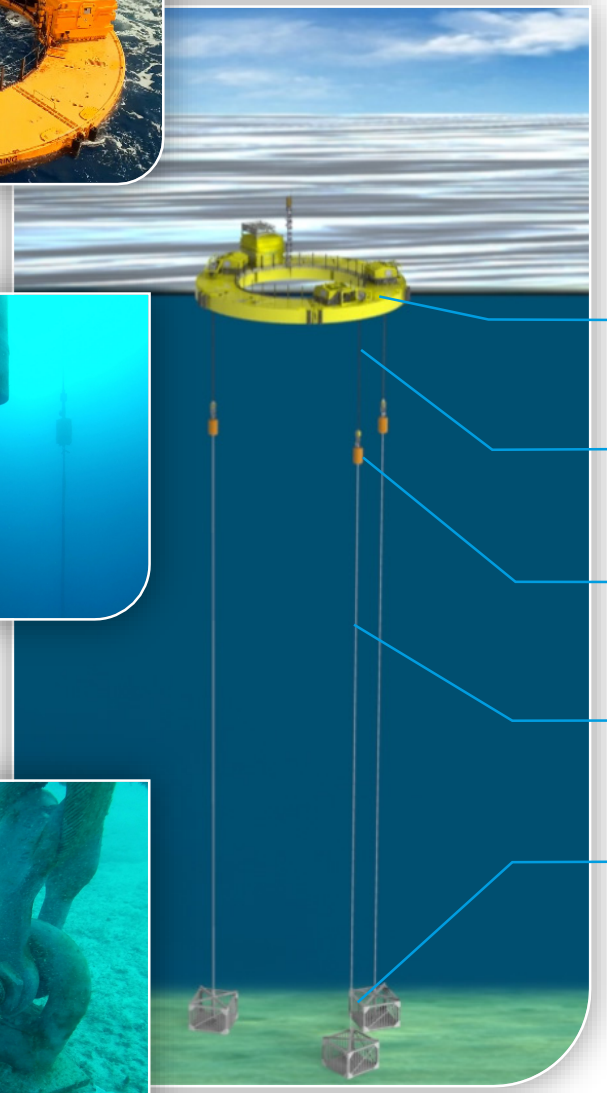
## POWER TAKE-OFF PRINCIPLE

- SIMPLE, ROBUST MECHANICS
- AUTONOMOUS OPERATION
- INTERNET CONNECTION
- ONBOARD ENERGY STORAGE







WAVE ENERGY CONVERTER

WINCH LINES

SUBSURFACE BUOYS

FIBER TETHERS

GRAVITY ANCHORS/ ROCK BOLTS

# CURRENT TECHNOLOGY

## BOLT LIFESAVER SYSTEM


16 METERS

### COMMUNICATION MAST
- Internet connection
- Radar reflector
- Lightening arrestor

### CONTROL HOUSING
- Controls computer
- Electricals hub
- Long term & short term energy storage
- Client power export system

### POWER TAKE OFFs
- High cycle power take-off winch
- Gear box
- Generator and inverter

### CLIENT SYSTEM
- Ocean sensing equipment package
- Data processing package

### FLOATATION HULL
- Steel torus
- Low free board for reduced loads

LINK TO VIDEO

# US NAVY DEPLOYMENT

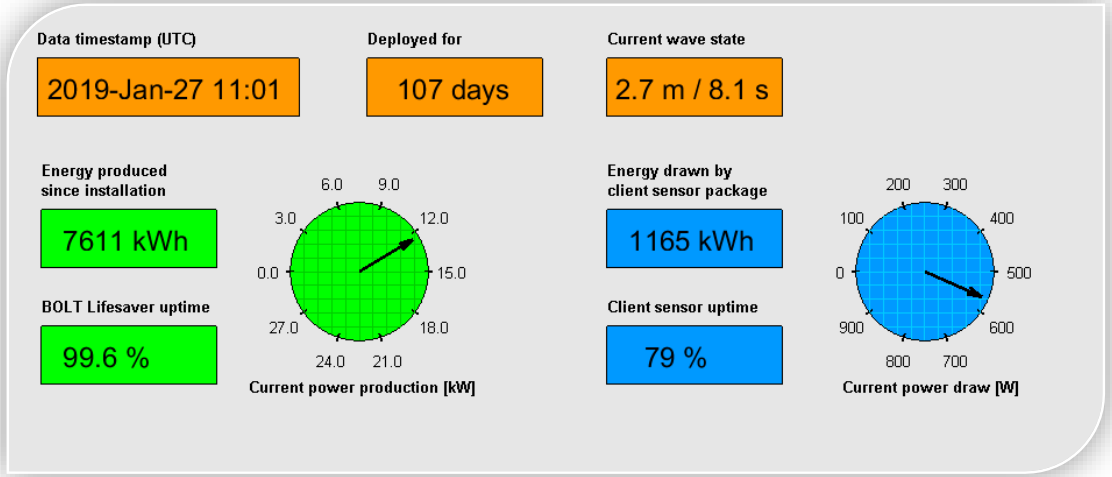
## BOLT LIFESAVER OPERATION IN HAWAII

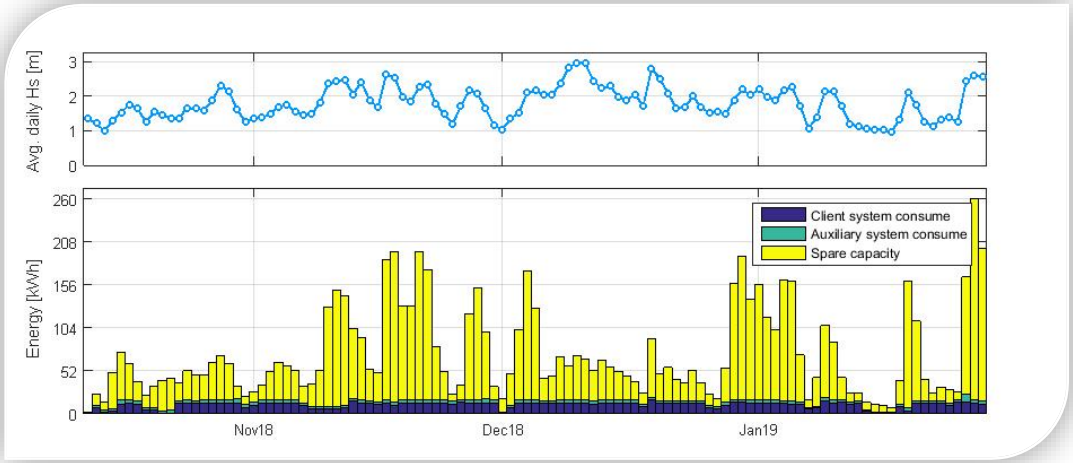
- 2015-2017 CONTRACT
  - DEMONSTRATE RELIABLE POWER PRODUCTION
- 2017-2019 CONTRACT
  - ACCOMMODATE LARGE OCEAN SENSING PACKAGE AND PROVIDE POWER AND COMMUNICATION

*"…the world's first demonstration of the potentially transformative capability for WECs to enable persistent oceanographic observation and **UUV re-charge** without a cable to shore."*

- US Navy press release

LINK TO VIDEO



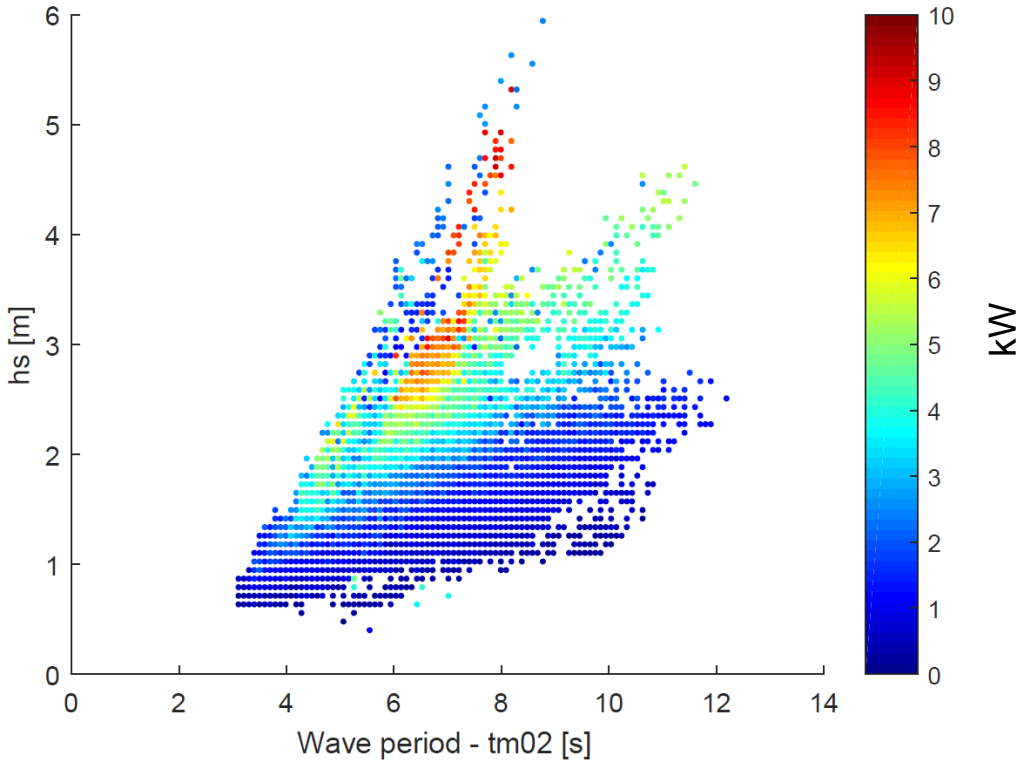
# WAVE ENERGY PROGRAM ASSETS TO DATE

## EXPERIENCE AND IP

- OPERATIONAL EXPERIENCE
  - 16 YEARS OF UNINTERRUPTED IN-HOUSE DEVELOPMENT
  - 5 WAVE ENERGY CONVERTERS BUILT AND OPERATED
  - DEPLOYMENT IN 3 COUNTRIES
  - 65.000 HOURS AT SEA
  - 70+ O&M OPERATIONS
  - DEMONSTRATED RELIABLE AND PREDICTABLE POWER PRODUCTION OVER SEVERAL YEARS AT SEA
  - REMOTE OPERATION FROM ACROSS THE GLOBE

- IP AND ASSETS
  - 2 KEY PATENTS: **HIGH CYCLE WINCH** AND **LOW MAINTENANCE GEAR BOX** (EUROPE, USA, ASIA)
  - KEY PERSONNEL WITH 10+ YEARS ON THE PROGRAM STILL TIED TO COMPANY
  - OPERATIONAL SOFTWAVE DEVELOPED WITHIN PROGRAM
  - FRED. OLSEN CORPORATION STRONG AND DIVERSE MARITIME AND INDUSTRIAL CAPABILITIES

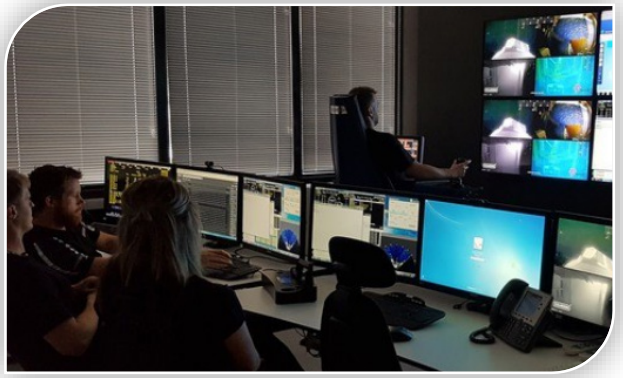
MEASURED AVERAGE POWER
OUTPUT FROM ONE PTO [2012 – 2019]

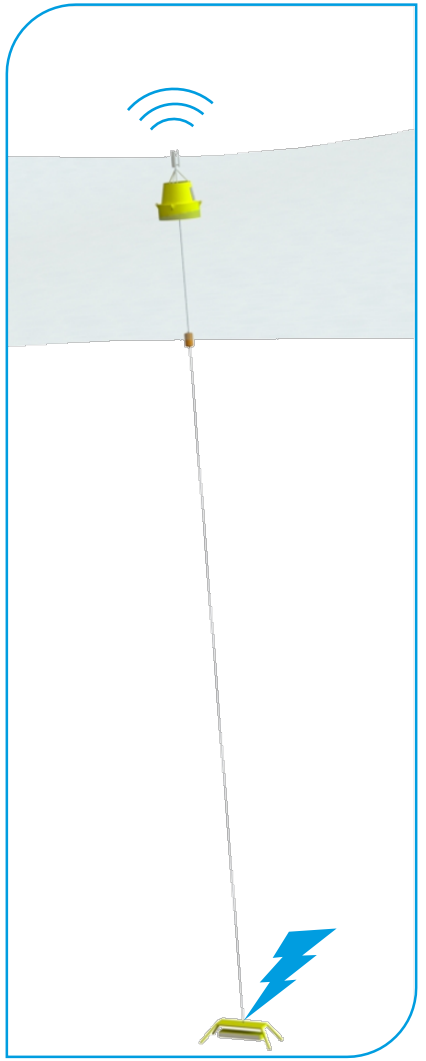


# POWER PRODUCT FOR SUBSEA SYSTEMS

## ENABLER OF REMOTE OPERATION

- LOCALLY GENERATED POWER AND LIVE INTERNET CONNECTION TO SURFACE AND TO SEABED
  - ENABLES REMOTE OPERATION OF OFFSHORE SYSTEMS
  - ELIMINATES SURFACE VESSELS
  - ELIMINATES RELIANCE ON AVAILABILITY OF POWER AND COMS INFRASTRUCTURE
  - LIVE DATA STREAM FROM AUTONOMOUS SENSORS
- COMMON CLIENT REQUIREMENTS
  - LOW POWER (1-10KW)
  - ONE MOORING LINE
  - POWER SUPPLY TO SEABED
  - COMMUNICATION LINK FROM SEABED TO SHORE
  - FAST INSTALLATION AND RECOVERY IN HIGH SEA STATES
  - DEEP WATER SITES
  - HIGH UPTIME / RELIABILITY
  - ROAD TRANSPORTABLE



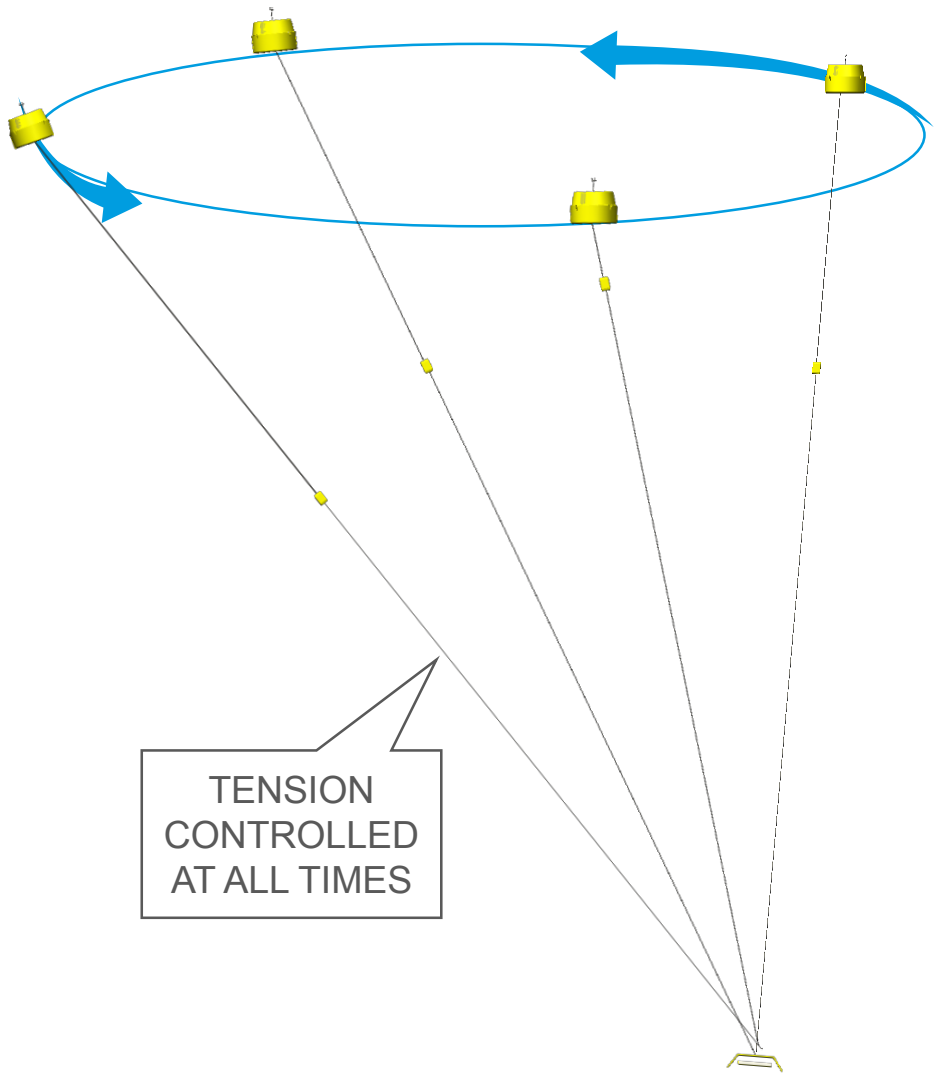


# POWER PRODUCT FOR SUBSEA SYSTEMS

## STRENGTH OF FRED. OLSEN TECHNOLOGY

### WHY WAVE ENERGY FOR STAND-ALONE POWER

- POWER SUPPLY UPTIME
  - WAVES AVAILABILITY VERY HIGH
  - COMBINED WITH ONBOARD STORAGE
  - CAN PROVIDE SUPERIOR CONTINUITY IN POWER SUPPLY
- DENSE ENERGY RESOURCE
  - COMPACT HARDWARE
  - SURVIVABILITY
  - COST EFFICIENT
- RELIABLE UMBILICAL
  - POWER AND COMMUNICATION EMBEDDED IN MOORING LINE
  - MOORING LINE UNDER CONSTANT TENSION CONTROL
  - PROVIDES STIFF AND HIGH RELIABLE LINE
  - AVOIDS SLACK UMBILICAL, FATIGUE WEAR AND SHOCK LOADS



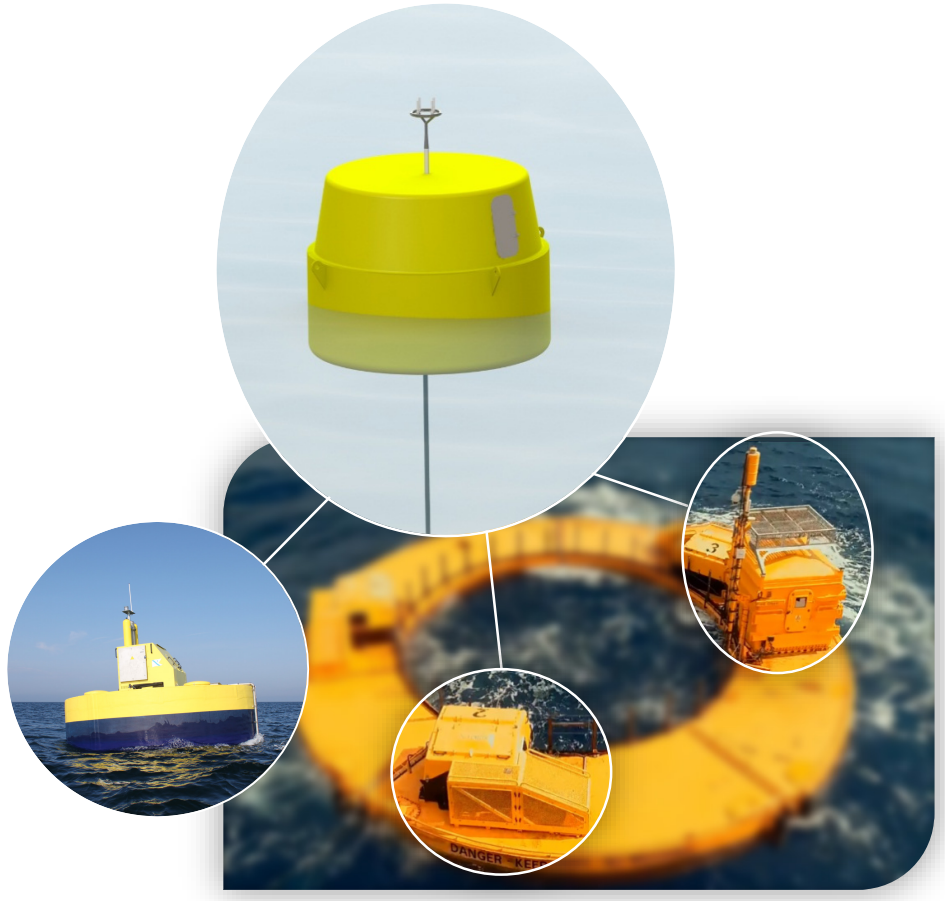
# POWER PRODUCT FOR SUBSEA SYSTEMS

## SINGLE PTO CONFIGURATION

- FRED. OLSEN TO CONFIGURE EXISTING DESIGNS TO A SMALER UNIT

- STAND-ALONE POWER SUPPLY AND COMMUNICATION PLATFORM FOR SUBSEA OIL & GAS, DEFENCE AND OCEANOGRAPHY MARKET

- PROPOSED PRODUCT
  - SINGLE PTO WINCH
  - 1-10 KW EXPORTED TO SEABED
  - 4G / SATELITE / RADIO LINK
  - ONBOARD BATTERY BANK
  - ONE SINGLE MOORING LINE
  - 3-5M DIAMETER HULL
  - 5-10 DRY TONS (DEPENDING ON SIZE)
  - SPLIT IN ROAD TRANSPORTABLE MODULES

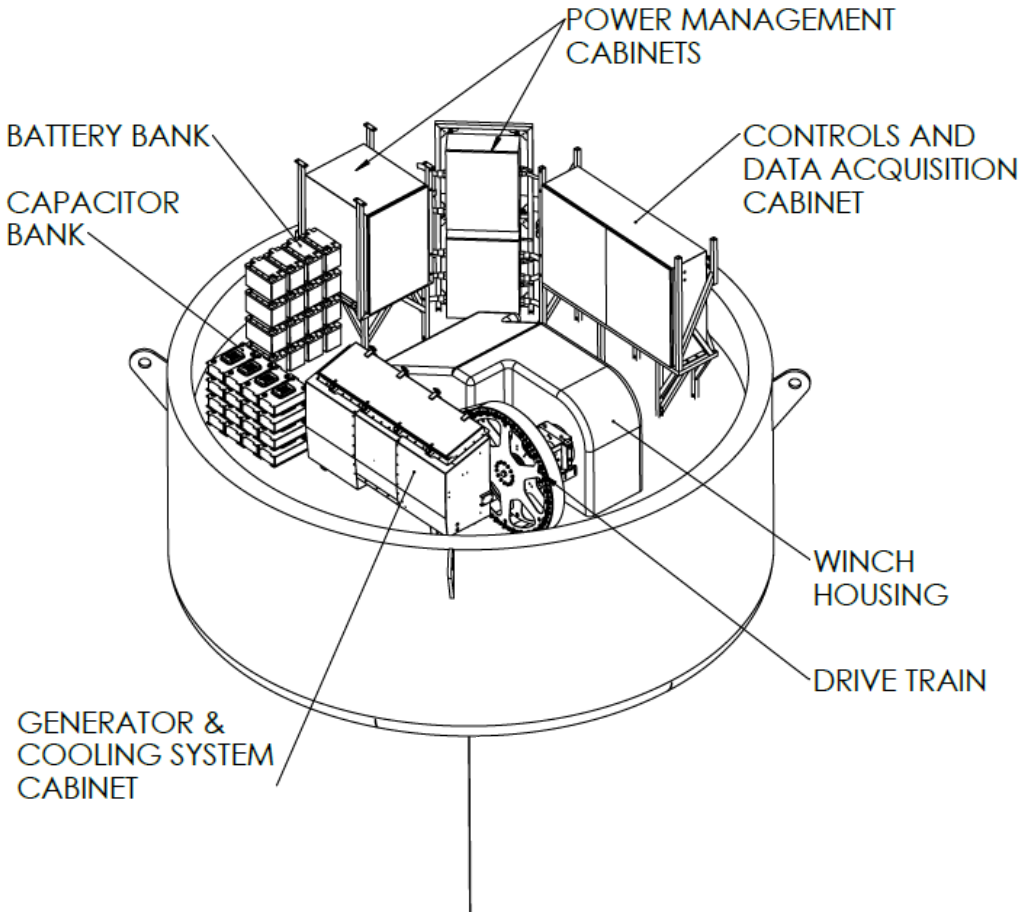


# POWER PRODUCT FOR SUBSEA SYSTEMS

## PRODUCT DEVELOPMENT PLAN

### EXISTING DESIGN FOR RE-USE

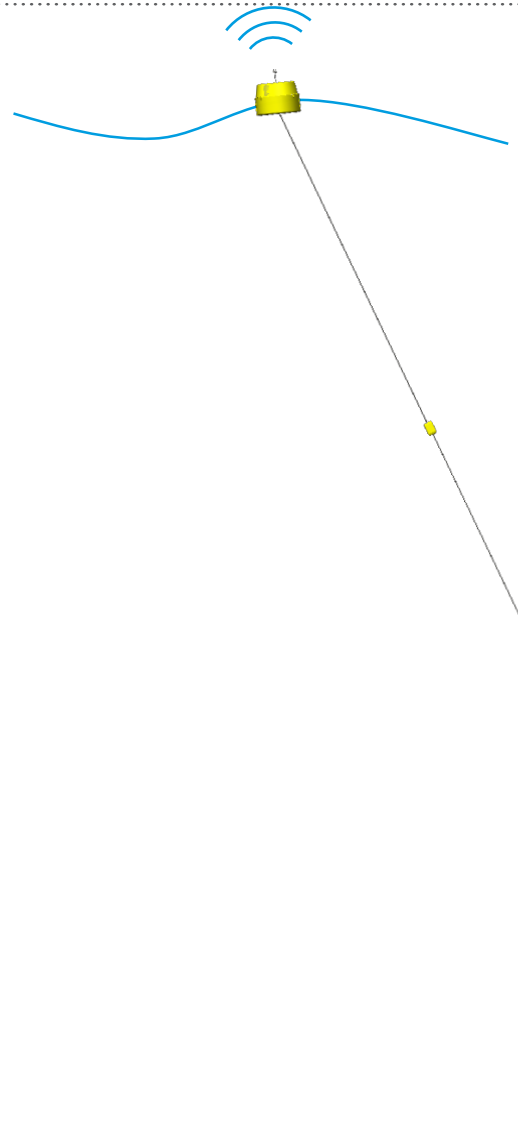
- WINCH SYSTEM
  - POWER PRODUCTION
  - STATION KEEPING
- DRIVE TRAIN
  - GEAR BOX
  - GENERATOR & FREQUENCY CONVERTER
- SOFTWARE
  - AUTONOMOUS OPERATION
  - GENERATOR CONTROL
  - LIVE MONITORING
  - DATA ACQUISITION
- POWER MANAGEMENT
  - EXPORT POWER CONVERTION @ 24 – 700V DC
  - SUBSURFACE POWER EXPORT THROUG WINCH LINE (DRUM TO 15M BELOW SURFACE)
  - BATTERY STORAGE
- COMMUNICATION SURFACE TO SHORE
  - 4G
  - PEER-TO-PEER RADIO LINK



# POWER PRODUCT FOR SUBSEA SYSTEMS

## PRODUCT DEVELOPMENT PLAN

- NEW FEATURES REQUIRED FOR
  - NEW EXTERNAL STRUCTURE
    - SMALLER, COMPACT HULL
    - TOP COVER
  - DEEP WATER MOORING
    - OPERATION AT 500M WATER DEPTH
    - POWER TRANSFER FROM SUB-SURFACE TO SEABED INTEGRATED IN WINCH LINE
    - COMMUNICATION BETWEEN SEABED AND SURFACE INTEGRATED IN WINCH LINE

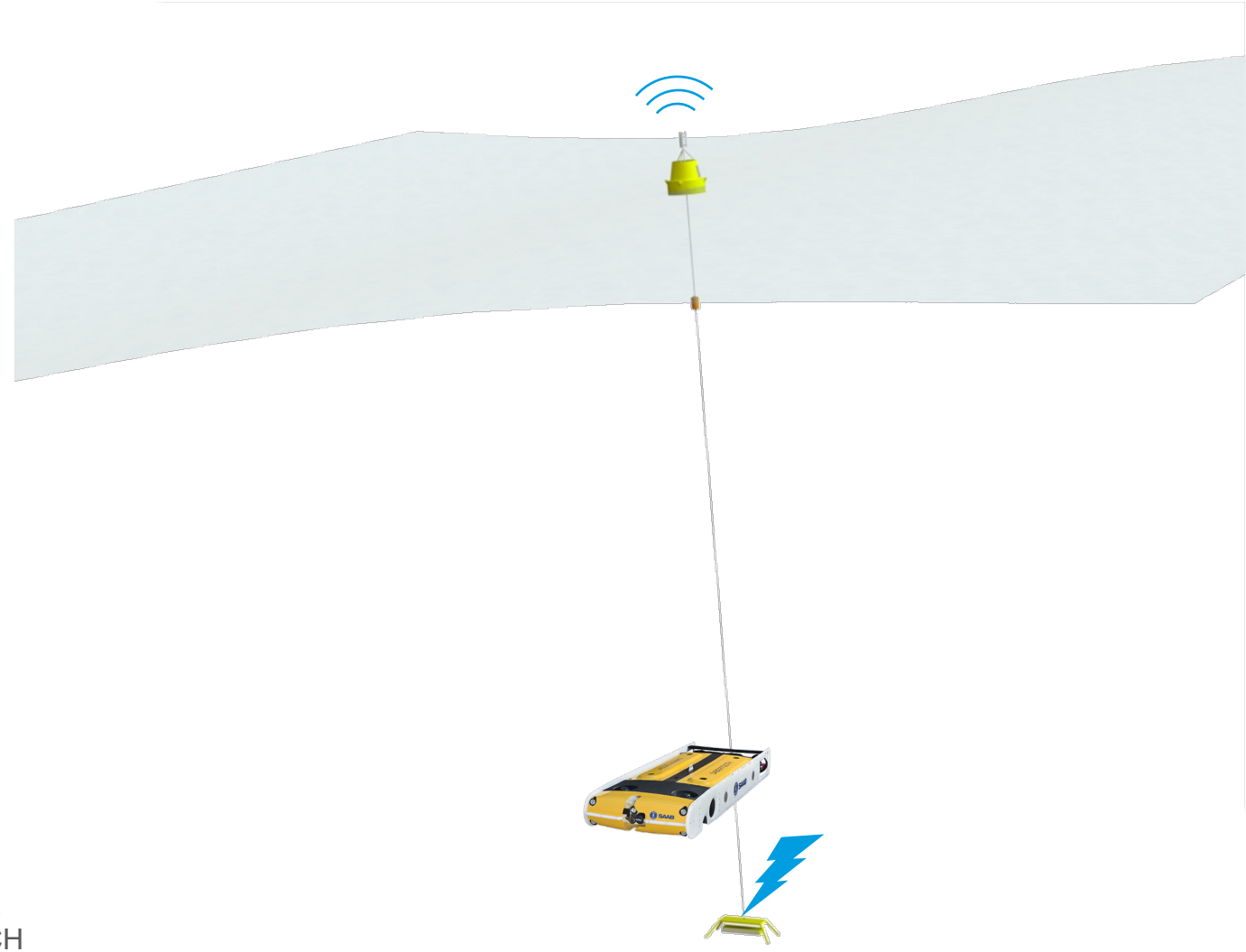


# APPLICATIONS

## POWER, MONITORING, INSTALLATION

### STAND-ALONE POWER AND COMMUNICATON:

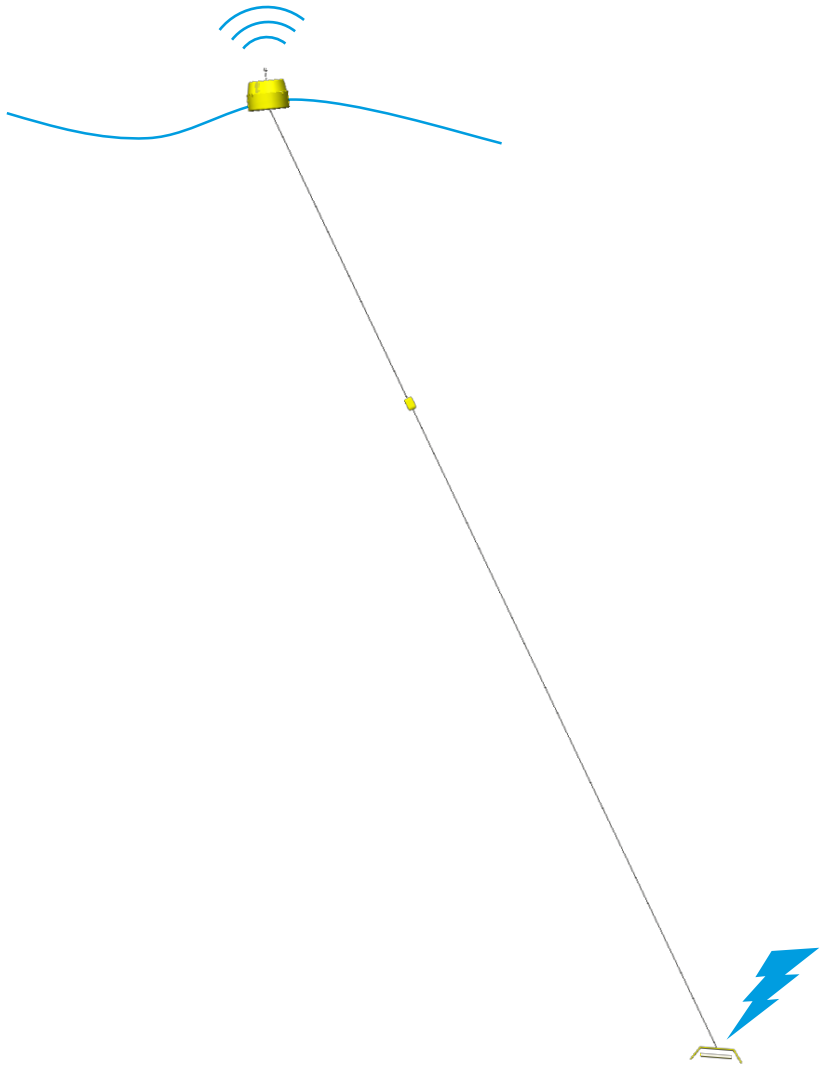
- POWER APPLICATIONS
  - UID DOCKING STATIONS
  - AUTONOMOUS SURFACE VESSEL RECHARGE
  - OFFSHORE FISH FARM
- MONITORING / SENSOR APPLICATIONS
  - WELL HEAD FATIGUE
  - LEAK DETECTION
  - WATER ENVIRONMENTAL MEASUREMENT (TEMP, POLLUTION,…)
  - METOCEAN DATA (WIND AND CURRENT PROFILER, TEMP, HUMIDITY, POLLUTION, WAVE DATA)
  - WATER CURRENT PROFILERS
  - FISH AND MARINE MAMMALS
- INSTALLATION
  - SUPPORT INSTALLATION AND RECOVERY OF SUBSEA EQUIPMENT USING FLOATING STRUCTURE AND WINCH



# SUBSEA OIL & GAS PRODUCT

## PRODUCT DEVELOPMENT PLAN

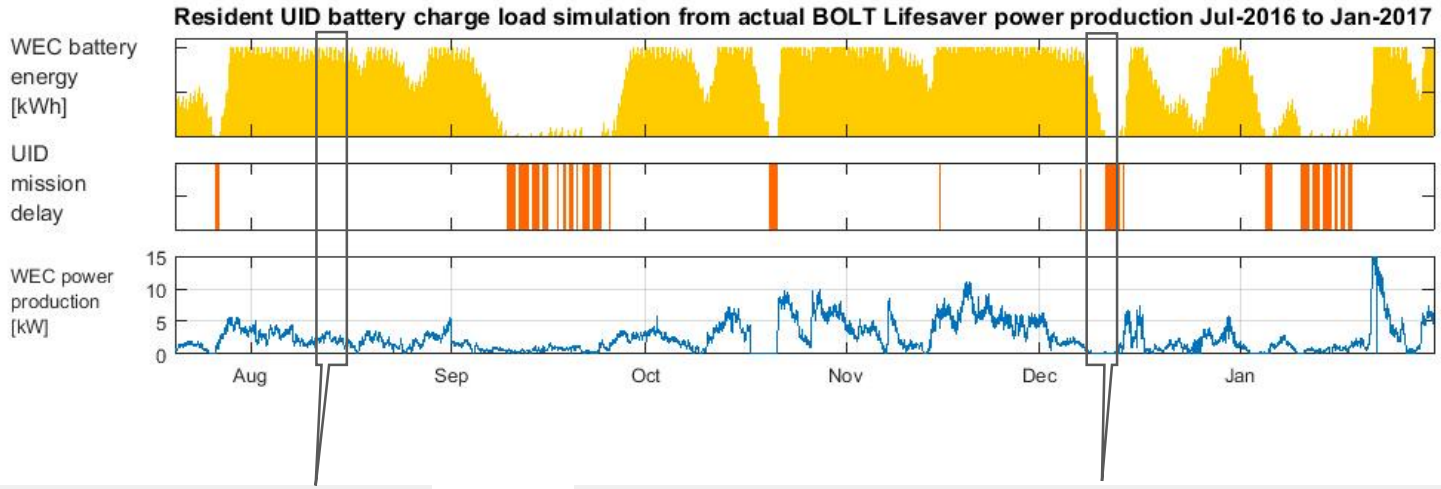
- PILOT DEMONSTRATION PROJECT
  - FRED. OLSEN PROPOSES PILOT PROJECT TO DEVELOP PROTOTYPE AND DEMONSTRATE POWER AND COMMUNICATION TO UID DOCK OR SUBSEA SENSOR IN THE FIELD
  - IDENTIFY SUBSEA INDUSTRIAL PARTNER WITH SUBSEA SYSTEM FOR DEMONSTRATION OF JOINT SOLUTION
- PILOT PROJECT TIME LINE:
  - DEPENDS ON RESOURCING / FINANCING
  - ENGINEERING: 6 - 12 MONTHS
  - MANUFACTURING: 3 - 6 MONTHS
  - VERIFICATION: 3 - 6 MONTHS
  - FIELD DEMONSTATION: 3 - 6 MONTHS
  - TWO YEAR FROM START OF PLANNING TO PROTOTYPE DEMONSTRATION COMPLETED VIABLE PROJECT PLAN

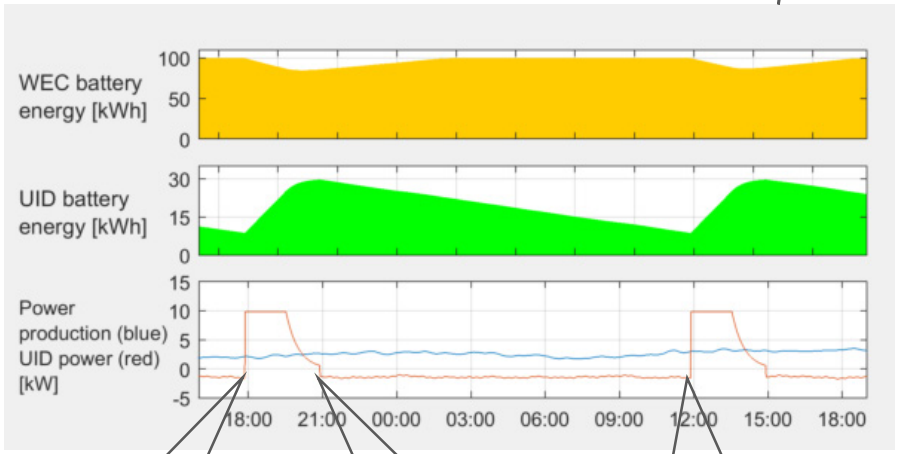


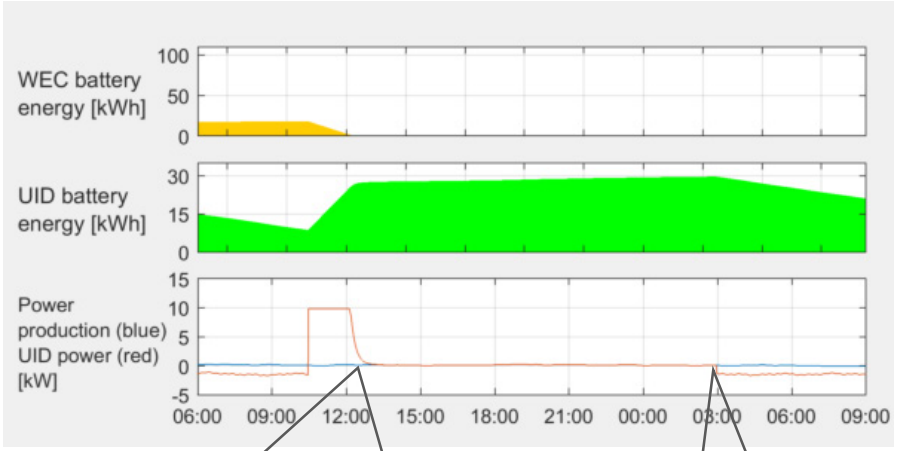
# SUBSEA OIL & GAS PRODUCT

**APPLICATION:** UID / AUV DOCKING STATION CHARGE SIMULATION

| | |
|---|---|
| WEC ONBORD BATTERY | 100KWH |
| UID BATTERY | 30KWH |
| MAX CHARGE RATE | 10KW |
| UID MISSION DURATION | 12 HRS |
| TOTAL DEPLOYMENT DURATION | 4674 HRS |
| TOAL UID MISSION DELAY | 484 HRS (10%) |




CHARGE START

UID BATTERY FULL

UID BATTERY 30% - RETURN FOR CHARGE

WEC BATTERY EMPTY BEFORE UID BATTERY FULL - MISSION DELAYED DUE TO EXTENDED UID CHARGE TIME

UID BATTERY FULL

BOLT Sea Power

www.boltseapower.com

# Fred. Olsen Ltd.