Tidal Energy

B. Tide Physics

   1. Lunar Tide

EARTH IS NOT A POINT, GRAVITATIONAL
FORCE VARIES WITH LOCATION

NET FORCE WILL BE DIFFERENCE BETWEEN
ACCELERATION & GRAVITY

        └ NO LONGER IN BALANCE

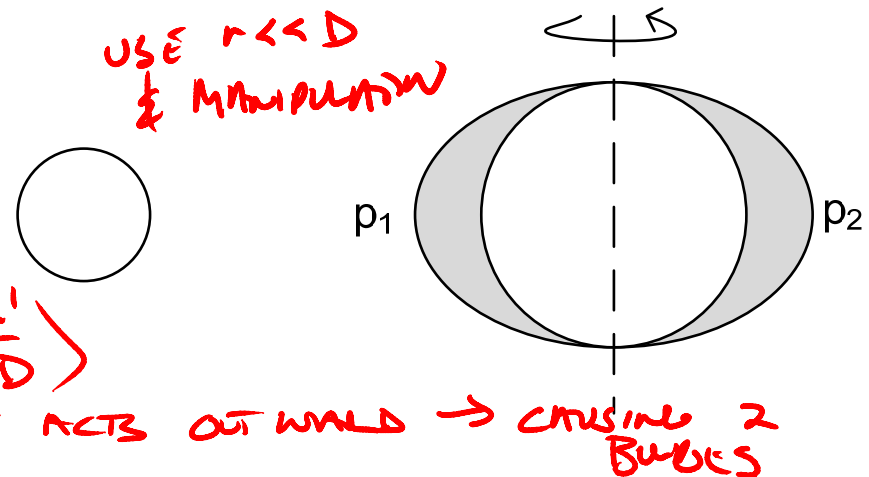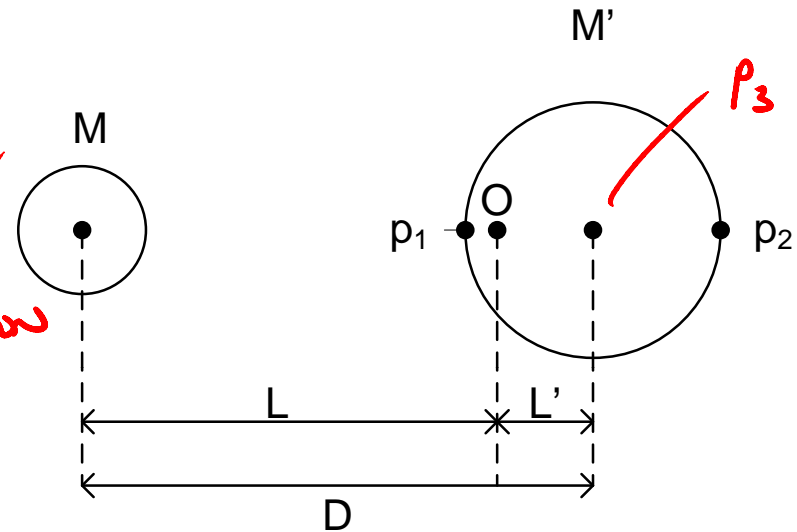CONSIDER FORCE ON MASS OF WATER m

$P_1: \quad F_{P_1} = \dfrac{GMm}{(D-r)^2} + m(r-L')\omega^2$

$P_2: \quad F_{P_2} = m(r+L')\omega^2 - \dfrac{GMm}{(D+r)^2}$

$P_3: \quad F_{P_3} = \phi \quad \dfrac{GMm}{D^2} = mL'\omega^2$

$F_{P,1} = F_{P,2} = Mr\omega^2\left(1 + 2\dfrac{L'}{D}\right)$

USE $r \ll D$
& MANIPULATION

NET FORCE ACTS OUTWARD → CAUSING 2
                             BULGES

M'

P_3

M

p_1 O p_2
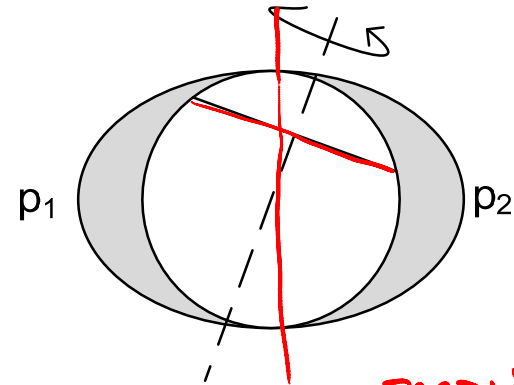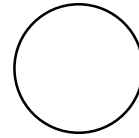
L   L'

D

p_1 p_2

Tidal Energy

B. Tide Physics

1. Lunar Tide

SIMPLE THEORY EXPLAINS BASICS OF WHAT IS OBSERVED, BUT THERE ARE DEVIATIONS:

1. BULGES CANNOT MOVE AT 1600 $\frac{km}{hr}$ REQUIRED BY EARTH'S ROTATION

   → TRAVEL AT 500 $\frac{km}{hr}$

   → LAGS THE MOON'S POSITION

   → EACH OCEAN BASIN DEVELOPS ITS OWN TIDES

2. MOON IS NOT ON THE EQUATORIAL PLANE

   → DO NOT GET 2 EQUAL TIDES

   → TIDE HEIGHTS WILL VARY

3. MOON MOVES AS EARTH ROTATES
   → CHANGE OF TIME BETWEEN TIDES
   > 12hr

Tidal Energy

B. Tide Physics

   2. Solar Tide

SUN ALSO PRODUCES TIDES

→ EXACTLY AT 12 hr INTERVALS

→ SUN DOESN'T "MOVE"

SOLAR TIDE RANGE IS 2.2 × LESS THAN
LUNAR TIDE

• SUN IS MORE MASSIVE, BUT MUCH
FURTHER AWAY

SOLAR TIDE MOVES INTO & OUT OF PHASE
WITH LUNAR TIDE

TIDE HEIGHT IS EXPLAINED BY S-E-M. POSITION

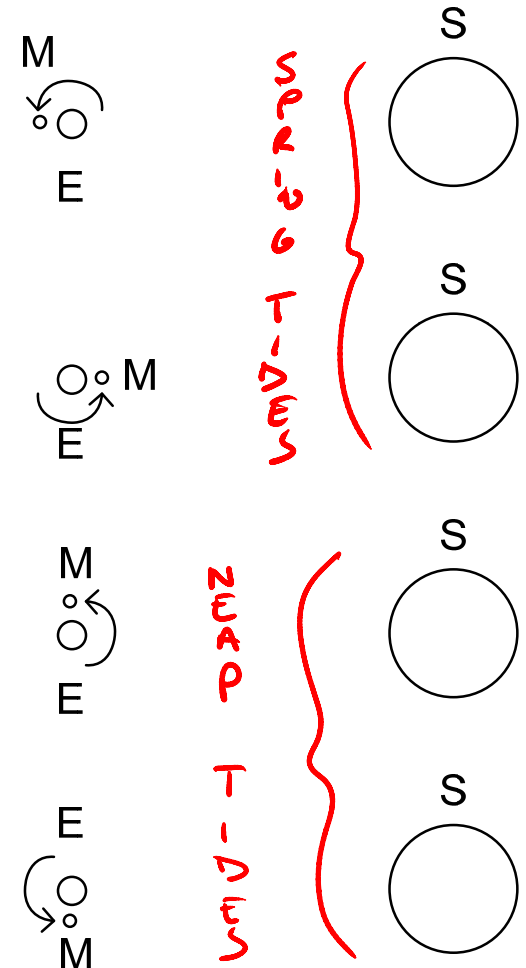RATIO OF SPRING TIDE RANGE TO
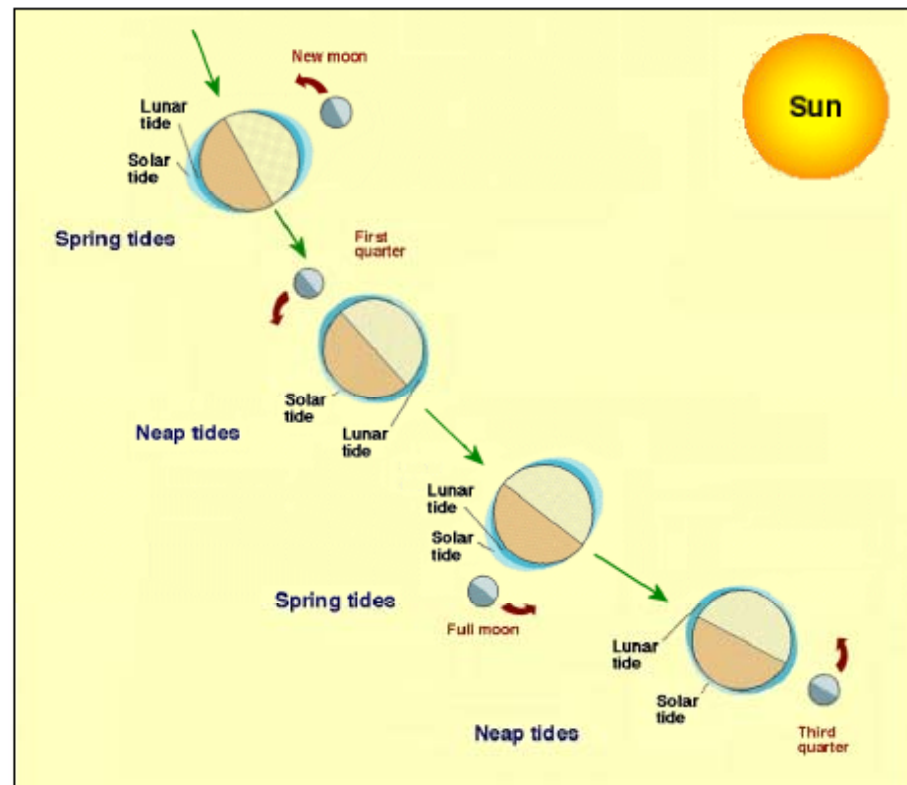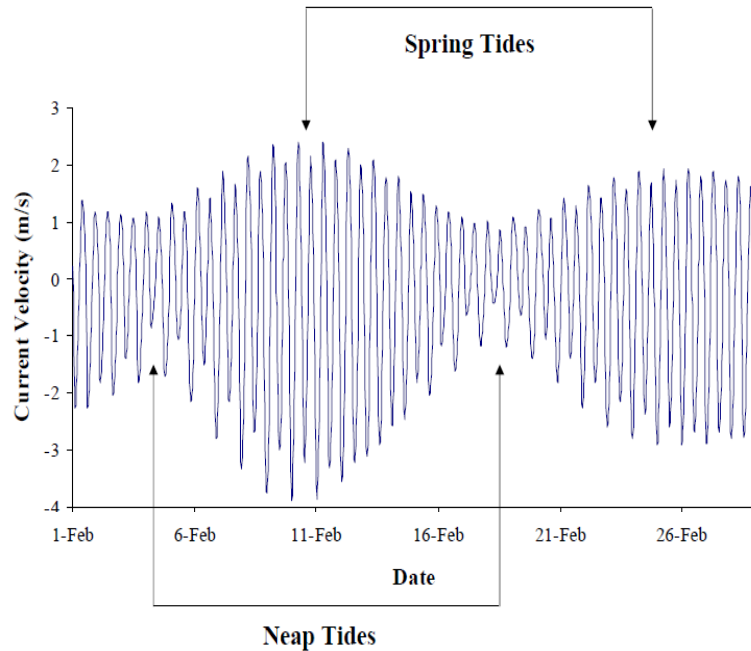NEAP TIDE RANGE ~ 2

Moon
Cycle

Full

New

Waxing

Waning

M
E

S

S

SPRING TIDES

M
E

NEAP TIDES

S

S

E
M

Tidal Energy

B. Tide Physics

3. Combined Solar/Lunar Tides

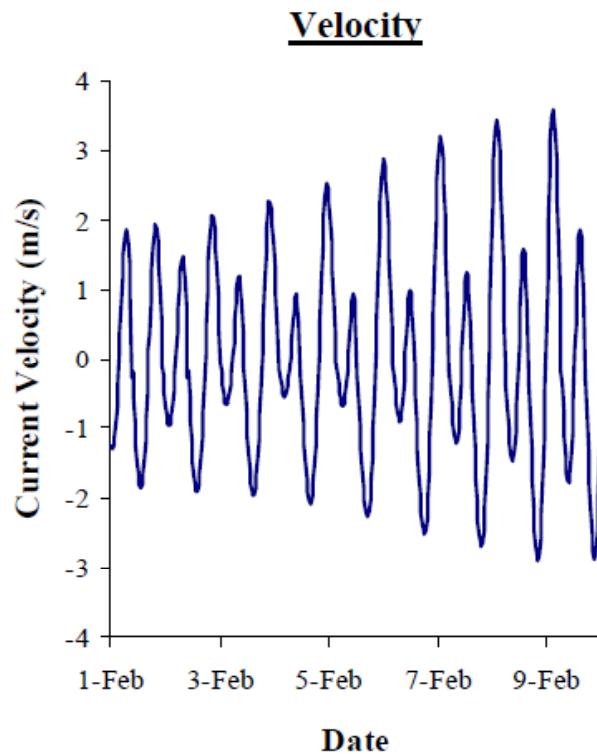# Tidal Energy

B. Tide Physics

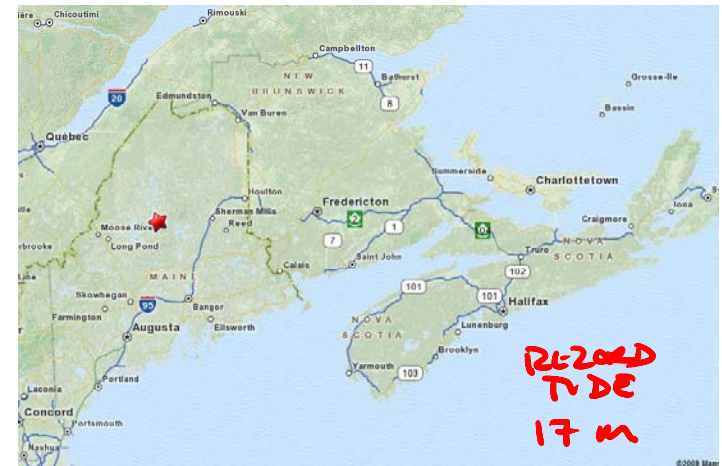   3. Combined Solar/Lunar Tides

Source: EPRI
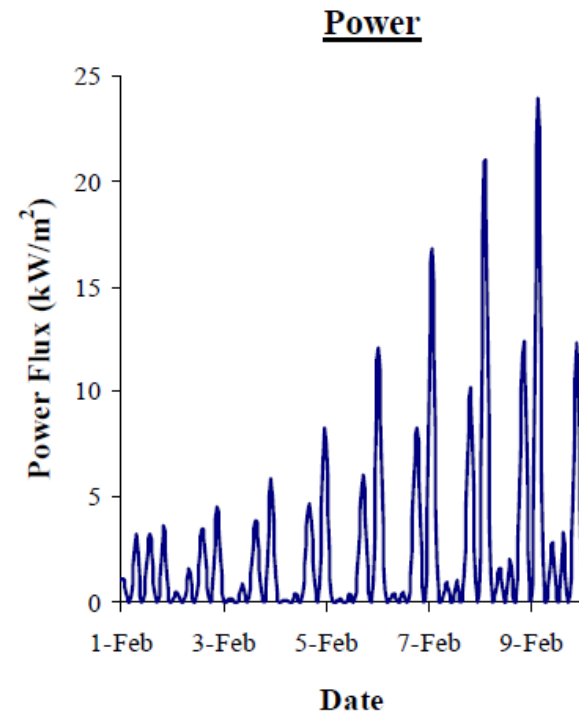
Tidal Energy

B. Tide Physics

    4. Basin Focusing Effects

(handwritten, red): BAY OF FUNDY

(handwritten, red): COOK INLET TURNAGAIN ARM

(handwritten, red): RECORD TIDE 17 m
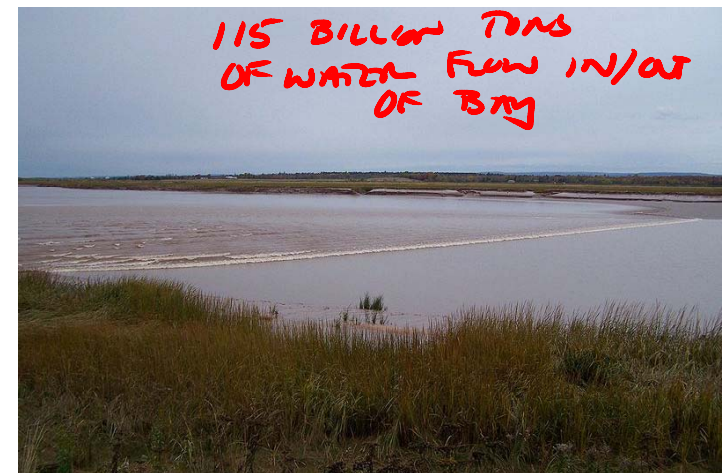
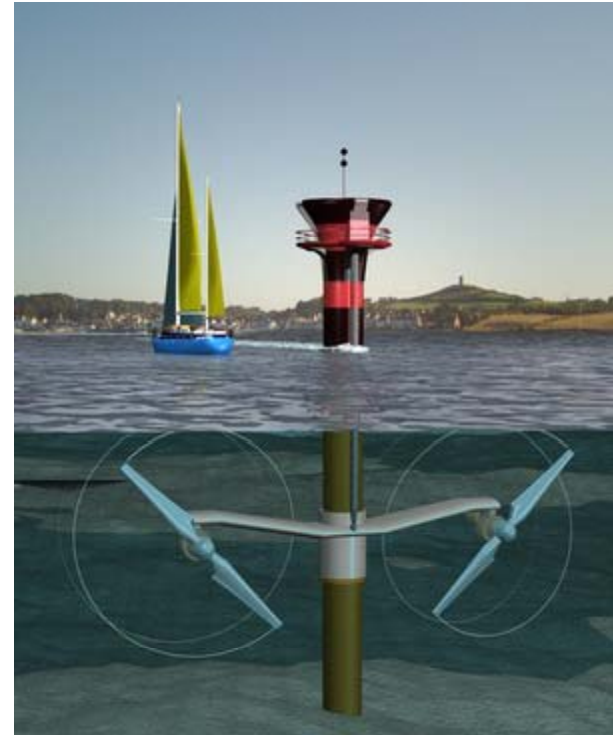
(handwritten, red): 115 BILLION TONS OF WATER FLOW IN/OUT OF BAY

Tidal Energy

C. Power Conversion

   2. Unducted Rotors

Tidal Energy

C. Power Conversion

   2. Ducted Rotors

The removable cassette

The generator module

The turbine

The gravity base

The duct

1MW RTT UNIT
Duct Diameter
15 metres
Duct Length
19.2 metres
Turbine Diameter
11.5 Metres
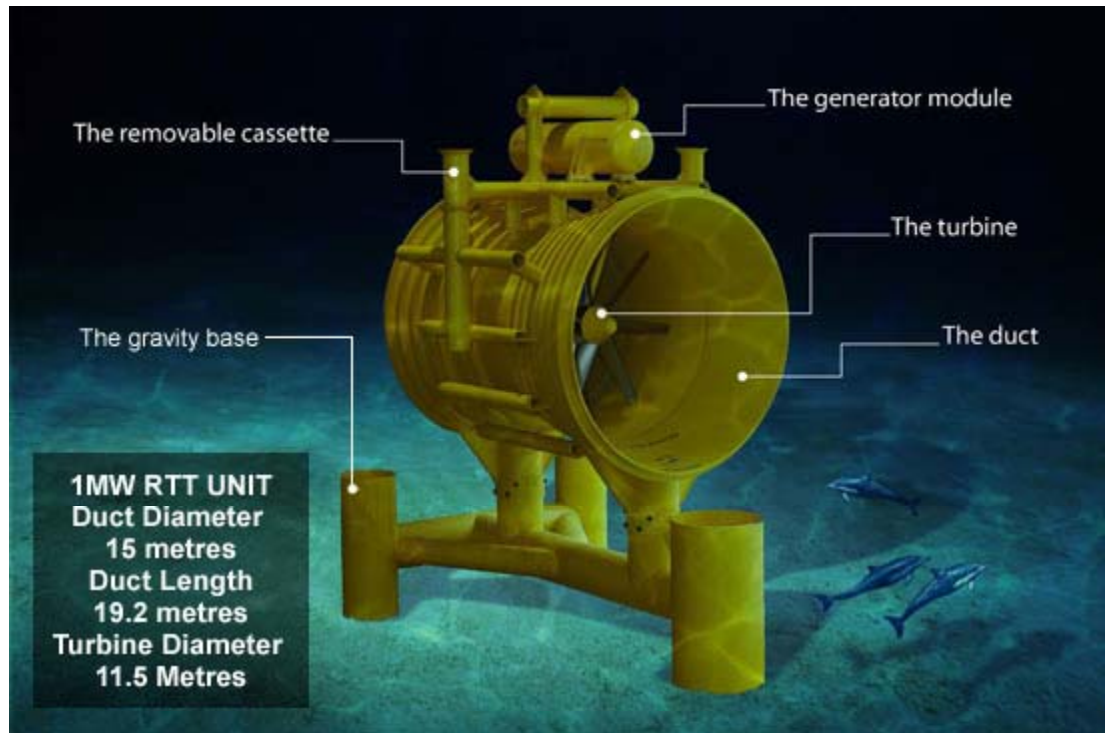
Tidal Energy

C. Power Conversion

   3. Vertical Axis Turbines

Tidal Energy

C. Power Conversion

    4. Other