A world view - Offshore Renewable Energy: Cable Interactions, and Hawaii

Neil Rondorf, SAIC Maritime Renewables Program Manager

Asia Pacific Clean Energy Summit, August 2012

NATIONAL SECURITY • ENERGY & ENVIRONMENT • HEALTH • CYBERSECURITY

SAIC®

Agenda

- Marine Renewable Energies
- Worldwide Projects
- Hawaii
- Cable Interactions – Power vs. Telecommunications
- Gap Analysis
- Summary

SAIC®

Offshore Renewable Energy

- Offshore renewables are a growing resource
- Emergence of wind, wave, and tide energy
- Resources will utilize submarine power cables and likely interact with international cable routes
- Installation of “super grids” to interconnect renewable resources and countries

Technology Overview

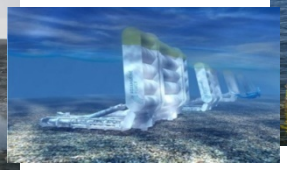
Tidal

Verdant Power

Ocean Renewable Power Company

Wave/Ocean Current

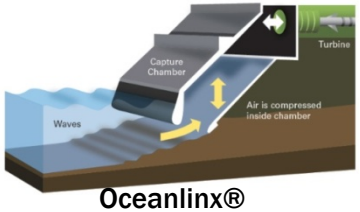
Pelamis



Oyster®

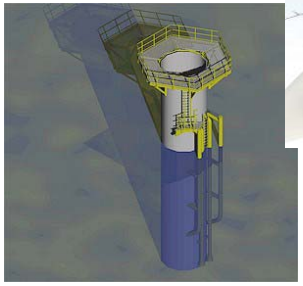
Wavebob®

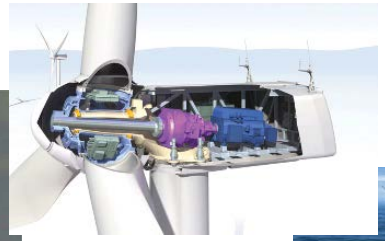
Poseidon wind/wave hybrid



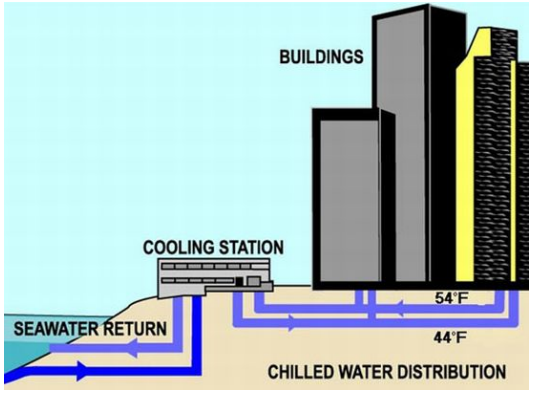
Oceanlinx®

Offshore Wind



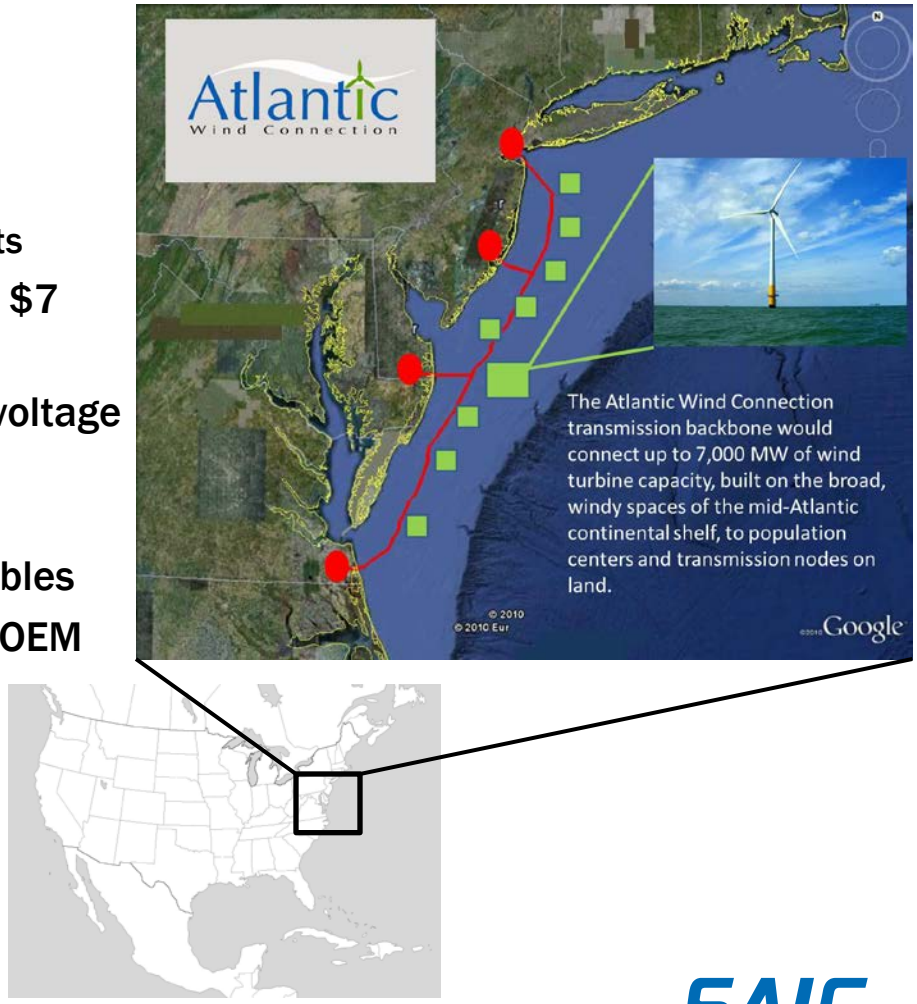


Seawater Air Conditioning (SWAC)



Atlantic Wind Connection

- 7000 MW HVDC line connecting New Jersey, Delaware, and Virginia
  - Enough to power 1.9 million homes
  - Scalable to increase capacity for future projects
- Multi-phase approach costing approximately $7 billion
- Aiming to reduce need for numerous, lower-voltage cables and reduce transmission network congestion
- Large potential for interactions with other cables
- Right-of-Way (ROW) application noticed by BOEM now preparing permit applications



HVDC = high voltage, direct current
BOEM = Bureau of Ocean Energy Management
Google is a registered trademark of Google Inc. in the U.S. and/or other countries.

SAIC®

South America

- Federal University of Rio de Janeiro is focused on a hyperbaric wave energy device to be installed on Brazilian northeast coast
- Potential for 15 percent of Brazil's energy requirements coming from wave energy by 2030
- Brazil is second to China in clean energy investments, with a cumulative investment potential in Brazil from 2010 to 2020 of $67 billion
- Brazil also wants to add offshore wind
  - Build 500 MW at a time for 11 GW total
  - 5 km offshore and 5-25 m deep
  - Already have permits

Europe

- Europe is a leader for installation of wave and tidal test sites
  - Lukksundet Tidal Sails AS (Norway)
    - Small-scale demonstration project with a capacity of 28 kW
    - Provides an excellent basis for scaling up systems to the range of several MW
  - Wave Hub (UK)
    - The 12-ton hub is linked to the UK's grid network via a 25km, 1,300-ton subsea cable operating at 11kV
    - Four separate berths available for lease, each with a capacity of 4-5 MW
  - EMEC (Scotland)
    - Billia Croo Test Site
      - Five cabled test berths with depths up to 70 m
    - EDAY/Tidal Test Site (Scotland)
      - 5, 11 kV subsea cables extend to the center of the tidal stream
      - Developers are responsible their own devices, connecting to the cables and removal after testing is complete
  - Belmullet Wave Test Site (Ireland)
    - Proposed distance from shore ranging from 6 km to 15 km, utilizing 10 kV subsea cables
    - The location of the cables will be published by Marine Notices and recorded on navigation charts
- November 2011, Principle Power launched a 2 MW WindFloat® turbine off the coast of Portugal

WindFloat is a registered trademark of Principle Power, Inc. in the U.S. and/or other countries.

SAIC®

Africa

- United Nations Energy Program (UNEP) pushing for renewable energy
  - Wants sustainable energy for all Africans by 2030
  - Excess power from solar developments could be sent to the EU to provide up to 15 percent of the their power needs
- DESERTEC® (DESERTEC Foundation)
  - Connection of renewable resources from African desserts to demands in Europe
  - Interconnection of grids
  - Greater concept includes:
    - Production of drinking water
    - Socio-economic development
    - Security

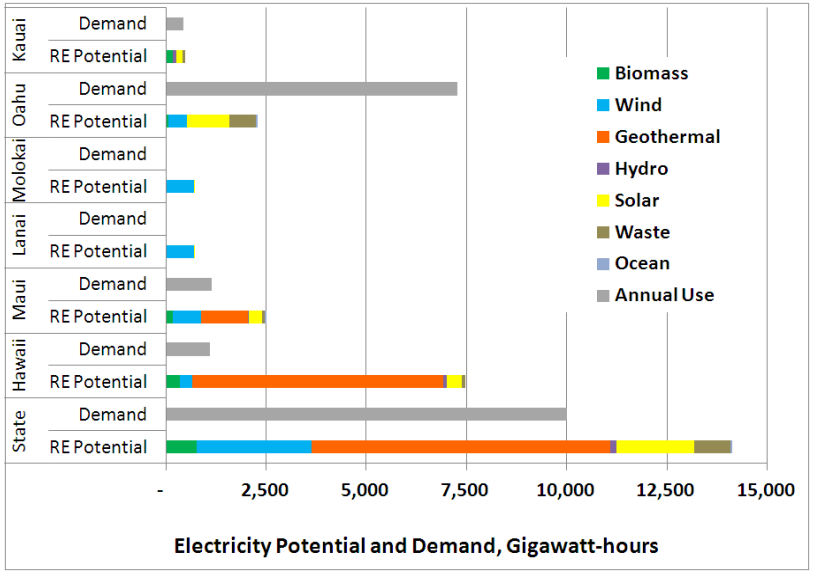
Asia

- South Korea is forecasted to use 13 percent renewable sources for their energy needs by 2030
- Taean Phase I in South Korea
  - 97 MW wind farm to be developed by Teaen Offshore Wind Co, Ltd
  - Utilizing 27, 3.6 MW turbines
  - Enough to power 54,350 homes
- Taean Phase II is planned for 200 MW, with an estimated 500 GWh per year
- Fukishima Floating Wind Farm in Japan
  - Phase I will consist of a floating 2 MW turbine, the world's first floating substation, and a subsea cable
  - Phase II will add two 7 MW floating turbines
- Taiwan initiative to install 600MW of offshore wind capacity by 2020 and 3GW by 2030
- China plans to have 10MW offshore wind turbines by 2015

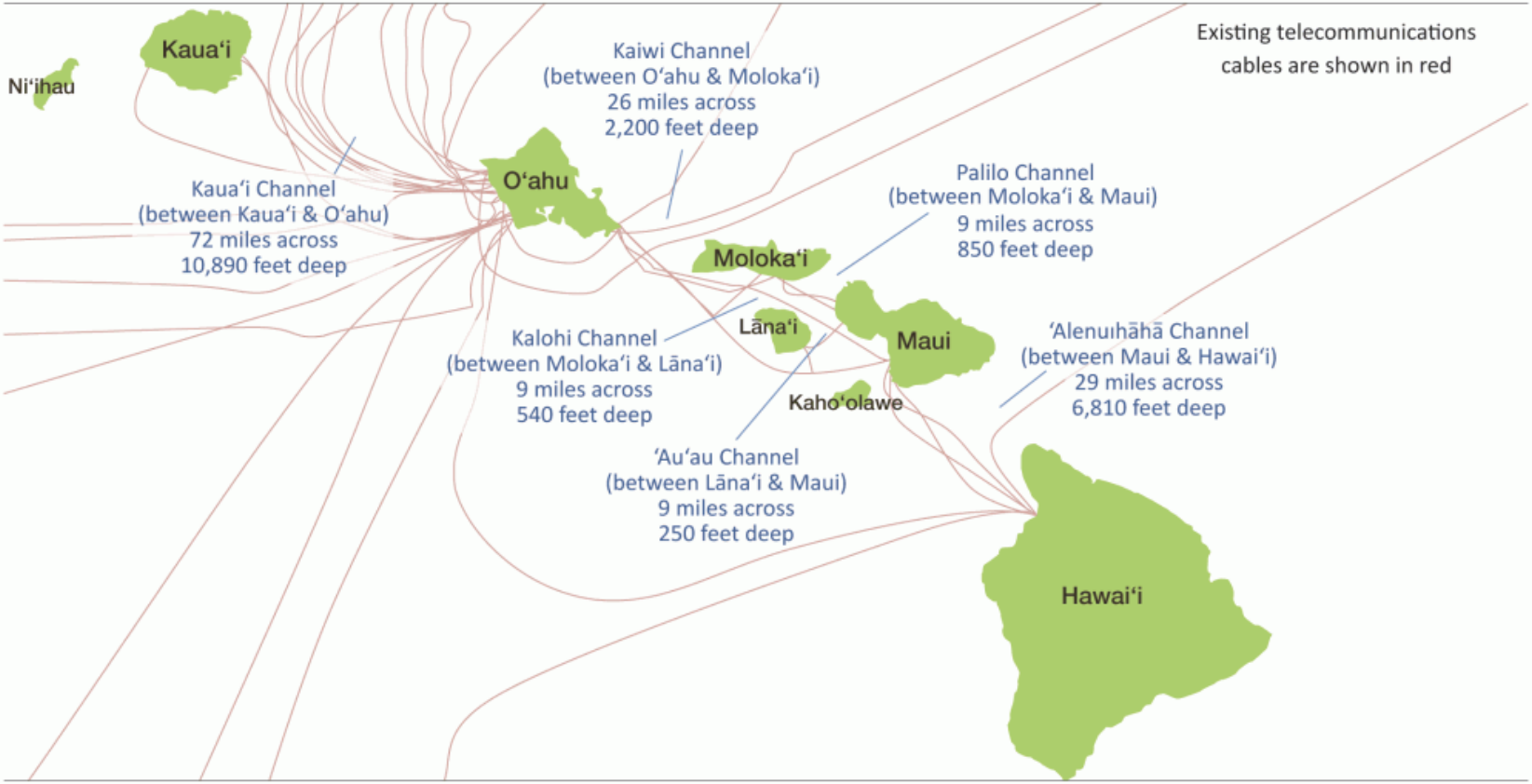
SAIC®

Hawaii's Proposed Inter-Island Undersea Cable System

- Goal of 70 percent energy independence by 2030
- Energy prices in Hawaii are roughly three times higher than U.S. average
- Installation of inter-island cables would facilitate the transport of various renewable energies (see graph)
- Would lessen Hawaii's dependence on petroleum-based fuels (77 percent compared to 1 percent for mainland U.S.)
- Legislation is already in place to establish a regulatory structure for the installation and implementation of the system



Existing Inter-Island Cables



Source: Bureau of Ocean & Energy Management & National Oceanic & Atmospheric Administration

Note: Current deepest submarine power cable is SAPEI in the Mediterranean at a maximum depth of 5,380 ft.

Submarine Cable Interactions, Power and Telecommunications

- Historically, submarine power cables linked shore-based power grids a rivers, straits, etc.
- Now, submarine cables carry power between countries and to offshore example, oil/gas platforms and ocean science observatories
- Increased submarine power cables increase potential of interaction wi telecommunications cables

	Telecommunications	Power
Avg Diameter	50 mm (largest, inshore)	150 mm (general)
Weight	0.5-3.2 lb/ft	10-94 lb/ft
Appx Cost	$4-10/ft (LW, SPA, or SA)	$50/ft (1MW)

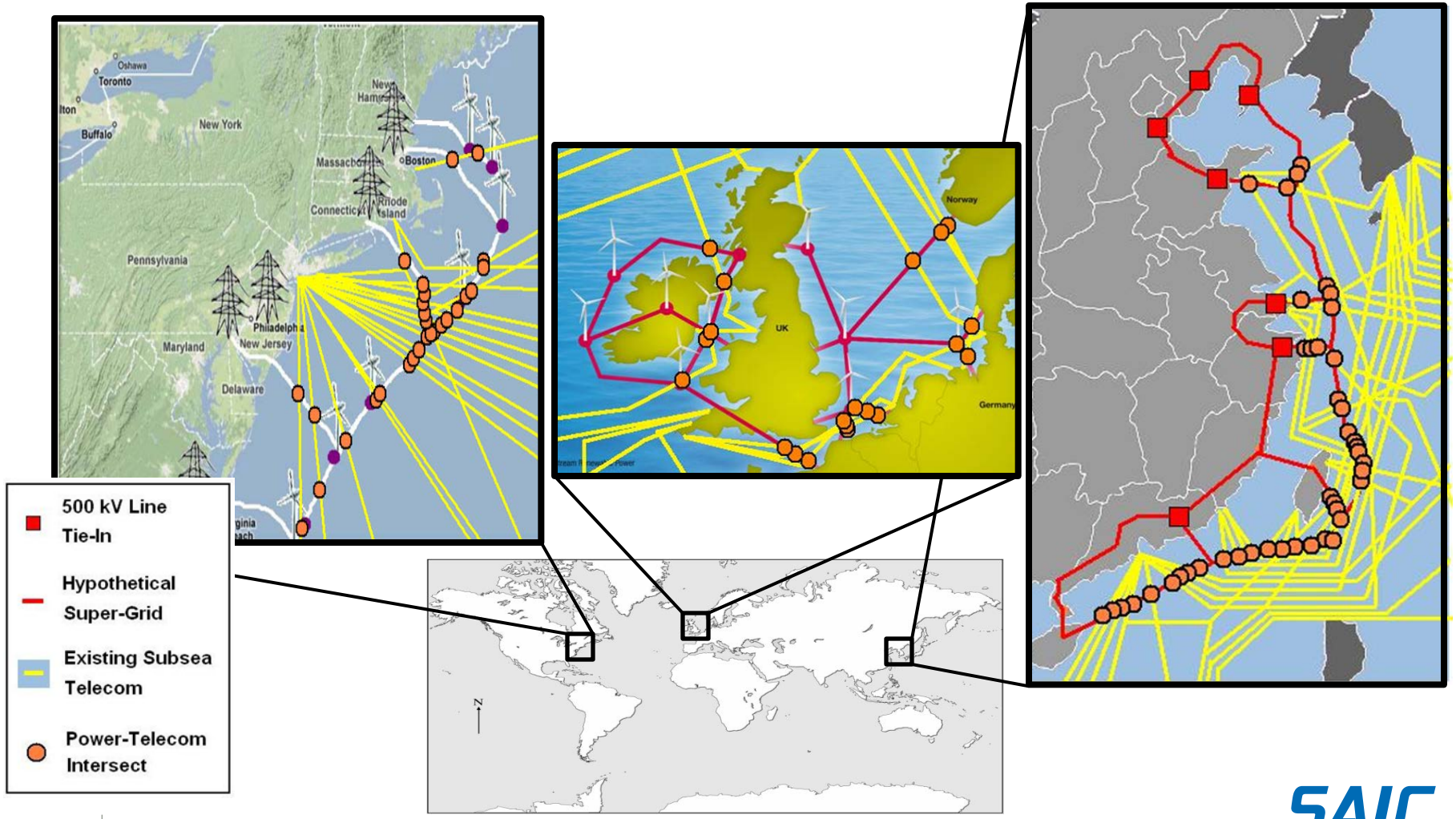
Avg = Average Appx = Approximate LW = lightweight SPA = special protection SA = single armor

Submarine Cable Interactions, Power and Telecommunications

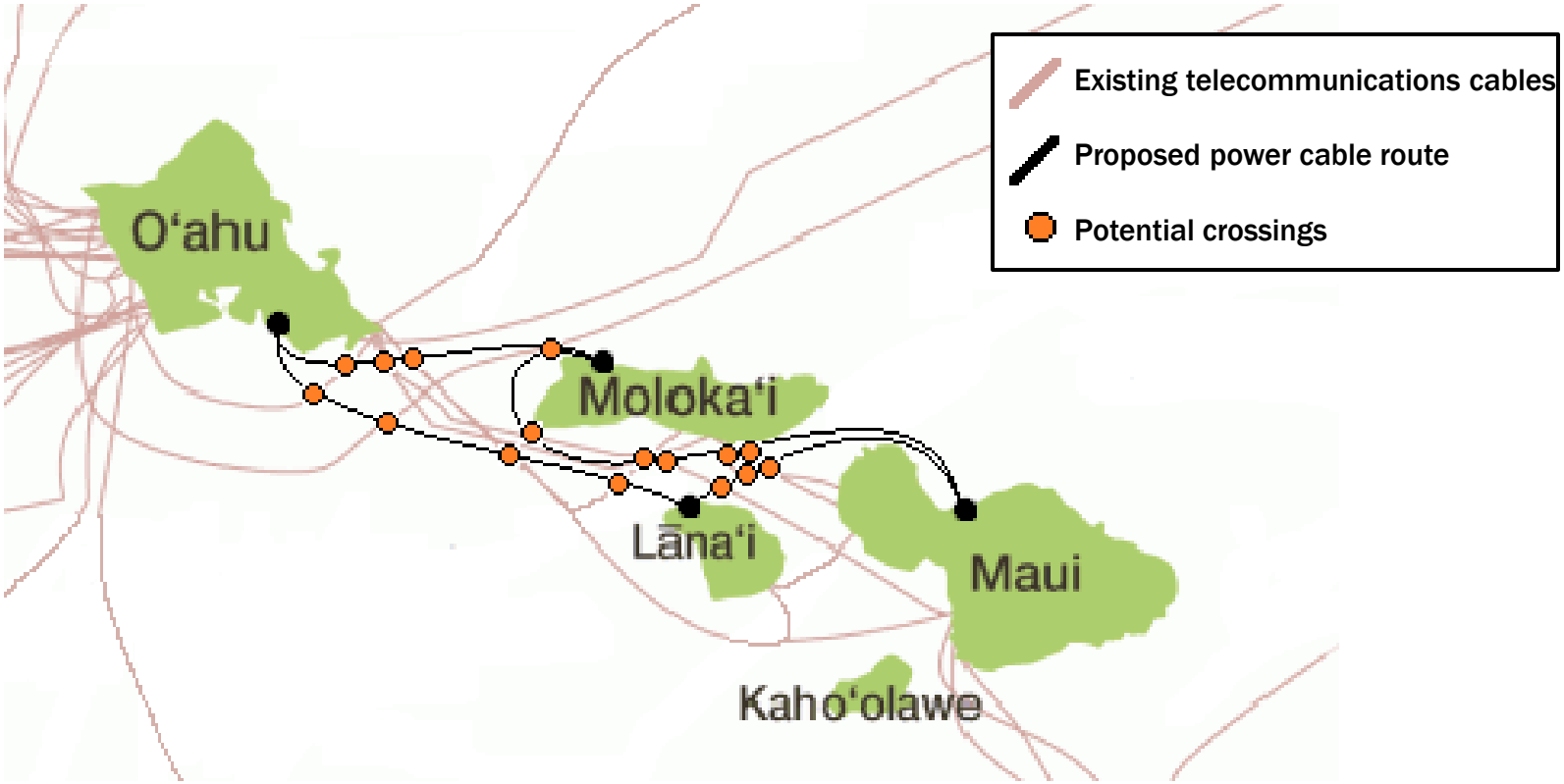
- Existing subsea telecommunications cables connect the world
- Super grids, and all maritime renewable technologies, will use the same seabed space
- Potential problems arise with shared space and resources
- Roles and responsibilities for these issues should be further clarified
- Cable interactions will be international and across multitudes of owners

Graphic from: http://www.telegeography.com/product-info/map_cable/index.php

Submarine Cable Interactions, Power and Telecommunications



Submarine Cable Interactions, Hawaii



Graphic based on February 2011 National Renewable Energy Laboratory (NREL) Oahu Wind Integration and Transmission Study (OWIT)

Discussion of Super Grids

- EU single energy market not feasible by 2014 due to a lack of cross-border infrastructure
- Scotland and Ireland are looking to link their power grids with a network of subsea cables
  - Feasibility study shows that as much as 2.8 GW could be transported between the two countries, with a second link increasing capacity to 3.4 GW
  - Estimated cost is £4.6 billion, including a web of onshore and offshore power stations
- Environmental planning statement has been published for a submarine cable project between Malta and Sicily
  - Link to Sicily will use a 3-core 245 kV AC cable buried 1.5 m below the seabed
  - 125 km in length with a 2x225 MW capacity

Hawaii super grid avoids international and interstate issues

Information from Sub Cable News: pgs. 15,17, 29

SAIC®

Gap Analysis

- Little dialogue between power developers and telecommunications (telecom) owners in many instances
  - Cable vendor versus cable installer planning
  - CPCs often brought in late and assist to correct issue rather than assist preventing
  - Owners need to consider both ends of cable – crossing telecom takes this from local to regional, instantaneously.
- Publication of international power/telecommunications cable-crossing agreements
  - Renewable energy installations could cross boarders and be connected to import energy to other countries
  - Guidelines available through ICPC and regional CPCs
- Submarine power cable database
  - Lack of information – limited organized publication
  - Limited power cable fault database
  - Protection of critical energy infrastructure information
- Hawaii can learn from international projects and organizations
  - Additional challenges are present

ICPC = International Cable Protection Committee CPCs = Cable Protection Committees

SAIC®

Summary

- Marine renewable energies are becoming more feasible and widespread
- Projects worldwide are exploring the potential of wind, wave, and tide energies and how to harness them
- As they do, submarine power cables become more numerous and important
- Attention needs to be paid to telecommunications and power cable interactions
- Hawaii can watch and learn from international efforts
- This is a worldwide effort to move renewable energy forward
  - Submarine power cables are technology enabler
  - The multi-user environment of the ocean requires careful planning and engagement

SAIC®

Points of Interest

- New power cable projects are reaching new bounds
  - Longest: 580 km NorNed, connecting Norway and the Netherlands
  - Deepest: SAPEI, linking Fiume Santo to Latina through the Tyrrhenian Sea (1600 m)
  - Highest capacity: 1,400 MW cable linking Honshu and Skikoku, Japan
- Renewable energy projects are increasing worldwide
  - U.S. looking to harness some of the 60 GW Atlantic wind potential
  - UK has potential 25-30 GW in wave and tidal resources
  - India has 15 GW of resources in the Gulf of Kutch and Gulf of Khambhat (Cambay)
  - China has 750 GW of resources for offshore wind
  - Brazil has 125 GW of resources between wave and offshore wind technologies

SAIC®

Thank You

Neil Rondorf, SAIC Maritime Renewables Program Manager
2877 Guardian Lane | Virginia Beach, VA 23452
Tel: 757.390.4935 | Email: neil.e.rondorf@saic.com

Visit us at saic.com