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Exploring Synergies and Prospects for India–US Naval Cooperation in Energy and Environment

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India and the US are strengthening their strategic and military partnership under the 10-year defense framework agreement. This paper proposes that there exists a strong case to extend this cooperation into the realm of energy and environment, and explores the synergies and prospects between the navies of the two countries. The paper argues that navies have a prime role in contributing to energy security and environmental protection, and this function will gain increasing relevance in the forthcoming decades. A comparative assessment of energy use, and the energy and environment roadmaps, of the US navy and the Indian navy are presented to highlight the similar challenges and actions being undertaken to address the common concerns. The paper also proposes specific elements and the scope of naval cooperation in the relevant domains before concluding that such a programme will be mutually beneficial for the two navies.

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Introduction

The growing relationship between India and the US is turning many heads. This strategic relationship goes beyond the realms of trade and commerce and is maturing into defence purchases along with a long-term alignment on addressing concerns about global climate change.[1] India, which follows the principles of non-alignment, was in the past supported by the erstwhile USSR with the US maintaining a cautious distance. However, consequent to the breakup of the USSR, the American dream of being the sole superpower was fulfilled, albeit notionally for a short duration.

The rise of China, emergence of an integrated Europe, resurgence of Japan, defiance of Russia and acknowledgement of the growth potential of other emerging economies has resulted in a multipolar world. India with its democratic background, demographic dividend and untapped markets has a strong foundation and is on a growth trajectory which is likely to extend for a couple of decades. This makes India a rising power and a potential strategic partner for the US, and both countries are exploring various avenues for enhancing their collaboration. Defense cooperation has emerged as a major area which can deliver rich dividends for both countries.

In 2005, the first US–India defence framework agreement was signed with the goal of "setting the US and India on a path to increasingly broad, complex and strategic cooperation."[2] A new initiative was launched in 2012 under then-Deputy Secretary of Defense Ashton Carter to further bilateral defense cooperation and trade through increasing the engagement of senior leadership from both sides.[3] This initiative has subsequently morphed into the present-day Defence Technology and Trade Initiative (DTTI). The defence relationship was further cemented when the second US–India defense framework agreement was signed on June 3, 2015, which "builds upon the previous framework and successes to guide the bilateral defense and strategic partnership for the next ten years."[4]

In the light of the blossoming defence partnership and growing confidence between the two countries, this paper proposes that the time is now ripe to develop India–US naval cooperation in energy and environment. The next section builds upon the need for India–US naval cooperation and the continued relevance of energy security and action for protection of the environment. A comparative assessment of energy use and the energy and environment roadmaps of the US Navy and the Indian Navy are presented thereafter. The penultimate section proposes specific elements and the scope of naval cooperation in the energy domain, before concluding that such a programme will be mutually beneficial to the two navies.

The Need for Naval Cooperation on Energy and Environment

There is a strong causality between energy consumption and climate change. Increased extraction of conventional energy sources such as coal and crude oil to feed unrestricted energy consumption has led to many environmental externalities such as local pollution. On a larger scale, both intertemporally and in terms of geographical coverage, anthropogenic emissions have led to global warming resulting in increasing threats from climate change. It is therefore necessary that issues related to energy, environment and climate change are addressed together.

Availability of commercial energy facilitated by energy trade over oceans continues to drive the global economy, and hence "security of energy supply" is vital for national security. In a world with depleting energy resources and increased competition for conventional sources of energy, ensuring security of energy supply will increasingly become more relevant. Hence, navies which protect the lifelines of global energy trade have a key role to play in maintaining the free flow of energy commodities across oceans. The US Navy and the Indian Navy are united in their mission to provide freedom of navigation and access to the global commons, and this commonality of goal provides a strong foundation for naval partnership.

Navies are technologically superior forces and serve as role models for other armed and paramilitary forces in the country. Hence, it is important that they set shining examples of what can be achieved in terms of resource efficiency by undertaking exemplary action in their missions and day-to-day operations. This leadership role has been exhibited by the US Navy, which has been a frontrunner in implementing the energy and environment programme. Similarly, the Indian Navy also adopted "green initiatives" in 2014[5] and leads by example.

While the above aspects provide a commonality of goals and similar motivation for the navies of both countries, there are many advantages which provide a sound basis to adopt an energy and environment programme for both navies.

1. Energy as a strategic resource

   "Energy" is a key enabler of military combat power and needs to be considered a strategic resource. While the cost of energy is not a prime consideration in undertaking and fulfilling a military mission, there are tactical imperatives such as the extended logistics tail and the strategic imperatives of energy independence which impact the success of a mission. Efficient energy use onboard ships increases the reach of platforms and reduces the requirement for refueling while at sea. This translates into direct benefits for the fleet as the platform is available for undertaking missions at sea for a longer time, and it also frees the crew from repetitive fueling activities. A 25% reduction in consumption of energy (which is achievable through technological improvements and adherence to economical engine regimes) leads to an equivalent increase in the range of the platform.

Energy also has an associated cost which cannot be ignored, especially during training and exercises. The US Department of Defense (DoD) is the single largest consumer of energy in the US government and accounted for 93% of its energy use.[6] In fiscal year (FY) 2012, the DoD consumed 827 trillion British thermal units (BTU) of site-delivered energy at a cost of US $ 20.4 billion, which in comparative terms is close to the total annual energy consumption of a country like Nigeria. Apart from the expenditure on fuel, the volatility of the international price of oil leads to problems in allocating annual budgets. The price of a barrel of crude oil has fluctuated between highs of US $147 (June 2008) to lows of US $43 (September 2015) in the past few years.[7] These price movements are uncertain and cannot be accurately forecasted in the medium to long term. This volatility in price upsets naval budgets which are set on a yearly basis, and hampers the long-term planning and deployments of naval assets in times of fiscal restraint.

Lastly, a dedicated programme to provide long-term energy alternatives for strategic platforms has the potential to become a game changer for navies. This has been observed on at least two occasions in history, viz. when the British navy replaced coal with oil on ships during the time period close to the First World War, and later with the advent of nuclear-powered platforms which have the ability to stay on the high seas for extended periods without refueling, thereby giving them a distinct strategic advantage. A third shift from petroleum products to an alternate source of energy for naval platforms may lead to independence from conventional energy sources and could significantly impact naval operations in a resource-depleted world.

2 Lowering the environmental impact

Fossil fuel extraction and consumption have significant negative environmental impacts such as carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions, and account for local pollution in air and water and on land. It is estimated that in FY 2012, the US DoD emitted 70 million metric tons of CO_2[8] which contributed to global warming. Navies can contribute to this effort to mitigate emissions by incorporating appropriate changes in propulsion systems, introducing effective emission control technologies and pioneering a shift to non-polluting energy sources.

While 85% of the oceans are polluted from manmade sources on land, providing a clean marine environment by using platforms which have a minimal environmental footprint at sea is also one of the responsibilities of the navy. Hence, ships need to be designed and operated in a manner so as to have minimum impact on the marine environment. This can be achieved by adopting a policy of no discharge at sea, ensuring the use of environmentally safe chemicals and paints, treatment of garbage before disposal, and enforcing these regulations strictly. Hence, greening the navy's footprint is therefore an emerging priority area, and both navies are responsive to this requirement.

Energy use in the Indian and US Navies

In FY 2008, the US air force with a share of 57% was the largest consumer of energy, followed by the Department of Navy (DoN) (34%), and the US army's share was 9%.[9] The DoN used 30 million barrels of petroleum, and its petroleum consumption profile is shown in Figure 1.[10]

While such a detailed breakdown for the Indian navy is not available, it is estimated that out of the total energy consumption for FY 2012–2013, 77% of the energy use was by operational platforms such as ships, aircraft and submarines, while naval bases, dockyards and other onshore facilities accounted for 23% of energy use.

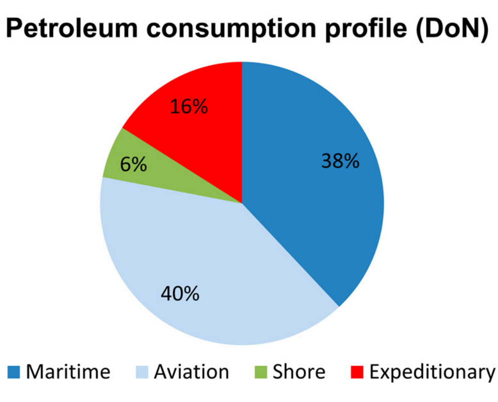

Fig. 1. Petroleum consumption profile of the Department of Navy (DoN) (Financial Year 2008).

The share of consumption of different energy sources used by the DoN in FY 2008 and by the Indian Navy in FY 2012–2013 are shown in Figures 2 and 3, respectively. While the dependence on petroleum products for the navies of both countries is evident, the US DoN has a 16% share of nuclear energy in its energy mix. On the other hand, as shown in Figure 3, it is estimated that 77% of the energy consumed in the Indian navy is based on petroleum products, and the balance (23%) is contributed by electricity.[11] This lack of diversification of energy sources and almost 100% dependence of war-fighting platforms (ships, submarines and aircraft) on petroleum products stands out starkly in contrast to the US DoN.

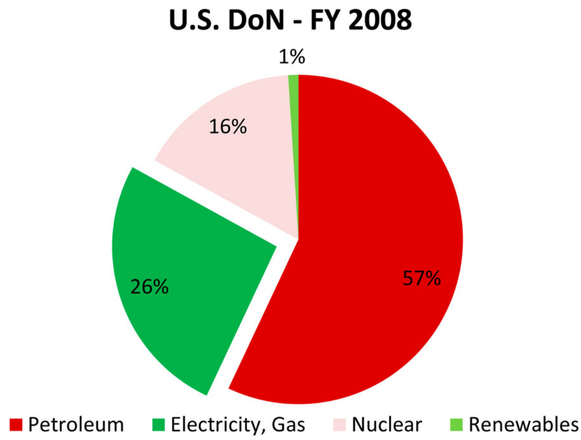

Fig. 2. Share of consumption of different energy sources DoN (Department of Navy Financial Year 2008).

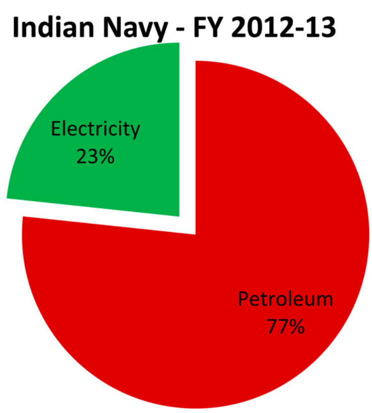

Fig. 3. Share of consumption of different energy sources, Indian Navy (Department of Navy Financial Year 2012–2013).

Apart from the excessive dependence on petroleum and its strategic implications, there are purely economic reasons which impact the energy budget of the navies of both countries. Figure 4 compares the life-cycle costs of platforms for the US navy in 1991 and 2009.

As can be observed from Figure 4, the share of the cost of energy increased from 13% (1991) to 25% (2009),[12] and the increase in the share over the past two decades has lowered the share of the amount which can be spent on other budget subheads such as acquisitions and maintenance. The cost escalation for various components is shown in the relative terms of the Consumer Price Index (CPI) in Figure 5. This clearly indicates that the cost of energy has increased by five times between 1991 and 2009, as compared to the CPI, which has resulted in the doubling of the share of expenditure on energy. This significantly impacts the balance of the budget and leaves lower financial resources for other subheads.

Figures 6 and 7 shows the growth in India's defence budget and the composition of revenue and capital budget for the Indian navy. Table 1 shows the further breakdown of the Indian Navy's revenue budget into expenditure on stores, and under other revenue subheads which include works, pay and allowances, transport, refit and other miscellaneous expenses. The naval stores budget, which accounts for procurement of various spares, new machinery and expenditure on fuel, has grown from Rs. 2967 crores in 2008–2009 to an estimated Rs. 4527 crores in 2013–2014, a large share of which is on account of the rising fuel expenditure.

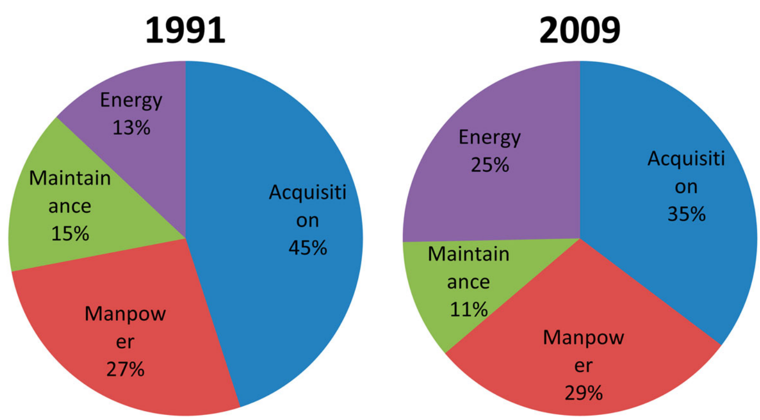

Fig. 4. Life-cycle costs of platforms for the US navy in 1991 and 2009.

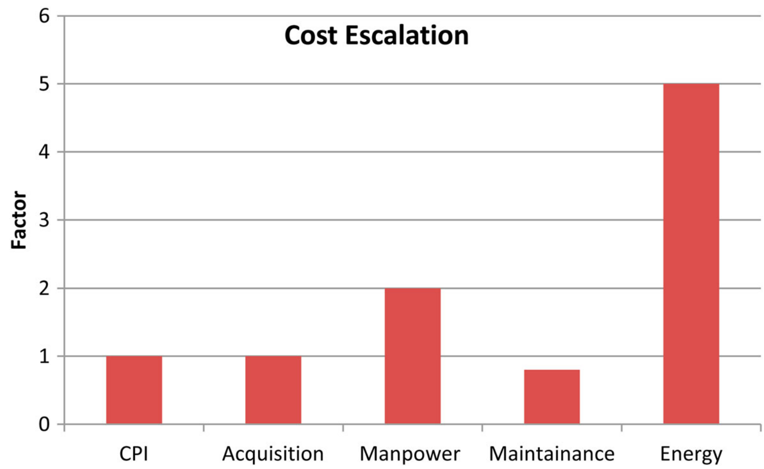

Fig. 5. Cost escalation for US navy between 1991 and 2009.
CPI: Consumer Price Index.

It also needs to be highlighted that in 2010–2011, fuel consumed by the Indian navy was 0.58% of the total defence budget, 3.4% of the navy's total budget, 9.13% of the navy's total revenue budget and 26.96% of the navy's stores budget. This increased to approximately 37% for FY 2012–2013. A detailed analysis of the Indian navy's stores budget (after segregating the amount spent on fuel and other spares) reveals that the

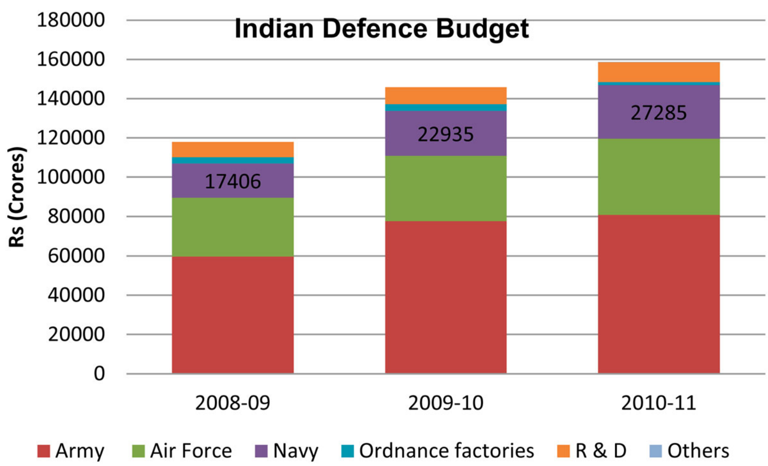

Fig. 6. Growth in the Indian defence budget.
R&D: Research and Development.

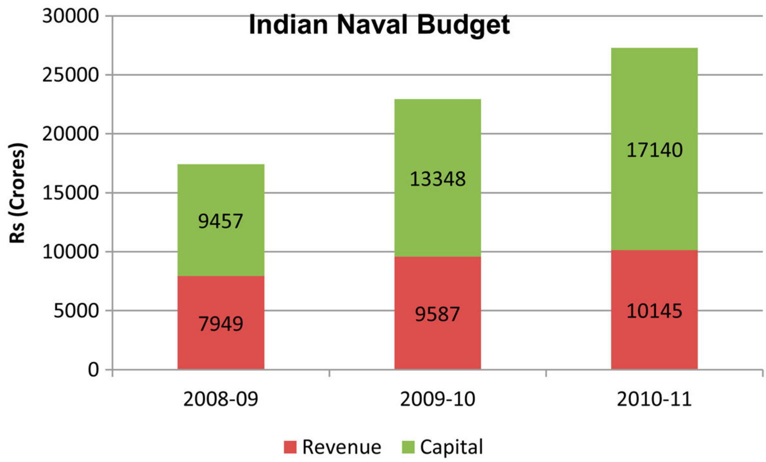

Fig. 7. Growth in the Indian naval budget.

expenditure on fuel is increasing at a rapid pace and is placing an additional stress on the already stretched revenue budget for the Indian Navy. Further, the percentage expended on energy is likely to increase in the coming years due to an additional number of operational platforms (including INS *Vikramaditya*) and a likely increase in their deployment. Hence, it is evident that energy expenditure as a percentage of stores is bound to rise further, leaving less room for the procurement of other store items such as critical machinery spares.

It is evident from the above discussions that the US and Indian navies face similar energy challenges and share similar concerns. It would therefore be apt to work together to enhance naval cooperation in this area.

Table 1. Breakdown of revenue budget for the Indian navy.[13]

	Total	Stores	All others
Year	(Rs. Crores)		
2008–2009	7949	2967	4982
2009–2010	9587	2957	6630
2010–2011	10145	3437	6708
2011–2012*	12146	4251	7894
2012–2013*	12548	4391	8156
2013–2014*	12934	4527	8407

* Breakdowns for these years are estimates.[14]

A comparative Assessment of Energy and Environment Roadmaps

The US DoN

In October 2009, Secretary of the US Navy, Ray Mabus, shared his vision of a leadership role for the navy and the Marine Corps in a document titled *Naval* Energy: A strategic Approach, which was aimed at increasing both tactical and shore energy security. It was supported by three pillars, viz. energy conservation, energy efficiency and increased use of alternate energy sources. He also laid out five aspirational energy goals in order to reduce dependence on oil while improving combat capability for the DoN. These goals were aimed at increasing energy security while providing environmental stewardship,[15] and are mentioned below:[16]

1. Energy-efficient acquisition: Evaluation of energy factors would be mandatory when awarding contracts for systems and buildings;
2. Sail the "Great Green Fleet": DoN will demonstrate a Green Strike Group in local operations by 2012 and sail it by 2016;
3. Reduce non-tactical petroleum use: By 2015, DoN will reduce petroleum use in the commercial fleet by 50%;
4. Increase alternative energy ashore: By 2020, DoN will produce at least 50% of shore-based energy requirements from alternative sources; 50% of DoN installations will be net zero;
5. Increase alternative energy use DoN-wide: By 2020, 50% of total DoN energy consumption will come from alternative sources.

Buoyed by this clear vision and having a similar agenda, the DoD established the Office of the Assistant Secretary of Defense Operational Energy Plans and Programs (ASD OEPP) to strengthen the energy security of the US military, and for overlooking the programmes of the DoD in 2010 with an underlying mandate to help the military services and combatant commands to "improve military capabilities, cut costs, and lower operational and strategic risk through better energy accounting, planning, management, and innovation."[17] The DoD also joined hands with the US Department of Energy (DoE) and signed a Memorandum of Understanding (MoU) to facilitate cooperation for accelerating research, development and deployment of energy-efficiency and renewable energy technologies.[18] In this partnership, energy efficiency was seen to serve as a force multiplier which could be used to increase the range and endurance of combat forces in the field as well as to reduce long-term energy costs.[19] The programme was also aimed at reducing GHG emissions in support of US climate change initiatives, and at protecting the DoD from energy price fluctuations.[20]

The US DoN was at the forefront of energy initiatives, which were guided by the "DoN's Energy Program for Security and Independence,"[21] and the "Navy Energy Vision for the 21st Century,"[22] which were released by the Chief of Naval Operations (CNO) in October 2010. This was closely followed by a document titled "Operational Energy Strategy: Energy for the War Fighter"[23] by the DoD in May 2011. This overarching effort for the armed forces laid out a roadmap for energy use in the defence forces.

"Operational energy"[24] was also mentioned for the first time in the Quadrennial Defense Review (QDR)[25] – 2010, and it was acknowledged that "climate change and energy are two key issues that will play a significant role in shaping the future security environment."[26] "Energy security," which was defined as "having assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet operational needs," was also mentioned as an aim for the DoD in QDR 2010. While the emphasis on energy was somewhat diluted in the QDR 2014,[27] it continued to support the energy initiatives of the DoD and noted the role of energy in overcoming anti-access/area-denial threats. It specifically stated that "energy improvements enhance range, endurance, and agility, particularly in the future security environment where logistics may be constrained," and that they have led to a stronger and more effective fighting force.

The DoD continued its emphasis on energy and issued the "DoD Energy Policy" on April 16, 2014. This was the first overarching defense energy policy in over 20 years, and it "provides a common energy framework to guide the full range of defense energy activities, including operational energy, facilities energy, and energy-related elements of mission assurance."[28] The directive also codifies responsibilities for implementing the energy policy across various departments of the DoD and other defense agencies. The directive states that "it is DoD policy to enhance military capability, improve energy security, and mitigate costs in its use and management of energy," and lists various actions to be undertaken towards this end, including the following:[29]

- Improve energy performance of weapons, installations, and military forces;
- Diversify and expand energy supplies and sources, including renewable energy sources and alternative fuels;

- Adapt core business processes – including requirements, acquisition, planning, programming, budgeting and execution – to improve the DoD's use and management of energy;
- Analyse and mitigate risks related to energy use; and
- Promote innovation for defence equipment as well as education and training for personnel, valuing energy as a mission-essential resource.

Behind the aggressive energy goals and actions of the DoD are various executive orders and federal legislations on energy and environment such as the Energy Independence and Security Act (2007), National Defense Authorization Act (2007 and 2009)[30] and Executive Order 13514[31] on "Federal Leadership in Environmental, Energy, and Economic Performance" (2009). These legislations are equally applicable to the DoD apart from other civilian and industrial entities and have helped shape the energy mandates on shore and tactical platforms. This has led to diverse actions such as acquiring alternative fuels, increasing energy efficiency, lowering energy consumption, GHG emission reduction, increasing renewable energy generation and reducing petroleum consumption in vehicles.

While the navy's energy programme is focused on improving energy security and enhancing operational capability, the US navy also demonstrates environmental stewardship by minimising impacts on the environment, both afloat and ashore. This includes efforts to assess and mitigate GHG emissions.[32]

It is therefore evident that the US navy has already integrated goals and actions on energy and environment in its operations and future planning, which can serve as a guiding beacon for the Indian navy.

The Indian Navy

Unlike the US DoD, the Indian defence services are excluded from the ambit of energy-related legislation. The Energy Conservation Act, 2001, which mandates that energy-intensive industries such as railways, steel plants, power generation plants, etc. will undergo periodic energy audits, is not applicable to the defence services. It is, however, noteworthy that despite there being no legal compulsions, the Indian navy has embarked on a mission for sustainability.[33] It adopted the "green initiatives" in June 2014 to cover all aspects – operations, administration, maintenance, infrastructure and community living[34] – and is well on the path of lowering its environmental footprint.

The three pillars of the energy and environment roadmap of the Indian navy with its associated components are shown in Figure 8.

The Indian Navy has the following mutually complementing energy and environmental goals:

– Goal I: Adopt an energy and environment policy;
– Goal II: Reduce energy consumption;
– Goal III: Minimise environmental impact;
– Goal IV: Build a “green” image (alternate energy);
– Goal V: Invest in capacity building.

In order to implement these five goals, the Indian Navy has a three-tiered structure consisting of various aspects, as shown in Figure 9. At the apex level, there is a centralised energy and environment policy, which is steered from the naval headquarters and is monitored regularly. At the implementation level, it has specific components which are applicable to ships and shore-based naval units spread across the country. This includes both technical and operational measures. At the lowest level, there are many interrelated elements such as regular monitoring, establishing accountability, training, collaboration, research, etc. which provide completeness to the effort and include flexibility and innovation as key elements.

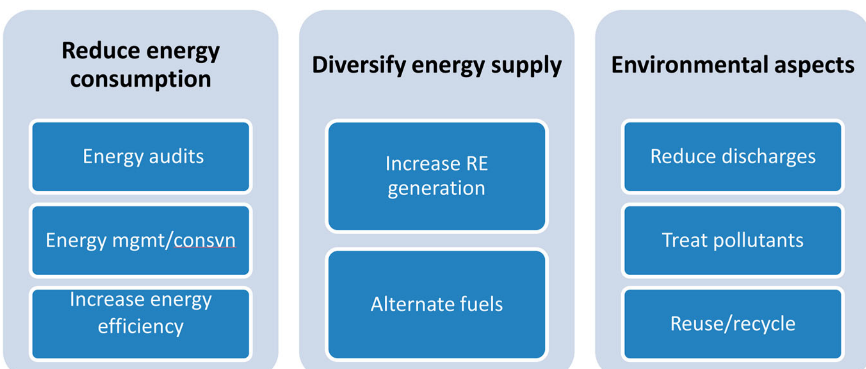

Fig. 8. Pillars of the Energy and Environment Roadmap of the Indian Navy.
RE: Renewable Energy. Mgmt: Management. Consvn: Conservation

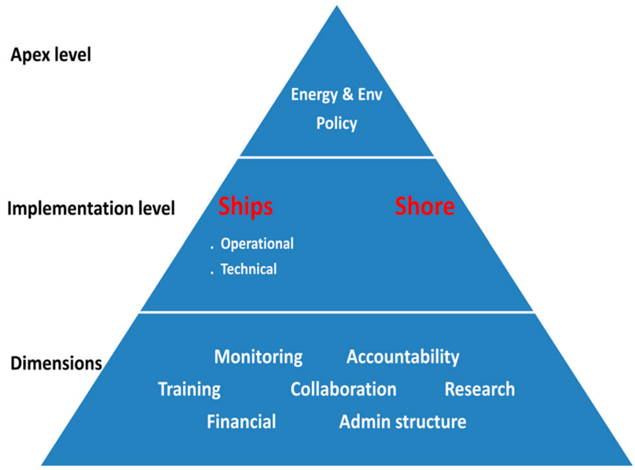

Fig. 9. Structure for Indian Navy's Energy and Environment Roadmap.

The energy and environment roadmap includes various aspects such as: energy efficiency in ship design and onboard equipment; green buildings; a pilot project on the use of biodiesel in Motor Transport (MT) vehicles, auxiliaries and yard craft; self-determined reduction goals for energy use ashore; an earmarked annual budget for solar photovoltaic (SPV)-based electricity generation; feasibility studies on marine-based renewable energy generation; waste recycling and management; water conservation and rain water harvesting; and a host of other steps to meet the adopted end goals.[35]

Elements for Naval Cooperation on Energy and Environment

A few elements which have the potential for developing robust and mutually beneficial partnerships are listed below:

1 Energy-saving propulsion systems

Hybrid electric drive–electric propulsion systems (HED–EPS), such as the one implemented on USS *Makin Island* (LHD-8), have resulted in more than 50% savings in daily fuel costs and are estimated to save fuel worth $US 250 million over their lifetime for the US navy. The ship uses diesel engines while cruising (approximately 70% of the total time at sea), and gas turbines are used for additional speed during operations. This combination along with use of a hybrid electric drive

(HED) has resulted in stellar fuel savings as well as an observed range increase of 16% as compared to similar ships.

The new DDG-1000 (Zumwalt class) destroyers are also designed to use energy optimally. They have an integrated power system (IPS) which provides power to propulsion, ship's service and combat system loads from the same prime mover. This unique architecture for power allocation has an inherent flexibility which results in significant energy savings, and is also suited to enable the use of high-energy weapons and sensors.[36]

2 Hull design

Ship design is an intricate and complex exercise. Incorporating lessons from including the fully burdened cost of energy (FBCE) into the decision-making process for selection of the main propulsion system of the ship, and making requisite changes in ship design for optimising energy use, is a potential area for cooperation. Experiences in designing a streamlined hull which lowers energy consumption during passage by use of stern flaps, anti-fouling coatings to reduce drag, etc. can also be shared for evolving futuristic warship design.

3 Alternate fuel sources

The US navy has an advanced programme on biofuels and demonstrated the use of blended fuel (50% mixtures of biofuel made from used cooking oil and algae, and 50% petroleum-based marine diesel or aviation fuel) during the 2012 Rim of the Pacific (RIMPAC) exercise held from July 19 to 20, 2012, towards its goal of sailing the "Great Green Fleet". During the exercise, surface ships were powered by hydro-processed renewable diesel (HRD-76) while naval aircraft used hydro-processed renewable jet fuel (HRJ-5).[37] It is proposed that a partnership in the use of third-generation algae-based biofuels onboard naval platforms can be explored between the Indian and US navies. The scope can be extended to include liquid hydrocarbon-based fuel from seawater using an electrolytic cation exchange module (E-CEM) and fuel cells (for distributed generation, backup power and unmanned vehicles) for naval applications.

Natural gas is touted as a fuel for the 21st century, and is a clean fuel. Hybrid natural gas-powered warships already exist in some coast guards and navies, such as the Norwegian navy and the US navy. A larger naval platform could be inducted initially to be used as a training vessel in both navies, and learning from the experience of operating and maintaining the platform would serve well for any future induction of natural gas-fired engines.

4 Energy monitoring and management

Benchmarking of energy consumption for different systems onboard ships could be considered along with periodic energy audits of ships to identify opportunities for energy optimisation. Smart energy management systems which optimise energy consumption during passage planning and operations can be considered for warships. The use of "shipboard energy dashboards"[38] could also help in influencing decisions to shift to an economical machinery regime and to optimise energy use. Design features for energy optimisation by automation such as advanced power management and waste heat recovery onboard ships, which contribute to lowering the energy consumption onboard ships, could also be a potential area for cooperation.

Conclusion

The future Indian navy is poised to emerge as an energy- and resource-efficient force which is resilient to volatility in energy costs and oil supply disruptions, and is an environmentally responsible organisation. The US navy, which has made large strides in implementing the energy and environment programme, therefore presents an ideal case study for the Indian navy. A joint programme to study the successes of the US DoN's energy and environment programme and the lessons therefrom for the Indian navy would be a good opportunity under the existing defence cooperation framework. The benign nature of the collaboration and the increasing relevance of the subject in forthcoming times is a good starting point for developing a strong partnership and for enhancing India–US naval cooperation.

Notes

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