and ballistic diodes. Theoretically, high efficiencies can be maintained as the device shrinks, but current optical rectennas have only obtained roughly 1% efficiency using light.

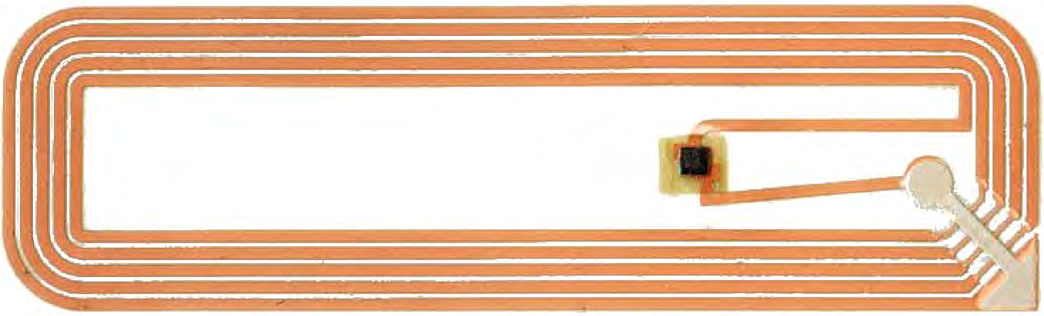

Fig 1 – Rectenna

Needless to say, this vision of IR energy harvesters for renewable power rests on engineers overcoming several technical challenges. This is certain to be a new energy frontier to tackle. However we can imagine one day a sheet printed with thousands of tiny infrared-harvesting rectennas that could be laminated on a solar panel or integrated into a solar water heater.

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THE TYPES OF CONTAINERS IN USE TODAY

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This article attempts to describe some of the types of containers in use today, and highlight some of the problems associated with each and all, in terms of cargo carriage. There are many types of containers in use today, but the purpose of each of them is essentially the same – quick and efficient handling and stowage, and compatible carriage between transport modes. With this in mind, itis somewhat of an irony that there is no complete world-wide standardization with regard to design, construction, materials, dimensions, etc. The most common standards are set by the International Standards Organization (ISO) and the most common containers have lengths of twenty feet (6.1 m) and forty feet (12.2m). These containers are often referred to as TEU’s (twenty foot equivalent units) and FEU’s (forty foot equivalent units) and have an ISO width of 8 feet (2.4 m) and height of 8 feet 6 inches (2.6 m).

The tare weight of a container is the weight of the container without cargo, and this will vary depending on the fittings, weight of construction materials and size of the container. It will typically range between 2-2.5 MT for a TEU and3.5-4 MT for a FEU. The payload weight is the weight of the cargo itself, and apart from the type of cargo this will be constrained by the container’s cubic capacity and the maximum gross weight (the tare weight plus the payload weight) not just for the container itself in terms of structural constraints, but also any weight restrictions imposed by State transport systems.

General purpose containers. As the name suggests, these closed containers are suitable for most types of general cargo, and temporary modification can allow carriage of solid and liquid bulk cargoes. Design and construction are basic - a metal box, with full width doors at one end and a wooden flooring. Lashing points are provided, usually with a Safe Working Load 3 of 2 MT each. Cubic capacity for a TEU is33.3 cbm4 and for a FEU is 66.9 cbm. The main problem peculiar to this type of container is ventilation when vents/ fans are not fitted. Such container are not entirely suitable for moisture sensitive cargoes, particularly on voyages from warm to colder climates. On such voyages, sweat can develop on the inner container surfaces and to prevent contact with the cargo, sheathing on such surfaces and waterproof coverings on the cargo are essential. Other problems are similar to those for general cargo carried in a vessel's holds, and if the carrier is responsible for stuffing, due regard must be given to dangers such as tainting, crushing and shifting.

Open Top containers. This general purpose container without a roof is commonly used for over-height goods and machinery and timber requiring top loading. The door end may also be removable to allow end loading. Removable roof bows can be used to support tarpaulins to the extent this is possible with over-height cargo. Other details are similar to those for general purpose containers. These containers can be more prone to structural failure than other containers, because they are commonly used for heavier cargoes and are often subject to point loading stresses when weights have not been properly distributed. These units also create stowage problems, as stowage on top must be avoided for over-height cargoes. Shippers may request protective stows and this usually means protection from sea sprays and waves over the deck, but in any case, specific instructions should be requested and conformed with.

Fantainers. These are essentially general purpose containers fitted with a hatch in the door, allowing for the fixing of an electric extraction fan (needing an external power source). Air at ambient temperature is drawn into the floor by the fan via a especially designed perforated lower front sill and replaced air is removed through the fan itself. The aim is to balance the temperature of the air within the container with that on the outside, to prevent condensation.

Problems peculiar to this type ofcontainer are the inadvertent closing of the fan, units not being connected to a power source and electrical failure either through fault or loss of supply. These units are unsuitable for moisture sensitive cargoes on voyages from cold to warmer climates. If moist warm air is drawn into the container it may be cooled by the cargo at its surface leading to the development of cargo sweat.

Flat-Rack containers. Commonly these containers consist only of a base and two ends, there are no sides or a roof. Despite this, tare weights are generally greater than those for general purpose containers, materials being of greater scantling for improved strength and wear. They are commonly used for over-width and over-length cargoes and problems similar to those for open top containers are experienced. Additionally, tarpaulins are not normally used so fitting these can be difficult. Stability when handling can also be a problem if the cargo weight has not been evenly distributed. As a rule of thumb, no more than 60 per cent of the weight should be in any one half of a container. The ends of some flat-racks are foldable to allow carriage of over-length cargoes, and to reduce stowage capacity of units not in use. It can be appreciated that the hinges on these end pieces come in for some fairly rough treatment and accordingly structural failure on such parts is common.

Reefer containers. There are two main reefer container types, the integral reefer and the port hole reefer. As their name simply, the former has a refrigeration unit forming an integral part of the container body and the latter has a porthole to which a refrigeration supply is connected. The integral container's cooling unit needs an external power source and the porthole container is connected up to a system of air ducts in the vessel's hold through which cold air is supplied from a central battery of air coolers. Normally reefer containers are designed to carry cargoes in either a frozen or chilled state within the temperature range of -25°C to +20°C.

There are numerous problems associated with reefer containers, but a less obvious one can arise when they are not being used for refrigerated cargo and are inadvertently connected up as refrigerated units. Depending on the cargo, extensive damage can result, and to guard against this there need to be clear instructions on transport documents and labeling on the container to the effect that it is "not to be refrigerated". Other common problems arise because the principle sand limitations of container refrigeration are ignored or not fully understood. For example, reefer containers are only capable of ensuring that the cargo is maintained at the temperature prevailing at the time of stuffing, and accordingly, they are incapable of freezing a cargo which is not already in a frozen state. Pre-cooling of the container, and indeed the cargo, to the required temperature is usually critical, but it is often thought that setting the container temperature at a lower temperature than that required for carriage will give speedier cooling. This is not the case, the rate of cooling will not be significantly different and there is the risk that the lower temperature will result in frosting damage to cargo. The ventilation openings on reefer containers can also be a source of problems, and it is often the case that these are not in the correct position for the cargo being carried.

Bulk containers. These general purpose type containers can carry dry powders and granular cargoes in bulk. Top loading is via hatches fitted in the roof and discharge (which requires a tipping trailer) is via a hatch fitted in the door. Mild steel floors are commonly fitted to enable easy cleaning. Tank containers for dry bulk cargoes are also in use, but give lower payload capacities than the box design (for a TEU, around 33.1 cbm for the former and 19.3 cbm for the latter).The main problems these units encounter are water ingress and condensation. Care must be taken particularly with fine powders, where the inadvertent opening of hatches has been known to cause product loss, especially in windy conditions.

Tank container. The tank container is a pressure vessel mounted in a frame, the latter of which determines compatibility with standard dimensions. Tanks are cylindrical, but materials, linings and fittings vary. The specifications of the shell and fittings determine the class of the tank and thus the type of product it can carry. The frame is designed to support the tank when fully loaded, and there are two different designs. The Frame Tank is a full frame with side rails connecting between end frames, and the Beam Tank has only end frames. The latter has a lower tare weight and thus higher payload capacity. Capacities generally range from 15,000 to 27,000 litres.

Open-sided containers. Another variation on the standard general purpose container design is the open-sided container, which as the name implies has no sides, only a base, roof and ends. The sides can be closed by full height gates and/or curtains (usually nylon-reinforced PVC). A common problem with this type of containers is the loss of cargo through shifting. The gates are not usually designed to IMO transverse strength requirements, and accordingly, care must be taken with regard to stowage and securing. Otherwise similar problems to the open top container may be experienced.

Other container types. One could go on to talk about ventilated containers, controlled atmosphere containers, half height containers, high cube containers, hanger containers (for the carriage of garments), and many more types, but it is felt that, for the time being, the units discussed so far are those most widely used.

General container problems. It can no doubt be appreciated that most containers come in for some fairly rough treatment and this can lead to metal fatigue. This is exacerbated if maximum gross weights are exceeded or loads inadequately distributed. Further structural weakening results from damage, such as dents, scrapes and even punctures. With extensive exposure to the elements in a salty environment such weakening can be accelerated by corrosion. Most damage is caused during handling. Using cranes in excessive wind conditions or with too great a speed of operation often leads to contact with other objects. Many containers are fitted with forklift truck pockets, and such forks have a nasty habit of causing damage. Improper stowage and securing (of the container and its contents) can also cause damage, as can wave impact and the leakage of corrosive contents.

A final problem worth mentioning is the shippers' declaration of contents and weight. With regard to contents, there are some jurisdictions, such as the United Arab Emirates, which still do not allow a carrier to rely on bill of lading clauses such as "contents unknown" or "shippers' load, stow and count", even when it is clear that the container was stuffed and sealed by the shippers. The description of contents can also cause problems, particularly if the cargo is dangerous or a threat to the environment. In cases of fire, loss overboard or salvage, the timely availability of correct and sufficiently detailed information is essential and this should be impressed on shippers.

To sum up, it can be seen that, whilst containers have revolutionised shipping and brought several benefits, they have also created a fair share of problems. Appreciating these problems and how to avoid or otherwise address them is an important part of the successful carriage of containers.

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3D PRINTERS AND 3D PRINTING

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3D printing or additive manufacturing is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. A 3D printer is a limited type of industrial robot that is capable of carrying out an additive process under computer control.

While 3D printing technology has been around since the 1980s, it was not until the early 2010s that the printers became widely available commercially. The first working 3D printer was created in 1984 by Chuck Hull of 3D Systems Corp. Since the start of the 21st century there has been a large growth in the sales of these machines, and their price has dropped substantially.

The 3D printing technology is used for both prototyping and distributed manufacturing with applications in architecture, construction, industrial design, automotive, aerospace, military, engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewelry, eyewear, education, geographic information systems, food, and many other fields.

3D printable models may be created with a computer aided design package or via 3D scanner. The manual modeling process of preparing geometric data for 3D computer graphics is similar to plastic arts such as sculpting. 3D scanning is a process of analyzing and collecting data of real object; its shape and appearance and builds digital, three dimensional models.

Both manual and automatic creation of 3D printable models is difficult for average consumers. This is why several 3D printing marketplaces have emerged over the last years.

To perform a print, the machine reads the design from 3D printable file (STL file) and lays down successive layers of liquid, powder, paper or sheet material to build the model from a series of cross sections. These layers, which correspond to the virtual cross sections from the CAD model, are joined or automatically fused to create the final shape. The primary advantage of this technique is its ability to create almost any shape or geometric feature. Printer resolution describes layer thickness and X-Y resolution in dpi (dots per inch), or micrometers.

Construction of a model with contemporary methods can take anywhere from several hours to several days, depending on the method used and the size and complexity of the model. Additive systems can typically reduce this time to a few hours, although it varies widely depending on the type of machine used and the size and number of models being produced simultaneously.

Traditional techniques like injection molding can be less expensive for manufacturing polymer products in high quantities, but additive manufacturing can be faster, more flexible and less expensive when producing relatively small quantities of parts. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer.