

ANALYTICAL BRIEF

ENTER THE SHARK CURVE

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This short article discusses the now famous “Duck Curve” as well as the less well-known “Nessie Curve” that have been used to describe California and Hawaii respectively and proposes a new member of the family, the “**Shark Curve**”. The Shark Curve, with its sharp (and often invisible) peak provides a more accurate picture of the daily electricity demand curve in most emerging economies.

QUICK READ:

1 The Duck Curve and the Nessie Curve apply well to electricity markets with high air conditioning loads and growing shares of solar PV like California and Hawaii.

2 However, the load curve of most places around the world, notably in emerging countries, looks more like a shark, with an abrupt peak often hidden by load shedding.

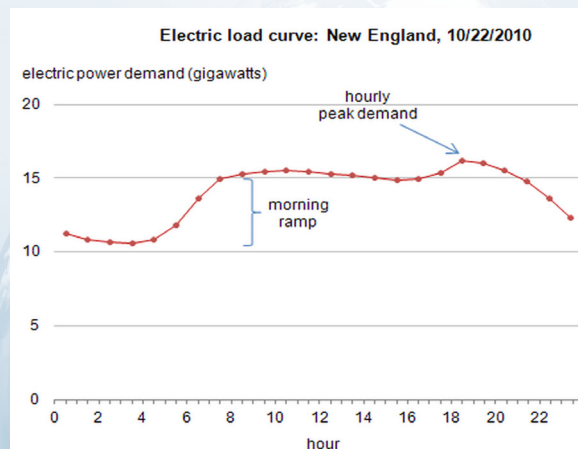
3 When load shedding is included in electricity system analysis, the need for smarter solutions, including energy efficiency, demand response, and both thermal and battery storage comes sharply into view.



In 2008, some colleagues at the National Renewable Energy Laboratory (NREL) in Colorado [noticed](#) that power systems characterized with growing shares of solar PV would start to look different from those we are used to seeing today.

GRAPHIC

Most load curves charting the power demand in the US and Europe tend to look something like [this](#):



Power demand rises early in the day as people wake up and businesses start to open. In the late afternoon, electricity demand experiences a peak, one that is often exacerbated (at least in the U.S. and in parts of southern Europe) by air conditioning loads (and previously, by millions of inefficient light bulbs).

When you stack the different power supply sources together, the picture looks somewhat like the depiction in the figure top right.

While not all jurisdictions will have the same “stack” of generation sources, the basic profile of the demand curve is broadly similar across most developed countries.

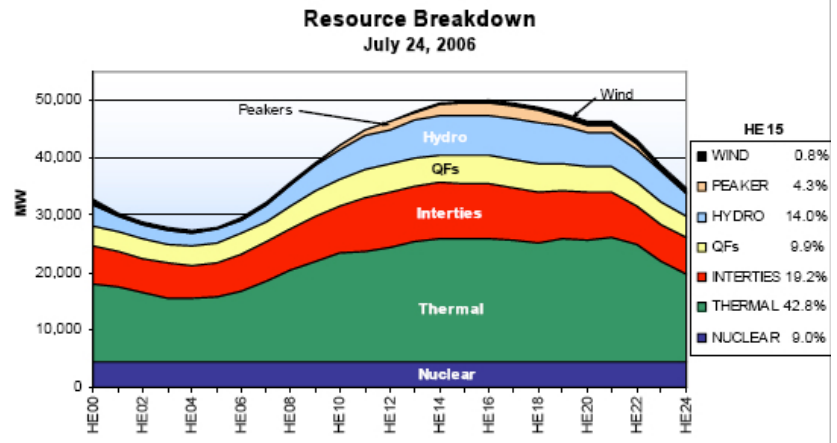
However, as the share of solar power starts to grow, it starts to reduce the net power demand during the daytime, leading to a trough. This trough gives rise to a steeper ramp in the early evening hours as the sun sets (see right). Steep ramps are costly and difficult to climb without compromising reliability.

Enter the Duck Curve

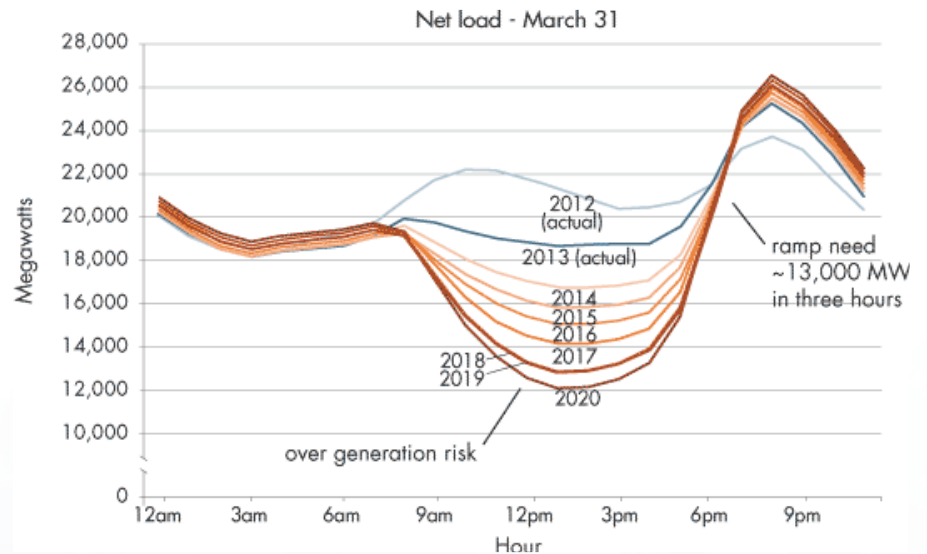
A few years after Paul Denholm and his colleagues at NREL published the original [paper](#), the California Independent System Operator (CAISO) published a [report](#) giving this phenomenon a name: **the Duck Curve** (see mid-right).

Indeed, the likeness is striking.

The term the “Duck Curve” as well as the phenomenon behind it has led to a flurry of articles in recent years, including from [GTM](#), [Vox](#), [NREL](#), [CAISO](#), the [NYT](#), among others, as well as a number of articles about how



Source: [Denholm et al. 2008](#)



Source: CAISO 2014

to solve or mitigate it (see [Exhibit A](#), [B](#), and [C](#)).

Not to be outdone, one of the main utilities in Hawaii (HECO) suggested that we needed a new term: the power demand in certain Hawaiian islands is characterized by an even steeper evening ramp than in California (partly due to the fact that residential demand represents a larger share of overall power demand).

In the utility’s opinion, the duck was no longer sufficient to describe what was happening.



Enter the Nessie Curve

The Nessie Curve was coined by [HECO](#) staff based on the ancient plesiosaur long believed by locals to inhabit Loch Ness in northern Scotland (see top right).

And yet, most jurisdictions in the world (particularly in emerging countries where I do most of my work) have a daily load curve that looks markedly different from those of California, or Hawaii.

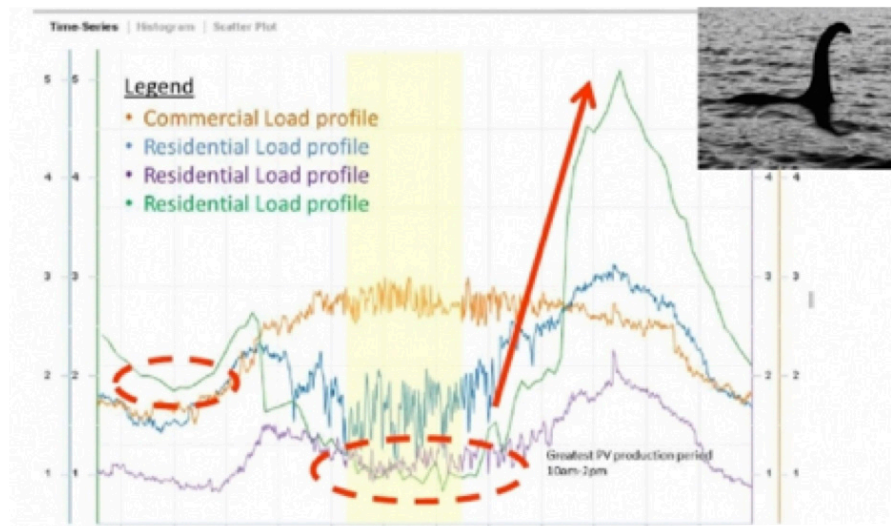
Crucially, in such jurisdictions the evening “ramp” is often even more pronounced, due in part to the smaller industrial base, the predominance of residential electricity demand (versus commercial or industrial demand), and the wider prevalence of lower efficiency appliances.

Perhaps more importantly, **this sharp evening peak is often invisible as it remains largely unmet**, due mainly to a lack of sufficient generation resources as well as a lack of demand side management. **These evening peaks are the cause of countless blackouts and untold billions in economic losses around the world.**

It all crystallized in my mind during a recent trip to Nepal while listening to a presentation on the power system by local energy expert Jiwan Mallik. He was presenting the daily load curve of Nepal (see right).

As pointed out above, load shedding is greatest during the early evening hours: however, this unmet electricity demand is often unrepresented in charts of daily load curves, partly because utilities don't like emphasizing how much latent power demand they are actually unable to serve.

The Nessie Curve



Source: HECO

When you add in this unmet load, the real shape of daily load curves in many emerging countries becomes clear.

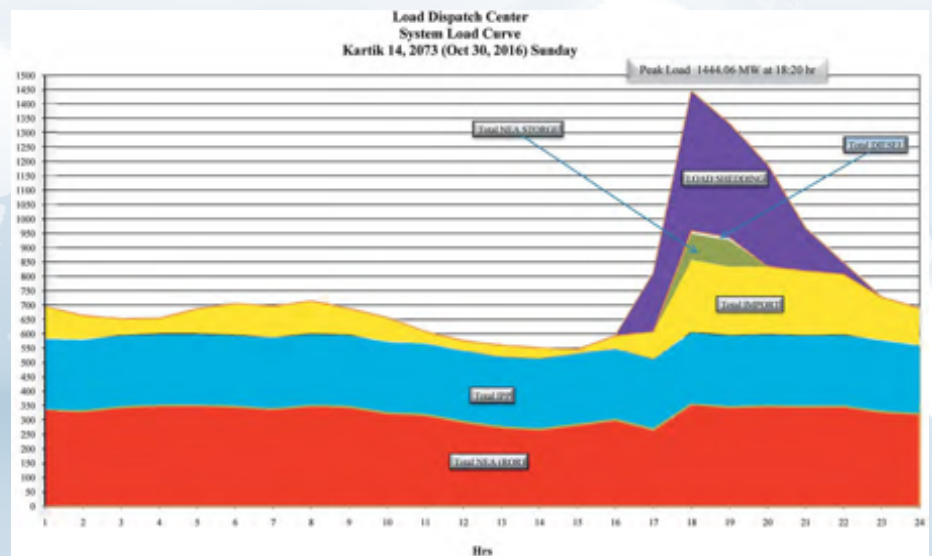
Introducing: the Shark Curve

The Shark Curve is the reality in most developing countries around the world. The duck comes later.

In the absence of concerted efforts at peak shaving, including the adop-

tion of more energy efficient appliances, demand side management, demand response, and greater use of both battery and thermal storage, the challenges associated with the Shark Curve are likely to get worse before they get better.

While everybody's talking about how to deal with ducks, electricity sector planners in emerging economies should be focusing first and foremost on how to deal with sharks.



Source: Nepal Electricity Authority