Introduction

All limited resources will eventually peak in production. The peak production of a resource is an important event because it is inevitably followed by a decline. Ideally, a renewable resource would replace falling supply of said limited resource.

The objective for this forward is to model the schedule necessary to replace a declining limited resource with a renewable resource. The important distinction between limited and renewable resources is the 'energy return' verse 'energy investment':

For limited resources:

- Energy return is immediate and constant
- Energy investment is a fixed cost as well.

For Renewable resource:

- Energy return is incremental over time
- Energy investment is relatively constant.

Predicting a limited Resource

Once at peak occurs the decline of a resource can roughly be predicted based on discoveries and the existing profile of the incline in production. This prediction can be modeled using a Gaussian Function.

q = quantity at peak production (Lot)

c = concentration of energy per Lot (Energy / Lot)

T = 1 unit of time (Time)

i = energy invested for a resource

h = time of peak production (Time)

w = time span between max *change* in production and peak production (Time)

x = point in time (Time)

$f(x)$ = the energy produced between time x and $x+T$ (Energy)

$$f(x) = c \cdot q \cdot \left(1 - \frac{i}{c}\right) \cdot e^{-\frac{(x-h)^2}{2 \cdot w^2}}$$

Modeling a Replacement

The goal is to introduce a replacement resource which can keep total energy output near constant going forward with minimum disruption.

r = energy output of renewable resource (Energy / Time / RenewableLot)

u = energy invested for renewable resource (Energy / RenewableLot)

P = duration of time to recoup investment = $\frac{u \cdot T^2}{r}$

$f'(x)$ = the quantity or renewable developed between time x to $x+T$ (RenewableLot)

The quantity of renewable resources that needs to be created at any given time is equal to the drop off of energy from limited resource depletion over the period of time subsequent to the resource 'recouping' its own cost.

$$f'(x) = \frac{f(x+p) - f(x+T+p)}{r}$$

$$f'(x) = \frac{c \cdot q}{r} \cdot \left(1 - \frac{i}{c}\right) \cdot \left(e^{-\frac{(x-h-p)^2}{2 \cdot w^2}} - e^{-\frac{(x-h-T-p)^2}{2 \cdot w^2}} \right)$$

Oil to Solar

Based on known data for peak oil, I'm choosing the following parameters:

q = 72.5 · 365 = 26,462 (million barrels)

c = 1,700 gwh / million barrel

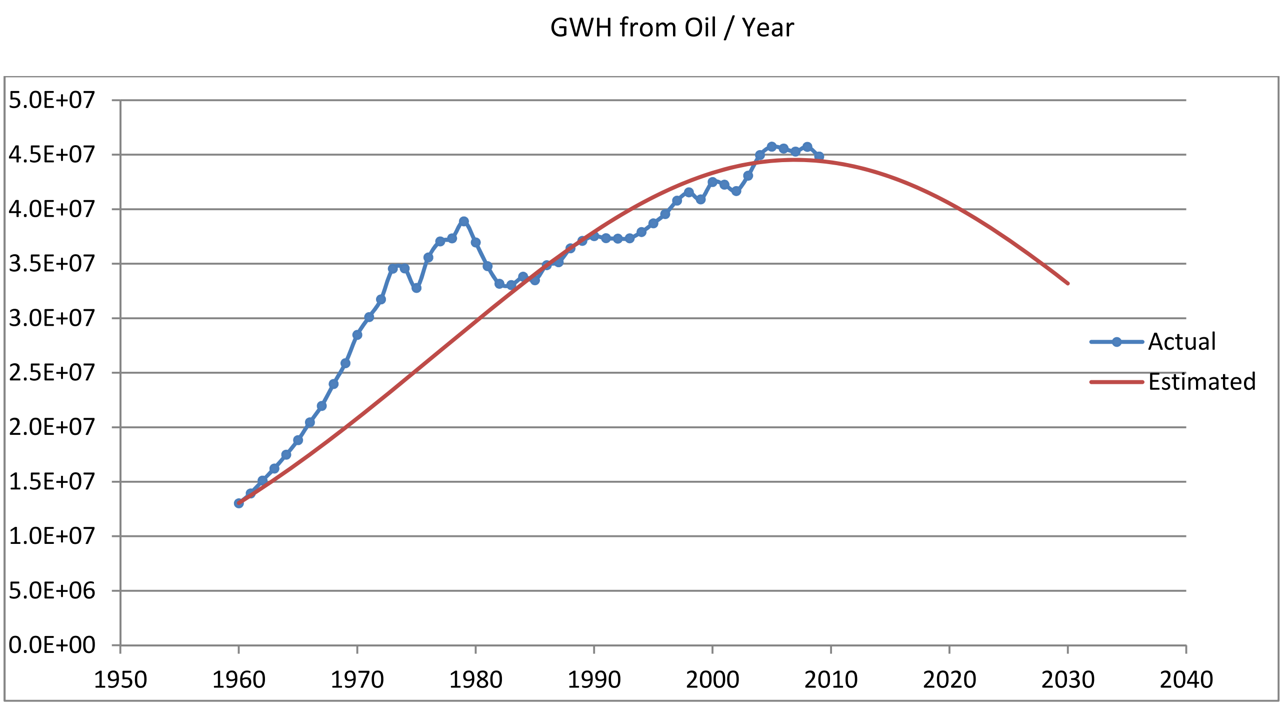
i = 1% of c = 17 gwh

h = 2007 year

w = 30 years

$$f(x) = 1{,}700 \cdot 26{,}462 \cdot \left(1 - \frac{17}{1{,}700}\right) \cdot e^{-\frac{(x-2007)^2}{2\cdot 30^2}}$$

$$f(x) = 44{,}536{,}387 \cdot e^{-\frac{(x-2007)^2}{1800}}$$



Based on known data for 1 square kilometer of solar panels, I've chosen the following parameters:

r = 1700 gwh/year/sqr.km

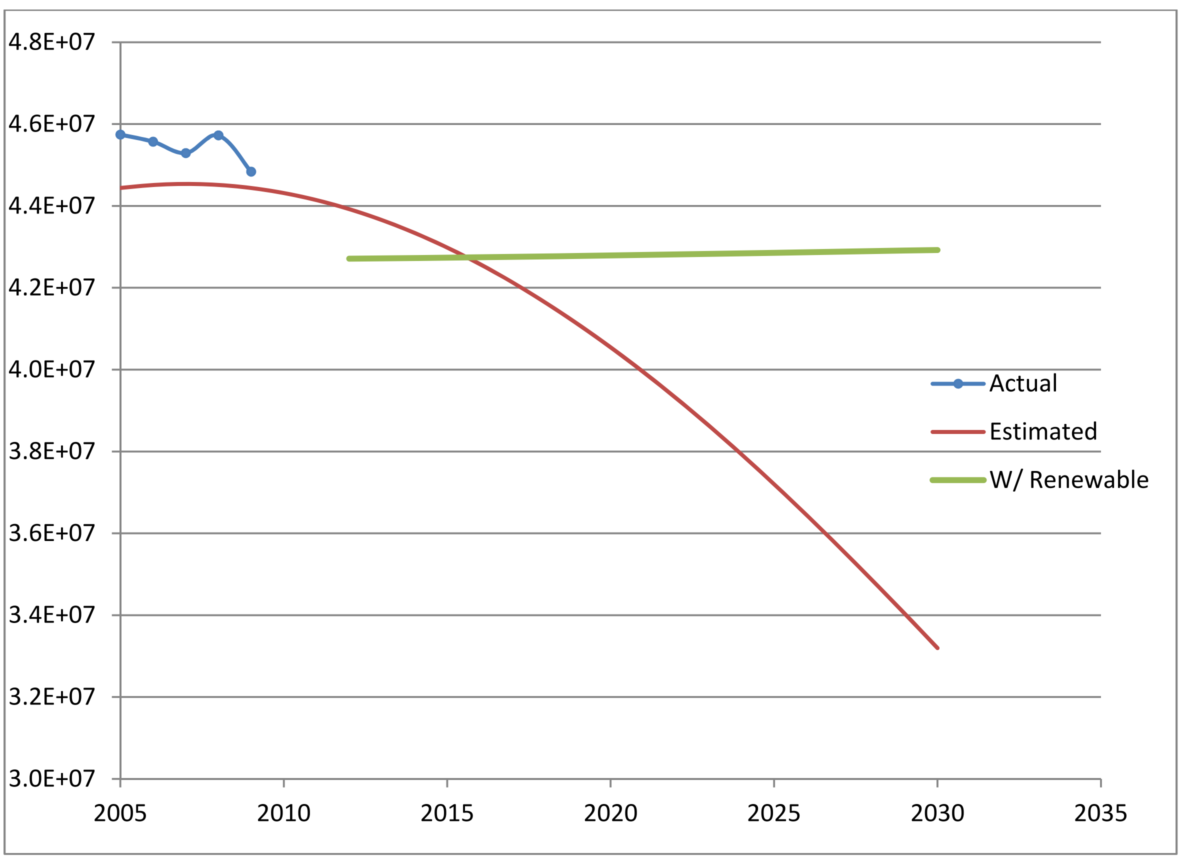
u = 5100 gwh / sqr.km

T = 1 year

P = 3 years

$$f'(x) = 26{,}197 \cdot \left(e^{-\frac{(x-2004)^2}{1800}} - e^{-\frac{(x-2003)^2}{1800}} \right)$$

GWH from Oil [and solar] / year



The following schedule would allow for a ‘flattening off’ in total available energy.

YEAR	Solar Panels KM^2
2012	237.6
2013	263.0
2014	287.4
2015	311.0
2016	333.6
2017	355.1
2018	375.5
2019	394.7
2020	412.8
2021	429.6
2022	445.2
2023	459.5
2024	472.4
2025	484.0
2026	494.3
2027	503.3
2028	510.9
2029	517.1
2030	522.1