SMART FIT

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ABSTRACT

How should PV electricity production be remunerated?

With widely differing remuneration systems in effect in different parts of the world, it appears there is a disconnect between value delivered and value received by PV generators. This article describes a value transfer mechanism, a smart feed-in-tariff (SmartFiT), designed to reflect the local value delivered by PV.

The proposed SmartFiT retains the attributes that contributed to make feed-in-tariffs the most successful PV remuneration system in the world -- simplicity and predictable bankable long term contracts -- but it differs in several fundamental ways:

- It is based upon the value delivered locally; hence it is not an incentive but a value transfer mechanism.
- The long-term end game is controlled – because value can be inferred locally at any level of PV penetration, a SmartFiT can be planned for the high penetration long-term without disruptions.
- There are market throttle controls to insure that the rate of installations matches any desired long-term penetration plan.

1. INTRODUCTION

PV may still appear expensive when compared without context to traditional power generation despite immense progress over the last few years. However the public generally accepts the argument that solar energy delivers a higher value than can be readily monetized in a business as usual setting. Energy and to lesser extent, capacity value delivered by PV are monetizable today, but this is not the case of environmental value, fuel depletion and fuel price mitigation value, market price reduction, economic development/ job creation, energy security enhancement, and value linked to displacing conventional resources' embedded incentives. Figure1 illustrates this multi-facetted set of values for case studies in New York and New Jersey [1, 2].

This general understanding is the reason why cities, states, provinces and countries around the world have developed financial transfer mechanisms in an attempt to level the playing field and make up for the part of the value delivered by solar generators that is not currently monetized. These financial transfer mechanisms are often referred to as "incentives." However the term incentive does not have to imply the notion of subsidy.

Incentives/ financial transfer mechanisms have taken many shapes and forms including buy-down grants, Solar

Renewable Energy Credits (SRECs), reverse auctions, net-metering, feed-in-tariffs (FiTs) as well as income tax credits (ITC), tax abatements, tax exemptions, low-cost financing, etc. (see [3]). These can be tax-financed and/or utility ratepayer-financed. In the US, the ratepayer-based transfers of value are generally driven by Renewable Portfolio Standards (RPS) whereby a renewable deployment goal is specified by the law and implemented by forcing utilities and grid operators to purchase renewable energy credits from renewable energy producers.

Feed-in-Tariffs (FiTs): Among all PV remuneration systems, the FiTs have undeniably been the most successful in terms of PV deployment, accounting for over 80% of PV systems installed worldwide [4].

As described in Wikipedia [5], “a FiT is a policy mechanism designed to accelerate investment in renewable energy technologies. It achieves this by offering long-term contracts to renewable energy producers, typically based on the cost of generation of each technology. Technologies such as wind power, for instance, are awarded a lower per-kWh price, while technologies such as PV are offered a higher price, because of their higher costs.”

The FiT success is a result of three key attributes:

- Administrative simplicity,
- Contracted long term revenue guaranty, and
- Simplicity of PV-grid interconnection.

However several of the world’s FiT programs have been victims of their own success. For example, the Spanish program has had difficulties because of an absence of adequate market controls, long-term planning and program flexibility. In Spain, the one-size-fits-all/no-limit FiT resulted in very large systems with large economies of scale rapidly flooding the market and, in effect, killing the program.

In addition, because FiTs are cost-based incentives, many question the rationale of preferentially subsidizing the most expensive technologies. FiT adjustments following cost reductions are often done by ad hoc steps, often taken on an emergency basis, leading to sharp market rushes and contractions. Although the German program has been the most successful in terms of market growth, it has not been immune to these flaws and has reached near crisis status more than once.

2. INTRODUCING THE SmartFiT

A SmartFiT retains the key attributes that have contributed to the FiT success: simplicity of interconnection, minimal administrative work and predictable bankable long term per kWh contracts. A Smart FiT, however, differs from a traditional FiT in several fundamental ways:

- It is value-driven.
- There are market throttle controls.
- The long-term end game is controlled.

Value-Driven: The Smart FiT is value-driven rather than cost-driven and thus addresses the underlying reason for incentives in the first place: to capture the renewable value that cannot be fully monetized under business as usual conditions. The argument is that investors should be fairly compensated for the value that they produce. In the case of PV, this value is multifaceted (Figure 1) and influenced by four factors:

1. The location of PV within the transmission and distribution networks;
2. The local penetration of PV;
3. The placement (orientation/tilt) of PV; and
4. The availability or not of emergency/dispatchable storage capability

These four factors influence the ability of PV to actively support the transmission and distribution grids by reducing peak demand-induced stresses and risks of power outages. They also influence the operational and infrastructural T&D measures and the associated costs that will be necessary to absorb a growing amount of solar generation.

Location influences environmental value resulting from the locally displaced energy mix;

Finally the availability of emergency storage, hence the ability to locally supply critical loads and mitigate the consequences of power outages and natural disasters generates value both at an individual and at a community level[1].

The Smart FiT should reflect these factors in an intelligent per kWh price that would depend upon location and system specs, and self-adjust over time as penetration increases.

[1] The recent example of superstorm Sandy shows that a substantial portion of the damages and losses could have been avoided if power had been available for critical loads such as gas pumps or emergency equipment, which properly designed PV installations could have delivered.

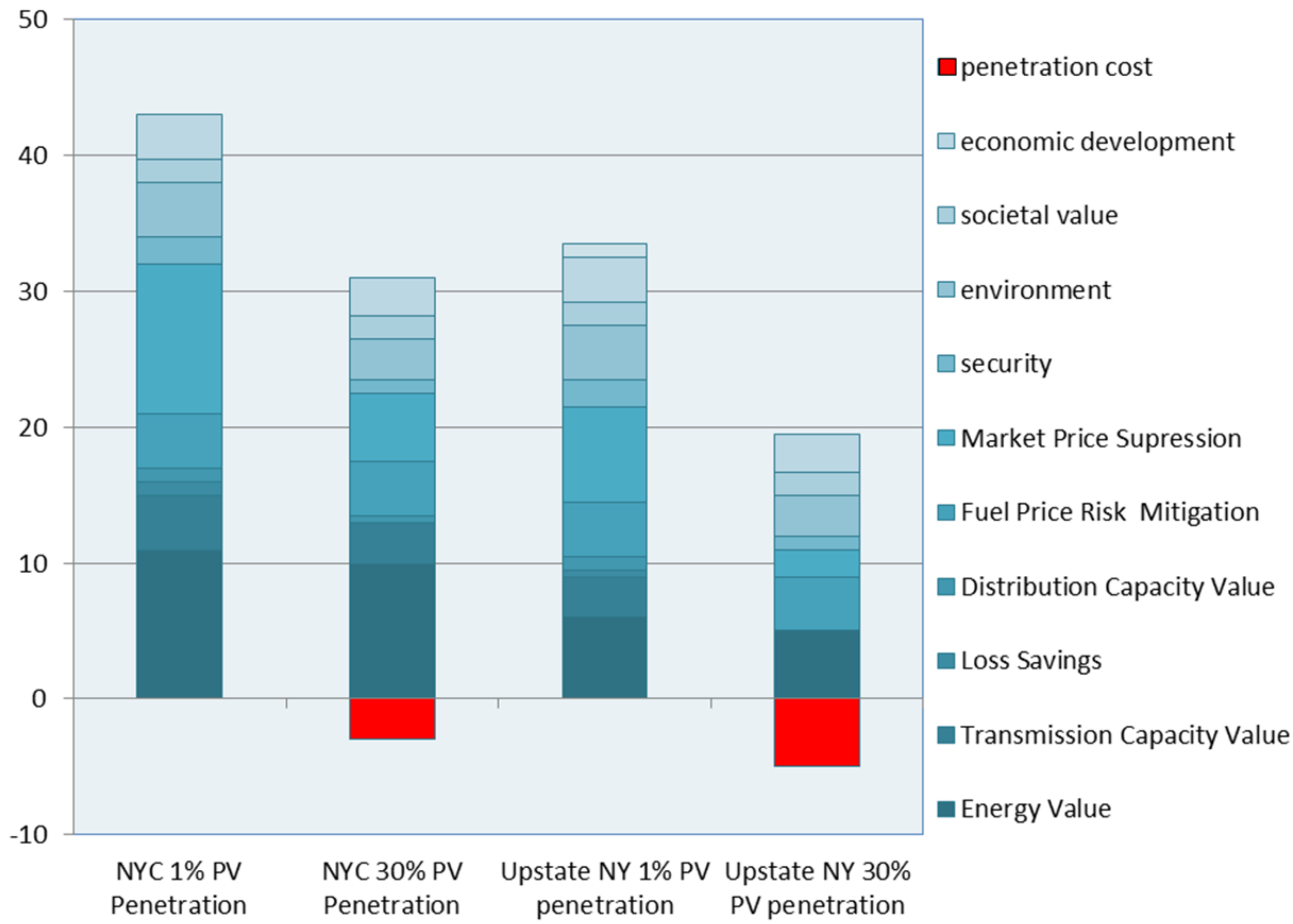

Figure 1: Example of value delivered by PV generation in the New York City (NYC) metropolitan area and in upstate New York at 1% and 30% PV penetration (source Perez et al., 2011, CPR, 2012). This example is shown for PV systems without emergency storage/outage recovery capability.

Market Throttle Controls: The examples of Spain, and more recently New Jersey have demonstrated that an incentive that is too generous can result in overbuilding, exceeding mandates and planners' expectations. This has resulted in the effective end of a thriving solar market in Spain and a drastic reduction in the value of the solar renewable energy credits in New Jersey. Therefore, PV value should inform the Smart FiT but not set its worth directly, at least not in cases where value would be much higher than current local system cost. Ideally the Smart FiT should be set at the minimum between a system's levelized cost of energy (LCOE) with an acceptable ROI and levelized delivered value and illustrated in Figure 2.

Real-time" throttle control" FiT adjustments for new systems should also be built-in by monitoring the rate of installations and adjusting current new FiTs down gradually if the rate exceeds the planned rate, or up if it is insufficient, but without exceeding value.

SmartFiT in relation to other existing incentives: In a country such as the US, where several forms of incentives are already in place to various degrees depending on location, the implementation of a SmartFiT would not occur in a vacuum, but should account for other sources of revenue. The full value should be considered when the FiT is the only value transfer mechanism available. The Smart FiT should be reduced commensurably by the value of other incentives (e.g., Federal ITC, State ITC, buy-down, and net-metering, as in New York State) when they exist as illustrated in the bottom of Figure 2.

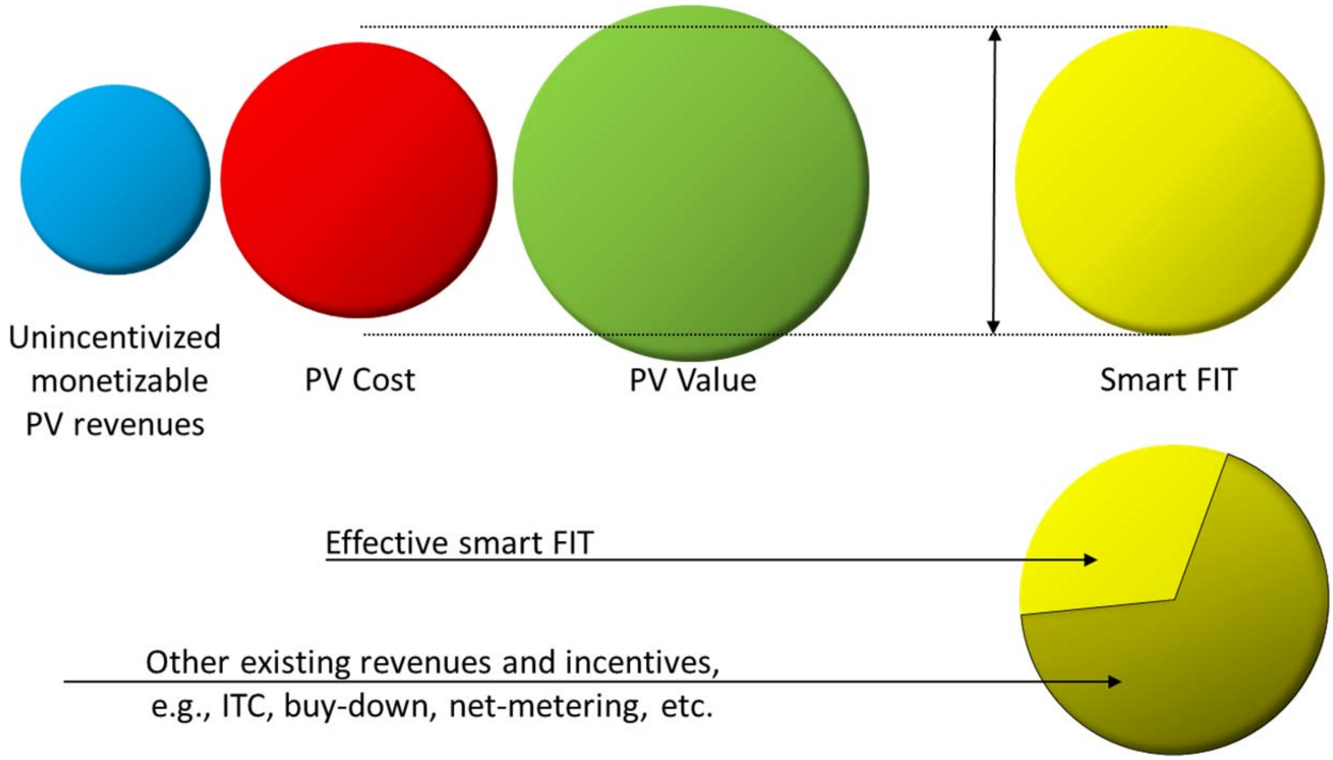

Figure 2: – Positioning the Smart FiT: unsubsidized business-as-usual revenues from PV (blue circle) are often less than the cost of deploying the technology (red circle). The value to the tax payers and ratepayers (green circle) may be considerably higher. The Smart Fit (yellow circle) is a transfer mechanism that would most effectively be positioned between the value generated by PV and its cost. The Smart FIT would have to be reduced commensurably in cases where other revenue streams exist (bottom right).

Controlled long-term end game: The Smart FiT should be designed to gradually decline over time because value decreases and integration costs increase as resource penetration increases. However, unlike sudden market price reactive changes affecting traditional FiTs, collapses affecting RECs, and threats of discontinuity affecting ITCs, the Smart FiT decline would be predictable and programmed from the onset to reflect planned PV penetration and the associated loss of value and increase in integration costs. This decline, occurring in parallel with expected PV price declines, would be designed to transition to a long-term very high-penetration equilibrium between value generated and the cost of the infrastructural enablers of high penetration PV including: load management, storage, solar/wind synergy, solar/gas synergy (initially), and long-distance interconnection. Figure 3 represents a hypothetical example of long-term high-penetration plan for New York metropolitan area.

Not a subsidy: It is important to point out that the Smart FiT is not a subsidy. This is because the SmartFiT is designed to be less than delivered value. As penetration increases the value will naturally reflect penetration cost and should be low enough to not even be perceived as an incentive by detractors.

What if cost exceeds value: the likelihood of justifiable value being below PV cost in most of the US is small today and will likely be in the future. For instance in the New York metro region at $4.5/W turnkey (certainly achievable today) it takes about 30 cents per kWh in the absence of any incentive to generate a 30-year 7% return on investment (ROI). This is well below the levelized value delivered by PV for the region, conservatively estimated at well over 35 cents per kWh [1, 2]. Using the DOE Sunshot's objective of $1/W turnkey as a gauge for the very high penetration future [6], it will take 8 cents/kWh to produce a 7% ROI in the considered region. Although the solutions that will enable high penetration are only being conceived at this time, it is unlikely that their cost will bring the total value delivered by PV below this level.

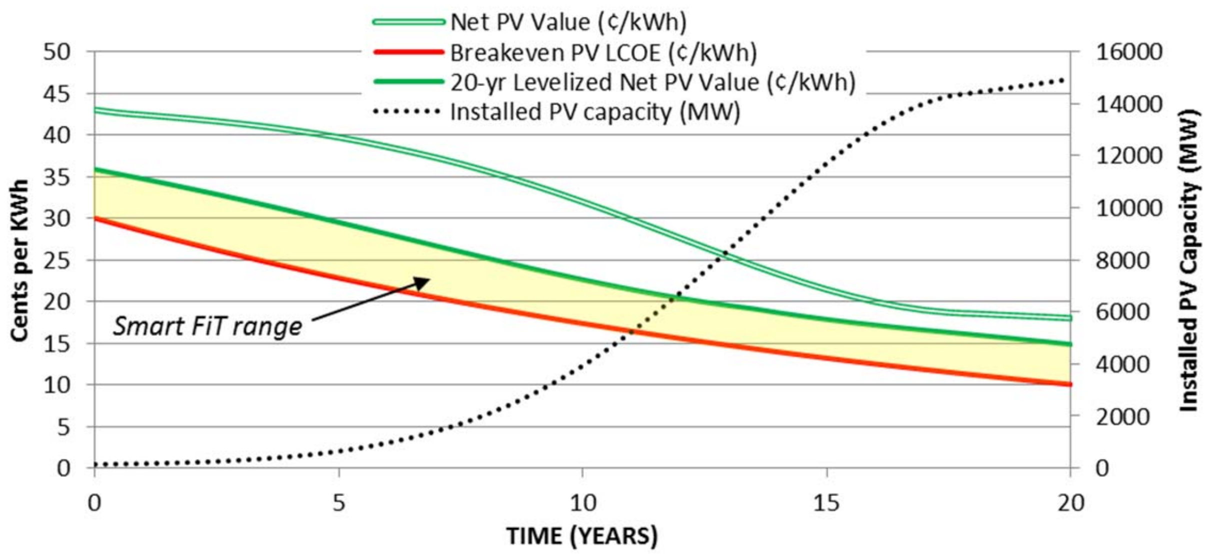

Figure 3: The net PV value (double green line) decreases over time as planned PV penetration increases in the New York metro area (black dotted line). The dotted green line is the 20-year levelized net PV value (derived from the green line) and would represents the 20-year Smart FiT contract's upper bound acceptable to the constituency at any point in time. The PV system's unsubsidized 20-year levelized cost (red line) represents the Smart FiT contract's lower bound acceptable to investors.

Very Smart: Of course a Smart FiT should include and embrace common sense and effective attributes that have been successfully pioneered elsewhere such as community solar gardens (e.g., see [7]) and virtual system ownership (e.g., see [8]). This will: (1) enable every energy producer large and small to participate and not only those in high value, high yield locations (e.g., a prospective producer with a shaded roof in a low value area could take part in an unobstructed, high value system); and (2) enhance high-value deployment without penalizing prospective investors in low value locations. In essence, the Smart FiT would use high value market forces to push PV development to those areas of the grid that need PV support.

Who would pay for the Smart FiT? PV deployment value and costs accrue to two parties: ratepayers and taxpayers. Although these two parties are often the same, it would be essential to retain this distinction in the cash sources of a Smart FiT program. From a practical standpoint, such a program would be most effectively handled by utilities, but with the ratepayer-traceable part of the Smart FiT originating from a specific rate surcharge and the taxpayer part originating from the taxing authorities – for instance, credited back to the utility through periodic governments contributions.

3. DISCUSSION: IMPLEMENTATION CHALLENGES

There are several challenges in implementing a Smart FiT. More specifically, a Smart FiT requires:

- An understanding, shared between all concerned parties, of the net value created by PV generation as a function of location, resource penetration and system specs. Arriving to a shared understanding will involve the collaboration of (1) utilities to identify how the physical value and costs of integrating solar varies throughout their networks (as a function of e.g., load shape and customer mix, expected load growth, generation mix, outage risk, etc.); (2) the insurance industry to ascertain the risk mitigation value of PV depending on system specs, (3) the constituency, its governments and regulating bodies to ascertain the taxpayer value of PV-generated energy.
- An adjustable long-term plan for local solar resource growth leading to high penetration, so as to inform the evolution of Smart- FiT value over time and bring certainty to long term contracts;
- Real time monitoring of PV deployment rate so as to efficiently operate market throttle controls if needed;
- A shared understanding of and an active planning for the infrastructural solutions to very high solar penetration, and of their cost, as these solutions (many

of which may not have been invented yet) develop over time.

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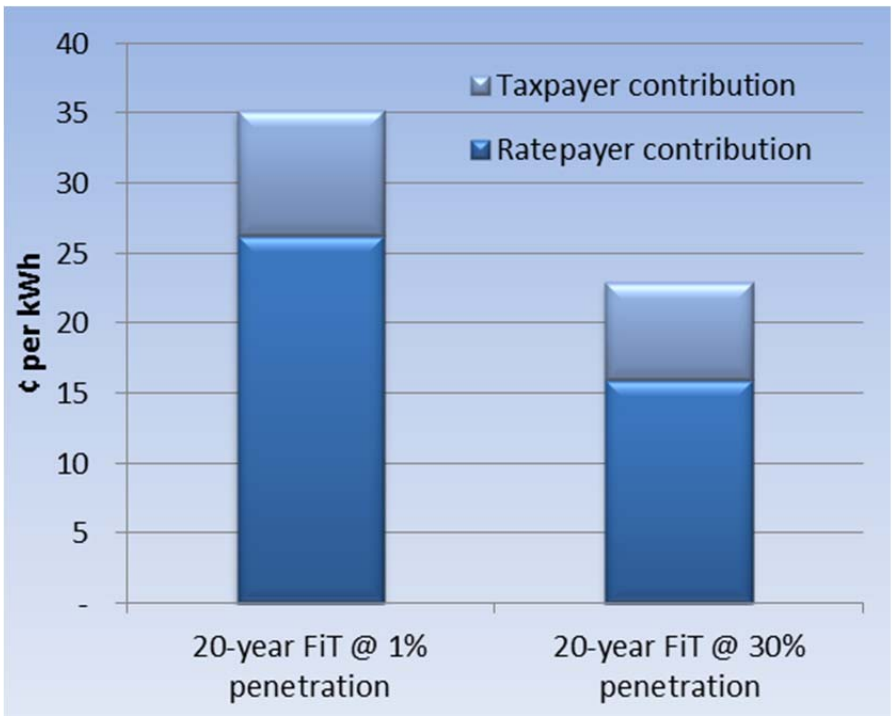

Figure 4: Cash sources of Smart FiT payment at 1% and 30% capacity penetration based upon the [hypothetical] data presented in figure 1 and figure 3