Accelerating the Growth of Solar Photovoltaic Deployment with Peer to Peer Financing

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ACCELERATING THE GROWTH OF SOLAR PHOTOVOLTAIC DEPLOYMENT WITH PEER TO PEER FINANCING

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ABSTRACT

Solar photovoltaic (PV) technology is a means of increasing energy security whilst reducing the negative externalities of fossil fuel dependence. Programs, such as feed-in-tariffs (FITs) implemented in many countries for on-grid PV, provide economic incentives for investment. On the other hand, off-grid PV systems reduce energy poverty and increase both entrepreneurial productivity and return in rural isolated areas. Despite these social and economic justifications, there is still limited access to capital and appropriate financing mechanisms for the upfront cost, resulting in the slow uptake of solar PV under government programs, especially for poorer individuals. Peer-to-peer (P2P) lending networks represent an abundant untapped financial resource for accelerating the deployment of PV technology. This paper considers an innovative P2P lending framework for A) financing solar PV on-grid under a FIT program and B) off-grid for a small business, whilst distributing both the environmental and economic advantages throughout the entire population. The requirements and limitations of the proposed funding mechanisms are analyzed and conclusions are drawn.

1. INTRODUCTION

To assist the world meet its energy needs whilst reducing the adverse impacts of fossil fuel dependence, solar photovoltaic (PV) technology is considered a technically viable, sustainable renewable energy alternative [1-3]. Recognizing this, many of the world's governments have developed research and financial incentives (such as Feed-in Tariffs (FITs), research tasks and rural electrification mandates) to improve the deployment and viability of solar PV [4]. However, lack of access to credit continues to be a barrier to solar PV development, despite policy directives [5,6]. The problem of gaining credit to finance energy demands and fight climate change is most severe for the world's poorest who are largely dependent on fossil fuels, such as diesel, and will most adversely be affected by climate change [7]. Two-thirds of the world's population live on less than US $1,400 per year, with only a fraction having access to financial services [8], and one third of a percent of these getting loans for energy [9]. In either the developed or developing world, poorer individuals experience both higher interest rates and onerous loan terms from both conventional and grey-market financial agreements [10-12]. If poorer individuals could access reasonable loans that would allow them to invest in solar PV to improve their energy security, and either take advantage of the income of a FIT or improve their micro-business, there would be economic growth [13]. Peer-to-peer (P2P) lending mechanisms (where money is lent between people without the involvement of formal financial institutions) provide a potential solution to this problem. Under such a lending program, small-scale solar PV generators, such as individual homeowners, could gain access to additional capital based on the investment return for their project under the FIT, or their business. Furthermore, carbon offsets would be an additional benefit for investors [14]. This paper explores the social and economic benefits of using P2P lending for solar PV deployment either on-grid with a FIT or off-grid with a micro-business.

2. ON-GRID AND OFF-GRID SOLAR PV

Solar PV systems can either be connected to an existing electrical grid (on-grid) or stand-alone (off-grid).

2.1 On-grid solar PV with FIT

The most common incentive for on-grid solar PV is a FIT [4]. A FIT is a rate that a local utility commits to paying for electricity generated by prescribed renewable energy producers. The size of the tariff is usually higher than local electricity market prices, offering an attractive return on investment for the producer over the contract length [6]. A contact length of 20 years is common, although ranges from 1 to 40 years can be found [6, 15]. Solar PV has seen large growth rates in countries such as Germany that have adopted FITs open to residential, commercial and utility scale applications [4,6]. Of 73 countries that have renewable energy targets in 2009, more than 60 jurisdictions have FITs, the majority supporting solar PV [4] for a range of solar irradiation [16]. Although FITs provide an economic incentive for solar PV investment, barriers to appropriate financing for low to middle income homeowners and micro-entrepreneurs limit their opportunities to benefit from the FIT for 1 to 10 kW projects and invest in a sustainable future [17,18]. Furthermore, increasing the solar PV electricity on a grid would reduce its green house gas (GHG) emission intensity, when dirtier sources are offset [3].

2.2 Off-grid solar PV

Off-grid solar PV systems are often found in isolated areas and rural electrification systems that do not have the benefit of a traditional electricity grid. Rural areas such as in Africa, India and South America use off-grid systems that are typically less than 50W (0.5kW), including "pico-PV" at 1 to 10W that support two LED lights (that replace costly and hazardous kerosene lanterns) and a radio or cellphone charger [4, 19]. Larger systems (~15-100W range) that costs between several hundred to US$1000 could provide power to light three to six small rooms and/or a black and white TV in sub-Saharan Africa [20, 21]. Other solar products include solar lanterns, solar drip irrigation systems and portable solar phone chargers [4, 14, 21]. The usual alternative would be fossil fuel based generators and conventional acid or dry cell batteries, which are difficult or expensive to obtain. However, replacing the fossil fuel based generator with a solar home system could save money, improve energy security and improve entrepreneurial business while reducing GHG emissions [8, 14, 19, 22, 23].

3. PEER TO PEER LENDING

3.1 Definitions and Organizations

Traditional financial institutions have rigid collateral and minimum loan size requirements that favor those with equity, which penalizes low-income individuals especially for modest investments. Thus it is useful to consider financing solar PV systems through socially responsible investing (SRI), which seeks to maximize economic and social benefit. Peer-to-peer lending (P2P) as a form of SRI facilitates lending/ borrowing between individuals whose income status can vary, without involving a traditional financial institution, but supported by an online platform organization [24].

P2P lending can involve secured and unsecured loans. Secured loans use the strength of collateral of the borrower to secure the lender's investment in the terms and conditions of the loans, but without the high transaction costs of a bank. Unsecured loans involve a lender's investment based on the borrower's credit rating and other attributes in either direct or pooled lending [25]. In direct lending, money is lent to a specific borrower based on their attributes (e.g. credit score, debt-to-income ratio and income) and the lender assumes a higher risk. In pooled lending, money is lent to a pool of borrowers, which helps mitigates the risk of any individual defaulting on the loan [26].

There are four distinct business models for P2P lending platforms which are (i) microfinance (MF) (non-profit), (ii) social investing (SI) (low return), (iii) marketplace and/or auction (MP/A) (profit maximization-high return) and (iv) social lending service (SLS) (low return between family and friends) [27]. Table 1 summarizes examples of P2P organizations and their characteristics, noting that some show a mixture of business models[1].

MF modeled P2P lending organizations assist MF institutions (MFI) access capital alternatively through the general public who are allowed to participate in the social benefits [27]. A few such organizations exist, although they offer different contribution types. For example, Kiva enables lenders to invest in micro- entrepreneurs in the developing world through an MFI without interest. MYC4, on the other hand, connects lenders anywhere with African entrepreneurs at low interest rates being a mixed SI/ MF model. Microplace allows investment in MFI funds in several locations, including Mexico, India and the United States, for the poor or small entrepreneurs. United Prosperity involves a loan guarantee from the "lender" at no interest to an MFI to raise more funds for micro-entrepreneurs. Wokai enables individuals to use their donations to Chinese entrepreneurs as a tax deduction in the United States. Finally, Energy in Common (EIC) is similar to Kiva, using MFIs to collect data and interact with clients, but focuses on raising funds for energy related investments of the poor, currently primarily in Ghana, but expanding to Nigeria and Tanzania. Unlike the other organizations, their field partners provide the micro-entrepreneur an energy product to improve their business and not money. Investors have the option of recouping their investment at no return with the respective carbon offset, or making a tax deductible donation with the carbon offset retired by EIC. EIC also allows 'nanoloans' requiring only US $5 minimum investment, lower than other systems, but for much shorter loan periods. These extremely small loans are designed to lower the hurdle that prohibits many investors from participating in P2P lending.

TABLE 1. SUMMARY OF EXAMPLES OF P2P LENDING PLATFORMS

Organization	**Business Model**	**Interest**	**Direct/ Pooled**	**Fees**	**Loan term**
EIC, Energy in Common (2010)	MF/ charity	None	Direct	No	< 2 to >12 months
Kiva (2005)	MF	None	Both	No	6-12 months
United Prosperity (2008)	MF/ loan guarantor	None	Pooled	No	variable
Wokai (2006)	MF/ charity	None	Pooled	No	N/A
Microplace (2006)	SI/ MF	1%-6%	Pooled	No	< 1 to >3 years
MYC4 (2007)	SI /MF/A	VR	Both	Yes	6-24 months
Prosper (2006)	MP/ A	MR	Both	Yes	3 years
Lending Club (2007)	MP	MR	Both	Yes	3 years
CommunityLend (2006)	MP/ A	MR	Both	Yes	3 years
Virgin Money (2001/2002)	SLS	FN	Both	Yes	FN

NOTES: MF: Microfinance, SI: Social Invest, A: Auction, MP: Marketplace, SLS: Social lending service, MR: Market rate dependant on risk, VR: Variable rate dependant on risk, FN: Fixed negotiation between family and friends
Sources: [27] and Organization Websites.

The MP model allows investment at rates dictated by the loans market an example of which is the Lending Club. This is sometimes combined with the A model, where lenders can bid interest rates and other loan terms as a competitive market as with Prosper. The A model ensures the borrower gets the lowest possible interest rates. Lastly, a SLS like Virgin Money is a facilitator for loans between family and friends only that does the paperwork and processes the transactions.

3.2 Connections between solar PV and P2P Lending

P2P lending has some existing application in solar PV deployment. For example, Prosper has green loans for green home improvement projects, which includes using renewable green energy like solar PV to get "off the grid". As mentioned before, EIC specifically raises funds to distribute energy products to micro-entrepreneurs (over 344 projects to date), the vast majority of which are currently solar PV based (95%). Finally, ArcFinance, providing 'P2P' between MFIs and energy enterprises, implemented an end-use finance program in Ethiopia for solar products employing a revolving fund with the US Solar Energy Foundation. Innovatively, traditional P2P lending could be expanded to facilitating capital to increase solar PV deployment globally. Under a P2P lending framework, lenders could direct their money to solar PV projects around the world while either gaining a return on investment for on-grid PV under a FIT program or carbon offsets from an off-grid application. Engaging the participation of low-income persons in solar PV deployment under FITs or in rural off-grid projects with P2P lending is one method to maximize the economic benefit to the poor while helping with climate change initiatives [7].

4. INNOVATIVE PEER TO PEER LENDING TO ACCELERATE PV DEPLOYMENT

All P2P lending network business models outlined here provide an accessible form of capital for even low-income individuals to invest in solar PV. However, an innovative global P2P lending network could provide the necessary financing to maximize the benefits of solar PV globally either on-grid (Option A) or off-grid (Option B).

4.1 Model Framework Option A: On-Grid PV with FIT

FIT programs are numerous and can be observed around the world through reports such as [4], providing the market for a global lending framework. Fig. 1 illustrates the basic framework for the proposed ideal P2P lending, FIT supported PV (P2P-FIT-PV) network. The income from the FIT for the PV system would allow the borrower to be an energy micro-entrepreneur. Existing P2P business models currently do not lend the large sums of required capital for PV projects, nor do they allow a long enough payback period to fully exploit the FIT programs as seen in Table 1. In the proposed system, online profiles would include accurate predictions of the PV system performance and costs, along with internal rate of return (IRR)[2] and payback period, using open-sourced software like RETScreen4 [28]. Thus, potential lenders could assess the project return on investment, and for added confidence, the project profile could be certified by a third party. Based on the PV project's financial analysis, the borrower or the P2P network would set the loan terms and lenders would choose their contribution depending on the business model employed. Interestingly, direct lending could be given to a particular energy-entrepreneur for a single PV project, or indirect/ pooled lending could support a group of similar PV projects. In pooled lending, this could be a community or co-operative based PV project. An opportunity of the FIT is using a waterfall payment scheme combined with an Escrow account to ensure investors are repaid. As shown in Fig. 1, as the solar PV panels generate income, payments due to the lender would primarily flow into a holding account (to earn interest) with the remainder forming the secondary flow to the borrower monthly or yearly for the loan term. An additional possibility is for those contracts that do not have a return, either a tax deductible donation could be made, or certified carbon offsets received arranged by the P2P organization.

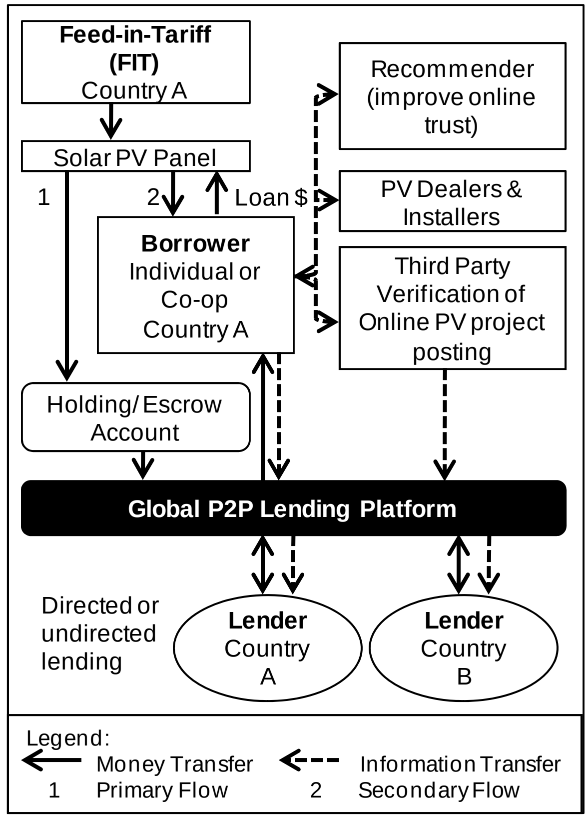

Fig. 1: Schematic of P2P-FIT- PV Network

Since all existing P2P portals have a web interface, opening access to members globally should be possible. However, modifications of loan conditions are needed to take full advantage of earning potential, and will require long-term investment on the part of the investors. The required modifications include (i) larger and longer loan terms; (ii) methods to invoke online trust and reduce risk of default (such as guarantors and recommendations from a social network); and (iii) using PV panel insurance and manufacturer warranty for the loan term for loan security [Branker et al., 2011]. The guaranteed contract of the FIT provides low credit risk mitigation, and a policy that would enforce loan repayment as the first priority would offer additional security [16]. Sec. 5 will illustrate the financial implications of the P2P-FIT-PV network for existing models.

4.2 Model Option B – Off- Grid PV

Beyond FITs, a global P2P lending network could support off-grid solar PV in a business model similar to EIC. Fig. 2 illustrates how the network would function. Field partners in the respective countries working with the P2P global organization would assess the energy needs and business potential of the micro-entrepreneur. Working with solar PV retailers and the borrower, a solar PV system would be chosen and the necessary loan requirements would be communicated to the P2P profile.

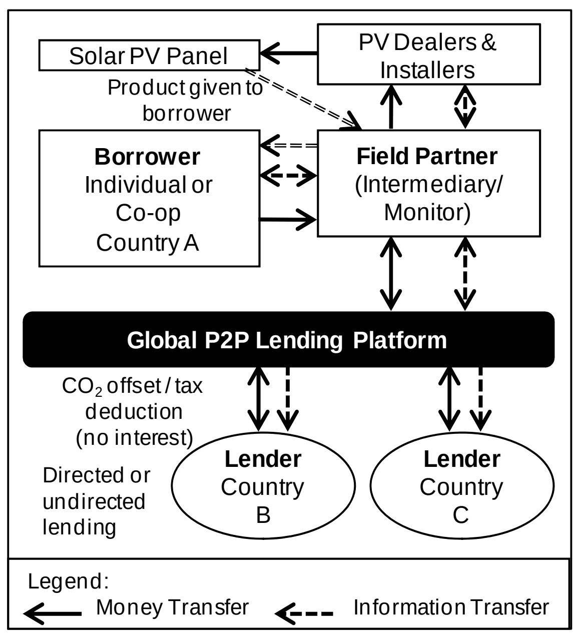

Fig. 2: Schematic of P2P-off grid- PV Network (adapted from EIC model)

Lender's can then assess the profile of the borrower, along with detailed investment information based on the micro-business and decide if they want to lend for a specific duration or donate. As with the EIC model, the field partner purchases and distributes the solar PV product to the borrower, who is then monitored for system satisfaction, business growth and loan repayment with or without interest. This ensures the benefit of the solar system is received and the money not associated with other expenditures. Finally, the field partner would monitor the GHGs before and after solar PV installation and determine the carbon offset during the loan term to be given to the lender or used by EIC in the case of a donation.

Although EIC fits closely with the framework, some modifications required for global success include: (i) third party verification or quote comparisons to ensure fair solar PV system costs; (ii) using only products with good (> 10 -20 years) manufacturer's warranty to reduce maintenance burden; and (iii) ensuring that tax deductions or carbon offsets will be recognized by lenders' countries. Furthermore, the knowledge base could be developed locally to manage the systems and other appropriate technologies that could be supported by solar PV. For example, it has been proposed that PV powered 3D-printers could be used for local manufacturing of appropriate technologies [29]. If the P2P lending network works with MFIs to target borrowers, care must be taken not to apply undue coercion for investment and efforts must be made to promote other financial services like savings accounts and budgeting.

Finally, elements of option A and B could be combined such as using carbon offsets, no return and a field partner in Option A. Option B could have a return if the business is improved that much by having the energy product and loan terms and amounts could be increased for B as in A.

5. CASE STUDIES: ON-GRID AND OFF-GRID

5.1 P2P lending for an Ontario PV Rooftop (on-grid-FIT)

Here, a case study is provided to show how the P2P-FIT-PV framework might function financially for an individual project when a working system is in place. First the investment potential of the PV under the FIT is determined and then the various P2P lending models are explored to finance the investment.

The analysis will use the Ontario Feed-in Tariff (FIT)[3] for a 1 kW solar PV system which receives 80.2 ¢/kWh for a period of 20 years for systems <10 kW. The income from the FIT makes the homeowner an energy generator and micro-entrepreneur. Using RETScreen4 [4], a 1 k W PV system in Kingston, Ontario (south facing, 45^o tilt) would generate 1,380 kWh per year (ignoring degradation) which is a FIT income of $1,106.70 per year. Noting that the estimated installed cost of the system is $9,835, a $60 annual insurance cost and an assumed 2% social discount rate, the IRR is 8.6%[5]. Adding a worst case degradation rate of 1% per year, the IRR is 7.6% with a payback period of 9.8 years. If a tax rate of 16.9 % was applied, the IRR and payback would be 5.0% and 12.1 years respectively. It should be noted that depreciation and other tools may be used to improve the taxed investment returns depending on jurisdiction and individual circumstances. Finally, the system would result in an annual GHG reduction of 270 kg of CO_2 emissions/year. Furthermore, if the analysis is expanded under the given assumptions, solar PV investments <10 kW could have IRRs from 4% to 15% depending on the deployed system size and taxation rate, giving the investment possibilities.

Table 2 illustrates how the investment breakdown could look under different existing P2P models with some modifications for loan term and size without the holding account. Note that the loan terms are all 20 years, with the exception of Kiva and EIC (time required to repay loan based on FIT income) and Wokai (donation with no repayment) models. From Table 2, it is clear that taxation has a significant effect on the borrower's income so that policy to make income from systems non-taxable for lower income classes could be beneficial. It is clear that all the models are able to fund the PV system at reasonable interest rates, with the main difference being the borrower's income bracket that is targeted. In the case of the Prosper model, however, if the income from the FIT is taxable, then the borrower loses money. Thus either a lower interest rate (i.e. < 5 %) or making the FIT income non-taxable would be necessary to use the Prosper model.

Recall that the FIT income primarily repays the loan (lenders) and then pays the borrower. A potential benefit to lenders in Option A is the use of a holding account for the loan term (Fig. 1). Using the MicroPlace results from Table 2, with a holding account interest rate of 5% p.a., the P2P interest earned would increase from $5,745.00 to $15,923.38. Allowing this would be akin to an educational savings or supplemental retirement plan whilst contributing to social and environmental benefits. Finally, under the Kiva and EIC models, lending at no interest could come with the additional benefit of getting a carbon offset of roughly 270 kg per year.

5.2 P2P Lending for an African PV Rooftop (OFF-GRID)

There are several examples in the literature of the returns associated with off-grid PV in different places in Africa. In one study, for a 10 W off-grid PV system powering two LED lamps and a radio, the payback period is 2 to 4 years after which energy budgets are reduced 80 to 90%, compared to expenses for kerosene lamps and dry cell batteries [19]. Furthermore, using a 1 kW system for a small village compared to a diesel generator, the PV electricity cost is cheaper once the price of oil is over 50 to 100 $/bbl.

One EIC project involves a US $200 solar home system for a clothing entrepreneur in Ghana that has the potential to reduce 100 kg of CO_2 per year, and increase working capital to US $950 (from US $530 beginning 2009) at the end of 2011, by meeting orders with evening lighting [14]. If the carbon offset, energy cost savings and productivity potential are estimated on the global P2P lending network, as is on EIC, a lender can help fund the solar PV system. In the case above, US $200 would be lent for a year after which the savings and increased business would allow the lender(s) to receive the $200 and a 100 kg of CO_2 offset or a tax refund if donated. If expanded to

TABLE 2. LOAN DETAILS FOR PV WITH ONTARIO FIT FOR DIFFERENT P2P BUSINESS MODELS

	P2P Lending Model *						
	Kiva	**Microplace**	**Prosper**	**Virgin Money**	**Wokai****	**United*** Prosperity**	**Energy in Common**
Loan terms							
Loan Amount (for 1 kW system)	$9,835.00	$9,835.00	$9,835.00	$9,835.00	$9,835.00	$3,278.33	$9,835.00
Years of Loan	**12**	20	20	20	n/a	20	**12**
Interest rate (%) for P2P platform	0.0	**5.0**	**7.0**	5.0	0.0	0.0	0.0
Loan Repayment (no tax)							
Yearly Payment (made using FIT income)	$819.58	$779.00	$915.00	$779.00	$0.00	$0.00	$819.58
Total Payment	$9,835.00	$15,580.00	$18,300.00	$15,580.00	$0.00	$3,278.33	$9,835.00
Total P2P Interest Earned (Lenders)	$0.00	**$5,745.00**	$8,465.00	$5,745.00	$0.00	$0.00	$0.00
Total Borrower revenue (overflow from making payments with FIT)	$2,725.40	$5,354.00	**$2,634.00**	$5,354.00	$1,046.70 /yr	n/a	$2,725.40
Loan Repayment (after tax)							
Yearly Payment (made using FIT income)	$819.58	$779.00	$915.00	$779.00	$0.00	$0.00	$819.58
Total Payment	$9,835.00	$15,580.00	$18,300.00	$15,580.00	$0.00	$3,278.33	$9,835.00
Total P2P Interest Earned (Lenders)	$0.00	$5,745.00	$8,465.00	$5,745.00	$0.00	$0.00	$0.00
Total Borrower revenue (overflow from making payments with FIT)	$485.00	$1,620.00	**-$1,100.00**	$1,620.00	$860.00 /yr	n/a	$485.00

Notes: FIT income is $1,046.70/year without tax, but $ 860/ year with tax of 16.9%, ignoring degradation. * Models include revisions needed using actual nominal interest rates but exclude actual company fees and geographical constraints such as currency risk and inflation. ** Wokai model is a tax refundable donation, not an investment. ***United Prosperity Model is a loan guarantee to get a larger loan, and is repaid when the larger loan is repaid.

larger systems or pooled community lending for bigger businesses, the potential carbon offsets could become substantial. If these carbon offsets are coupled to existing and growing carbon markets [30], they represent a significant supplementary source of income for the project.

6. DISCUSSION

Despite challenges, combining P2P lending platforms with FITs for solar PV or off-grid applications offer several advantages over traditional financial institutions.

The advantages of a P2P-FIT-PV system for lenders include the following: (i) contributing to both social and environmental sustainability, (ii) the ability to make very small investments while earning a reasonable rate of return, tax refunds and/or carbon offsets. For those lenders that cannot either fund an entire PV system themselves due to lack of access to capital, or do not have an appropriate dwelling, they can help other PV projects through P2P lending. For the borrowers, the benefits include: (i) an income stream, (ii) access to necessary capital, and (iii) beneficial environmental contributions.

Some limitations in the approach include the effect of varying exchange rates, inflation and tax rates across international borders. Furthermore, the extent of the FIT policy, local PV prices and expertise will affect the replicability of the projects and return through the network. The disadvantages of the P2P-FIT-PV system could include (i) potential diversion of funds from some developing countries in favor of countries with FITs; (ii) diverting funds to PVs in only locations with FITs may crowd those sectors while leaving other locations underfunded; (iii) more difficult to police than a normal loan; (iv) potential diversion of funds from needed expenses in low-income homes (such as education) in order to generate revenue and; (v) without collateral investors would assume a greater risk of default. None-the-less, having global P2P lending access could create investment swarms to solar PV projects under FITs, even guaranteeing loans for local manufacturing of facilities.

The advantages of the P2P-off-grid-PV system are also enabling lenders to contribute to social and environmental benefits with relatively small payments but instead simply recouping their investment with carbon offsets or making a tax refundable donation. Borrowers receive the greater benefit with improved standard of living, micro-business activity and energy security. Again, differences in economic systems across international borders and PV system expertise will be a hurdle. Further, it is important that tax deductions and carbon offsets are recognized in lenders' countries. In addition, it is necessary to establish regulation in regions where this was implemented to protect individuals from unethical coercion should they be unable to repay their loans, especially if the terms are unreasonable (if unregulated) or if individuals, as is

the case with MF, have multiple loans simultaneously. However, it is recommended that field partners and P2P organizations take actions to mitigate these.
One concern of the existence of two options is Option A may dominate the investments in solar PV under FITs, depriving the impoverished off-grid communities from the same investment. Although it should be noted that the returns for the off-grid communities are potentially much higher than those from on-grid FITs. The global lending network would need to devise a means of investment sharing between initiatives. Finally, in both cases, the web-based P2P lending platform would need adequate protection from hacking, potential fraud through individuals with multiple aliases and planning for increased costs as it becomes a highly complex network.

7. CONCLUSIONS

This paper clearly demonstrated that P2P financing can be an effective means of providing capital to increase solar PV deployment capacity for both on-grid (under a FIT) or off-grid in the developing world, whilst distributing both the environmental and economic advantages throughout the entire population. FIT policies assist PVs in being worthwhile financial investments. However, the long-term nature of the FIT contract requires longer-term repayment plans than are currently offered. For rural / off-grid electrification, solar PV offers high returns from business development and energy cost savings. Furthermore, in both on-grid and off-grid, there is a potential for carbon offsets. Thus, P2P lending platforms, with some adjustment, provide an ideal system to allow micro-entrepreneurs with little or poor credit history to qualify for the favorable loan rates that would allow them to deploy PVs on their properties. This enables the benefits of pro-solar policy to reach lower income families in PV deployment.

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ENDNOTES

[1] Organization websites for P2P lending can be consulted online for further information

[2] OPA Feed-in Tariff: http://www.powerauthority.on.ca/FIT/

[3] RETScreen4 is a decision support tool provided by Natural Resources Canada (NRCan)

[4] The Internal Rate of Return (*IRR*) of the project is considered the discount rate at which the net benefits and costs (or net cumulative cash flows) equal zero. It is also considered the break even interest rate and is compared against other project *IRR*s or an individual's minimum acceptable rate of return to determine which project is most. The payback period or years to positive cash flow is the time to the first year that the cumulative cash flows for the project are positive. Common loan calculation methodology applies compounding interest annually and adding principal and interest payments to create the total annual payment.

[5] US and CAD dollar at parity assumed. Basic financial analysis used with cost-benefit equations adapted from [31] and RETScreen4. Assumptions given based on Kingston, Ontario sources.