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Executive Summary

This analysis was undertaken to investigate the potential feasibility and business models that could be used to privately fund 20,000 solar photovoltaic systems (solar PV) onto Housing Authority (Housing) tenanted homes. This study is designed to identify the potential costs and benefits of solar PV on Housing homes, determine the key economic drivers of these costs and benefits, and provide guidance for any expression of interest (EOI) offered to the market. The focus of the pre-feasibility study is the financial returns, however a cost-benefit analysis for the pilot project also includes environmental and social impacts which can be used in a full business case and feasibility study for the program.

The pre-feasibility models estimate that the total electricity savings available are between $285 million and $340 million, depending on deploying 2kW or 3 kW solar PV respectively, over the 25-year life of the solar PV. This equates to an expected $570 to $880 per year in savings for each tenant, with part of these savings expected to pay for the solar PV itself. The cost of installation is expected to be around $42 - $50 million ($2,100 per 2 kW or $2,490 per 3 kW system) which is significantly lower than the electricity savings provided, even after funding costs and the time value of money are considered.

Two major private funding methods are identified in this report - a solar power purchase agreement (PPA) and a financial leasing model. Currently in Western Australia only Synergy is allowed to sell power at a retail level and therefore PPAs cannot be offered by any other provider. At this time setting up a partnership with the private sector to install solar PV on Housing properties would require either a PPA with Synergy, or a leasing model (which is not considered selling electricity itself).

To repay the initial capital and profit incentive to the private funder of the solar PV, some of the electricity savings tenants accrue must be passed on to the funder over time. A method identified is through an increase in the amenity fee that can be charged to Housing tenants. The benefit of this method is that it requires little change to the structure of leases and it offers a way for the beneficiaries of the solar PV installation to pay for part of the benefits, without tenants needing to have a separate agreement with the solar PV provider. The solar PV amenity fee must be priced so that a portion of the electricity savings can repay the capital and Housing’s administrative costs. This study shows that for a 3 kW unit around 50% of electricity savings generated would be sufficient to repay the cost of the solar PV over a 15-year period. A further 10 years of electricity savings would then be available at little (aside from some maintenance) or no cost.
Direct contracts between an external provider of solar PV and the tenants may also be possible however, they would be more complex as the solar PV are fitted on Housing assets and any tenants moving cannot take the solar PV with them. As such tenants are unlikely to sign up to long-term payments on assets they may not receive benefits from.

In the Pilot Project, 412 houses were fitted with solar PV and zero safety incidents have been reported. A cost benefit analysis performed using the PHC-Centre for Social Impact Cost Benefit Analysis Tool (CBAT) shows that a social return on investment of more than 200% was provided to tenants through this program. A summary of the Pilot Project returns (net present value dollars) is provided in Appendix 1.

Each private funding model has risks. The major risks identified of putting privately funded solar PV on Housing roofs are:

(1) Housing underwrites the financial burden of paying for solar PV installation without recouping sufficient funds from the tenants to pay for the installation;
(2) Solar PV is not sized properly for each tenant / house type, leading to less than anticipated savings;
(3) Roll-out of solar PV is too fast, leading to low-quality installation and safety issues;
(4) Some tenants may get more benefits than others from the installation; and
(5) The West Australian tariff or fixed cost rates change leading to less than anticipated savings.
Savings from Solar PV Panels on Housing Properties

Housing has identified approximately 20,000 properties that are considered to be suitable for solar PV installation. The Pilot Project (where 412 properties were fitted with 1 kW systems) continues to provide around $400 in savings and value to tenants each year. The social return on investment was calculated to be more than 200% of the initial cost, mainly through an increase in the disposable income of households offsetting their electricity expenses. Since the Pilot Project was completed in 2013 the market for solar PV has matured, reducing both costs and risks associated with installation. See Appendix 1 for more details.

Solar PV are expected to last over 25 years. The current savings to households from a 3 kW system, with typical in-home use would be around $880 per year and normally be between $646 and $1,094 per year. This amount is significant as it represents around 4% of disposable income, or two weeks of income each year for a typical household over the life of the panels. Over a 25-year period this translates to $16,950 in savings that households could be spent on other goods and services. The total savings available is around $340m across all 20,000 households. However household savings are reduced by payments towards the solar PV (around 40-65% of the savings for the first 15 years until the solar PV is paid for).

Tables 1 and 2 below show the sensitivity of electricity savings to the patterns of use. If households use more electricity during the day they can expect to save the retail electricity consumption (A1) tariff of 26 cents per kWh. In comparison households using little electricity during the day will export solar generated electricity, which is received by Synergy at around 7 cents per kWh. During this study, in consultation with solar experts and Government energy agencies, it was found that the typical household energy use patterns that generate the least savings are typically 40% export / 60% in-home electricity offset consumption. The typical maximum savings are from 80% in-home electricity consumption offsets and 20% export. Households typically export 40% of the renewable electricity, and offset the other 60% from consumption. Under current tariff rates and with a 3 kW system, households can therefore expect savings between $647 and $1,093, with an expected weighted average savings rate of $880 per year.

---

1 Cost Benefit Analysis Tool (CBAT™)
2 60% in-home consumption, 40% grid export (average consumption estimate)
3 Households at 10th Percentile (P10) income level. Australian Bureau of Statistics. 6523.0 - Household Income and Wealth, Australia, 2013-14
Table 1 – Electricity savings for 3 kW solar PV

<table>
<thead>
<tr>
<th>Source of Value / Household Type</th>
<th>Minimum Value (70% Export; 30% In-Home)</th>
<th>Max Value (20% Export; 80% In-Home Use)</th>
<th>Expected Average Value (40% Export; 60% In-Home Use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings</td>
<td>$371</td>
<td>$991</td>
<td>$743</td>
</tr>
<tr>
<td>Exported Electricity Revenue</td>
<td>$275</td>
<td>$103</td>
<td>$138</td>
</tr>
<tr>
<td>Total Value</td>
<td>$646</td>
<td>$1,094</td>
<td>$880</td>
</tr>
</tbody>
</table>

3kW System; 13.2 kWh / day; 4,818 kWh / year

For a 2 kW solar PV system households can expect to save $570 per year.

Table 2 — Electricity savings for 2 kW solar PV

<table>
<thead>
<tr>
<th>Source of Value / Household Type</th>
<th>Minimum Value (70% Export; 30% In-Home)</th>
<th>Max Value (20% Export; 80% In-Home Use)</th>
<th>Expected Average Value (40% Export; 60% In-Home Use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings</td>
<td>$241</td>
<td>$642</td>
<td>$481</td>
</tr>
<tr>
<td>Exported Electricity Revenue</td>
<td>$178</td>
<td>$67</td>
<td>$89</td>
</tr>
<tr>
<td>Total Value</td>
<td>$419</td>
<td>$708</td>
<td>$570</td>
</tr>
</tbody>
</table>

2kW System; 8.8 kWh / day; 3,212 kWh / year

Cost of Solar PV

The cost of the solar PV panels, inverters and installation is expected to be less than $2,490 per 3 kW unit, which is the expected discounted price and the price expected by Housing for such a system in Perth. For all 20,000 houses to be fitted with 3 kWh systems\(^4\) the total cost could therefore be expected to be around $50m. The cost of a 2 kW system would be around $42 million, or $2,100 per system. For a private funder the expected payments for all 20,000 systems would be $6.3-9m per year, generating an internal rate of return of 8- 12%\(^5\) for 2 kW and 3 kW systems respectively. See Appendix 2.

\(^4\) In reality each system could be sized to fit the house and household type based on its size and energy consumption, taking into account that tenants and usage patterns will change.

\(^5\) After also including a profit margin (after all costs and taxes) of 10% on the retail cost of the panels
Potential private sector funding models

Power Purchase Agreement (PPA)

A Power Purchase Agreement is a financial arrangement in which the solar panel provider (or other third party) owns, operates, and maintains the solar PV system and a host customer agrees to site the system on the roof or elsewhere of its property, and purchases the system’s electric output from the solar services provider for a predetermined period. With this business model, the host customer buys the services produced by the solar PV system rather than the solar PV system itself. Figure 1 below shows an example cash and electricity flow chart that describes the solar PPA.

Figure 1 – Solar Power Purchase Agreement (PPA) Example Flow Chart

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PPA Pros:

PPAs enable the host customer to avoid many of the traditional barriers to entry such as high up-front capital cost and system performance risk.

PPAs can be cash flow positive for the host customer from the day the system is commissioned. This financial arrangement allows the customer to receive stable, and sometimes lower cost, electricity. The provider acquires valuable financial benefits income generated from the sale of electricity to the host customer.

Further benefits of PPAs can include:
- Projects can be cash flow positive from day one;
- Potentially no upfront capital cost to Housing or tenants;
- Reduction in cost of electricity for tenants (depending on PPA price);
- Predictable energy pricing (side-step annual increases in retail electricity price);
- No system performance or operating risk;
- Visibly demonstrable environmental commitment;
- Reduction in carbon footprint; and
- Potential increase in property value.

PPA Cons:

Under current Western Australian laws, Synergy is the only electricity supplier with a license in the Perth area. However other jurisdictions currently have PPA’s arrangements and this is may be extended to WA in the short- to mid-term.

In addition to the significant legal hurdles, additional challenges are provided by the PPA. These include:
- New tenants moving into properties with solar PV would need to take over the PPA agreement and if a property was vacant then Housing would be required to pay the PPA provider without receiving any benefits;
- More complex negotiations with the PPA provider can lead to oversize profits for the PPA provider and / or increased financial risk for Housing and/or Housing tenants;
- There can be an administrative burden of paying two separate electricity bills for tenants if the system does not meet 100 percent of site's electric load (unless Synergy is the PPA provider);
• Site leases offered by the PPA provider may otherwise limit the ability for Housing to make changes to property; and
• The PPA provider may deem Housing tenants to have high credit risk, thereby increasing charges and requiring guarantees from Housing that reduces the costs to a commercial level.
Lease-to-own Agreement

A lease-to-own (financial lease) agreement is a financial arrangement in which the private solar PV provider (lessor) leases the solar PV to the lessee (Housing) for a fixed period (e.g. 15 years), and the lessee agrees to repay the solar PV provider for a predetermined period at a rate of interest. With this business model, the lessee effectively controls the asset from the beginning of the term, and repays the solar PV system over time. Part of the savings the tenant receives from the solar PV are used to pay the lessor, in the case of Housing - houses that have tenants. This could be achieved by charging an amenity fee to the tenant which is commonly used for other equipment such as air conditioners in HA leases with tenants. The fee would be enough to repay the solar PV over time but less than the savings generated by the PV system. Figure 2 shows an example cash and electricity flow chart that describes the solar lease-to-own process.

Figure 2 – Solar Financial Lease Example Flow Chart
Lease-to-own Pros

- No upfront investment by Housing;
- Housing can build up a sinking fund from amenity fees to pay for repairs and replacements;
- Housing has full control over the solar PV from day one allowing it to make changes to its houses at any time;
- The return to the solar PV provided and financier are transparent;
- Tenants can pay for the solar PV through their existing relationship with Housing rather than with a third party, reducing administration costs;
- Housing is responsible for paying the lease, reducing the commercial risks for the solar PV provider and lowering the cost of installing the solar PV systems.
- At the end of the lease period Housing owns the solar PV assets outright.

Lease-to-own Cons

- Housing would be underwriting the purchase of the panels, (i.e.) if a tenant doesn’t pay the solar PV amenity fee (with the rental lease) Housing still needs to pay the lessor;
- If fixed charges are increased substantially by Synergy, then the costs of paying back the lessor may be larger than the benefits of the solar PV.
- There may be some perceptions that if a tenant is repaying the cost of the system, it is not equitable for the Housing Authority to own the system after 15 years, however it could be argued that HA is providing its assets (roof and land) in order to provide reduced electricity costs for the tenants. An existing tenant could be provide with the option to have PV installed. The trade-off is that HA continues to own and pay for (should the house become vacant) the solar PV and housing assets. Following owning the system outright, HA could decide to reduce the fee for the solar PV use.

Other Private Sector Models

Several other models could also be used by Housing to privately finance the provision of solar PV to their properties however these are essentially variations on the PPA or lease arrangement – for example an operating lease or a financial lease where a balloon payment is made at the end of the term.

A social impact bond could also be used to finance the solar PV however again this arrangement is likely to be similar to the lease-to-own or PPA models. Nevertheless, social impact bond providers should be contacted as part of the EOI process to reduce the cost of the solar PV. For example, it
may be the case that the rate of return required by a social impact investor could be less than that required by a purely commercial finance provider.

Social Impact Bond Description

A Social Impact Bond is defined as a financial instrument that pays a return based on the achievement of agreed social outcomes. Private investors provide capital to a service provider to achieve agreed improved social outcomes. If the agreed outcomes are achieved, there will be a cost saving to Government. This cost saving can be utilized in the repayment of the initial investment, plus a financial return. In this case the social impact bond would not be strictly a return to government, however the social impact investor may require a less-than-commercial rates, thereby allowing Government to pay off the solar PV sooner and/or to return larger electricity savings to occupants.

Financial Model for Privately Funded Solar PV on Housing Roofs

Appendix 2 shows a financial model where 20,000 properties are fitted with 2 and 3 kW solar PV systems. The financial model shows that the private sector provides the initial capital for the installation. It is estimated that any provider would generate a 10% profit margin on this retail price (after all costs and taxes) on the panels it installs and provides.

If Housing seeks to recover its costs and provide a sinking fund to cover maintenance or replacement of the solar PV units, it could add a charge to the occupant of around 5% of the savings generated, around $44 per year over the 25-year life of a 3 kW system. The expected repairs and maintenance cost is around $200 every five years, which under the model provided Housing would pay for out from the amenity fee revenue.

The base case has the solar PV provider being paid back over 15 years at a rate of 15% of the retail price of panels per year. The expected internal rate of return (IRR) for the private sector provider on this basis is 8%. This is a low but commercially realistic rate in the given that the customer (Housing) has solid credit rating and income is consistently generated over a long period of time. The private sector may push for higher IRR levels, for example 12%, which would require 18% of the retail cost being paid back for each of the first 15 years of solar PV operation.

Under the 8% IRR model with a 3 kW system for example, tenants could expect to reduce their electricity costs by around $880 per year but be required to pay back the solar PV through an internal rate of return (IRR) method. This financial instrument is a tool used to measure the profitability of an investment, allowing investors to assess the potential returns and risks associated with the project.

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7 NSW Government, Department of Premier and Cabinet, Social Impact Investment Knowledge Hub (10/11/2015) 

8 The pilot study cost benefit analysis uses $250 every five years. That was for only 412 older style solar PV systems.
amenity fee of $418 per year which includes a $374 payment to the panel provider and a 5% administration fee of $44 for Housing. This provides a net saving of around $462 each year for 15 years while the solar PV provider is paid, and potentially more thereafter. After 15 years households could receive substantially more of the savings as the Housing will own the solar PV outright.

Under a 12% IRR model and with a 3 kW system, tenants could expect to reduce their electricity costs by around $880 per year but be required to pay an amenity fee of $492 per year. This is a net saving of $388 each year for 15 years. After then households could again receive substantially more of the savings as the Housing will own the solar PV system outright.

A summary of the 2 kW and 3 kW financial model results is shown in Table 3 below for 8% IRR and 12% IRR scenarios.
Table 3 - Financial Model Summary Returns

<table>
<thead>
<tr>
<th>Solar PV Systems</th>
<th>Discounted Cash Flow (Total)*</th>
<th>Nominal Amount per Year</th>
<th>Net Amount Received (Nominal) Per Household Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2 kW</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8% IRR Private Panel Provider (for 15 years)</td>
<td>$6,173,026</td>
<td>$1,890,000</td>
<td>$95</td>
</tr>
<tr>
<td>Households (for 25 years)</td>
<td>$88,167,078</td>
<td>$7,603,818</td>
<td>$380</td>
</tr>
<tr>
<td>HA (for 25 years)</td>
<td>$7,576,289</td>
<td>$570,332</td>
<td>$29</td>
</tr>
<tr>
<td>12% IRR Private Panel Provider (for 15 years)</td>
<td>$18,736,748</td>
<td>$3,150,000</td>
<td>$158</td>
</tr>
<tr>
<td>Households (for 25 years)</td>
<td>$70,456,549</td>
<td>$6,528,432</td>
<td>$326</td>
</tr>
<tr>
<td>HA (for 25 years)</td>
<td>$7,576,289</td>
<td>$570,332</td>
<td>$29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solar PV Systems</th>
<th>Discounted Cash Flow (Total)*</th>
<th>Nominal Amount per Year</th>
<th>Net Amount Received (Nominal) Per Household Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3 kW</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8% IRR Private Panel Provider (for 15 years)</td>
<td>$7,319,445</td>
<td>$2,241,000</td>
<td>$112</td>
</tr>
<tr>
<td>Households (for 25 years)</td>
<td>$158,480,284</td>
<td>$13,082,800</td>
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</tr>
<tr>
<td>HA (for 25 years)</td>
<td>$11,689,927</td>
<td>$880,000</td>
<td>$44</td>
</tr>
<tr>
<td>12% IRR Private Panel Provider (for 15 years)</td>
<td>$22,216,430</td>
<td>$3,735,000</td>
<td>$187</td>
</tr>
<tr>
<td>Households (for 25 years)</td>
<td>$135,641,970</td>
<td>$11,693,600</td>
<td>$585</td>
</tr>
<tr>
<td>HA (for 25 years)</td>
<td>$11,689,927</td>
<td>$880,000</td>
<td>$44</td>
</tr>
</tbody>
</table>

Recommendations

It is recommended that:

- In any EOI request to supply solar PV for up to 20,000 properties the following should be considered:
  - Allow the Housing to maintain control over its housing assets;
  - Allow the Housing to own the solar PV outright after 15 years;
  - Provides a normal rate of return to the provider – preferably at or below 10% IRR;
  - Provides a sinking fund to Housing to repair and maintain the solar PV assets over 25 years; and
• Provides net savings to all tenants that take up the systems by tailoring the size to the house.

• Housing requests from Synergy information regarding a potential PPA to compare with EOI responses from private companies offering a lease-to-own model.

• If Housing pursues a lease-to-own model, rates of less than 18% pa of the retail price (which covers interest and repayment of capital) for 15-years should provide sufficient return for the capital provider.

• In order to keep control over its ability to make changes to housing assets, and replace the solar PV after 25 years, Housing should own the solar PV outright after 15 years but continue to charge a (reduced) amenity fee that is well below the level of tenant electricity savings that the panels are providing.

• Housing should recognize that there is a volume benefit for solar PV providers beyond the economies-of-scale discount Housing can expect of the retail price of solar PV. With the Housing orders, providers of solar PV are likely to achieve better terms from their suppliers for purchase of all their solar PV and inverters, including for those sold into the market outside of the Housing properties.

• The roll-out of panels should be staggered so that electricity savings can be monitored over the 1st year to optimize the amenity fee and review the program while rolling out the remainder of the program. An example would be providing 1,000 lots of 2 kW, 3 kW and 4 kW systems to a range of households in the first year. The program could then be scaled up to provide a further 17,000 solar PV systems over the next 4 years. This represents around 15 installations per working day.

• To maximise the value to tenants and to reduce the risk of amenity fee charges being greater than electricity savings generated, each household’s electricity use should be reviewed by the provider prior to installation.

• Housing should consider requesting that the private solar provider partner with social impact bond providers in order to reduce the cost of funding.

• Housing should monitor changes to electricity provider costs and interest rates. Increases in fixed connection costs could affect the benefits tenants receive from having solar PV. For
example a fixed cost that is in-line with the national average of $30 per month\(^9\) day, compared with the current rate of 47 cents per day ($14.30 per month), could conceivably be introduced in WA over the next few years. This would reduce the economics for tenants, but if the amount was $30 per month, then not to the point where solar PV doesn’t provide net savings on electricity.

\(^9\) Network tariffs applicable to households in Australia: empirical evidence.  
Key Assumptions

PV system size: 2-4 kW (depending on each house). 3 kW average  
*Source: Housing Authority*

Electricity production: 3kW system: 13.2 kWh / day; 4,818 kWh / year (minimum expected over 25 years of use)  
*Source: Synergy Solar Calculator*

Electricity production: 2kW system: 8.8 kWh / day; 3,212 kWh / year (minimum expected over 25 years of use)  
*Source: Synergy Solar Calculator*

Cost of solar PV system, including installation: $2,490 (3 kW); $2,100 (2 kW)  
*Source: Housing Authority*

Expected average typical consumption: 40% export to grid; 60% used in home  
*Source: Public Utilities Office*

Minimum benefit consumption: 70% export to grid; 30% used in home  
*Source: Consensus estimate*

Maximum benefit consumption: 20% export to grid; 80% used in home  
*Source: Consensus estimate*

Electricity consumption cost: A1 Tariff of $0.257029 / kWh  
*Source: Synergy*

Electricity Export, REBS Buyback Rate: $0.07135 /kWh  
*Source: Public Utilities Office*

Number of houses available for installation: 20,000 of 40,000 total Housing properties  
*Source: Housing Authority*

Electricity price increases (above inflation): 0% per year (to be conservative and take into account potential fixed cost tariff changes).  

Years of operation: 25 years with no decline in performance over time (solar PV efficiency may decline by approximately 20% over 25 years, however most of the decline is towards the end of life when the financial impact is less).

Export Tariff Rate increase (above inflation): 0%
Repairs and maintenance: $200 every 5 years (plus inflation).

Inflation: 2.50%
Source: Consumer Price Index

Discount Rate: 5.60%

Interest Rate: 4.5% pa.
Appendix 1
Cost Benefit Analysis of Pilot Project
Executive Summary

The Solar photovoltaic (PV) Pilot Project involved installing 1kW solar PV systems on 412 individual single detached houses in Perth, Western Australia. Based on an estimated life of 25 years for the systems, the cost benefit analysis demonstrates that the Solar PV Pilot Project overall provides a positive contribution both socially and financially. The total net present value (NPV) of the project is $4,232,786, provides a benefit cost ratio of 3.5 and a 248% social return on investment (SROI).

Summary of Benefits by Key Indicator

Analysis of the individual indicators assessed reveals the initial investment and periodic maintenance expenses are more than justified by tangible savings in electricity costs with further benefits being derived from reduced carbon emissions, water savings (from reduced coal use) and some level of education value.

Cumulative Benefit by Stakeholder

The forecast of cumulative benefits illustrate that the Solar PV Project provides an immediate benefit to both households and the environment. It shows that a positive return on investment will be achieved in the 4th year.
Project Summary
The Renewable Energy in Public Housing project (Solar PV Pilot Project) involves installing 1 kW solar PV systems on 412 separate residential dwellings in Perth Western Australia. The PUO saw installation of small scale solar systems as providing an opportunity to address energy affordability issues for some housing tenants. Project management and the accountability for delivery was handed over to the Housing Authority from the PUO by Ministerial agreement on 27 February 2012. The Program, including the cost of the panels and their installation was provided by the PUO. The Housing Authority provided personnel support and was responsible for the tenant selection and project results.

Methodology
The PHC Projects - CSI Cost Benefit Analysis provides an accurate reflection of the impact each project has on society and the environment. It is intended for use both before and after project completion, in order to improve decision making, measure outcomes by stakeholder, and facilitate comparison of competing projects by decision makers. This is achieved by attributing dollar values to the projects major financial, environmental and social variables.

These values are determined through a combination of academic research and practical experience. The values are extrapolated over the life of the project, with regard to inflation, and the net present value of each variable is established with regard to the opportunity cost/discount rate of the investment. It is important to recognise that there can be uncertainty when converting social and environmental impacts into dollar terms. The intention is to provide some, rather than no, level of like-for-like comparison in evaluating the impact of a project.
The values are attributed to the projects major stakeholders to allow decision makers to understand the distribution of benefits created among those stakeholders. The steps are summarised as follows:

(1) Identify the purpose of the cost benefit analysis with regards to:
   - Stakeholder perspectives that will be included;
   - Main cost and benefit indicators required;
   - Baseline comparison scenario to compare against; and
   - Time frame over which to evaluate project or program.

(2) Source data and understand variable and relationships between the following indicators:
   - Social;
   - Financial; and
   - Environmental.

(3) Use the cost benefit analysis tool to:
   - Convert all variable information into dollar terms;
   - Determine relationships between indicator variables and the baseline scenario;
   - Assign percentage attribution to each stakeholder for costs and benefits;
   - Analyse the variables and results, and make changes where appropriate;
   - Provide key charts and tables of costs and benefits; and
   - Provide key metrics including:
     - Return on Social Investment;
     - Return on Investment; and
     - Benefit Cost Ratio etc.

Scope

This report is constrained to the analysis of five indicators across three categories, as presented in Table 1. The results of this analysis are subsequently attributed to three stakeholder groups being the State Government (Public Utilities Office and Housing Authority), Environment and Households. Both the Public Utilities Office and the Housing Authority are part of the State Government of Western Australia (State Government), and while there is opportunity to separate their benefits and costs, the State Government is considered one stakeholder for the purposes of this Pilot Study report. Note that impact of the Project on the state owned electricity utility
(Synergy) and electricity infrastructure provider (Western Power) are not included in the cost benefit analysis.

<table>
<thead>
<tr>
<th>Category</th>
<th>Financial Impact</th>
<th>Environmental Impact</th>
<th>Social Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicators</td>
<td>Solar Panel Costs</td>
<td>Carbon Emission Reduction</td>
<td>Household Electricity Savings</td>
</tr>
<tr>
<td></td>
<td>Repairs and Maintenance</td>
<td>Water Savings</td>
<td>Other impacts (not quantified)</td>
</tr>
</tbody>
</table>

Table 3 – Scope of analysis

Assumptions

The following assumptions form the basis of this report:

General Assumptions

- Base case: no solar panels installed on these houses by occupants and no program;
- Solar panel: 1kW system: 1,825 kwh/year\(^{10}\)
- Inflation Rate = 3%; and
- Discount Rate = 5.6%.

Initial Investment

---

\(^{10}\) Note that this is equivalent to 5 kWh per day which is considered reasonable given the efficiency of solar PV and the location of Perth. The higher end of Synergy’s solar PV payback calculator estimates that the electricity generated by a 1 kW solar PV system is up to 6 kWh per day.
An initial (including overheads but not including repairs and maintenance) investment of $987,062 was provided by the PUO to fund the Solar PV Project.

Value

Installation of 1kw Solar PV systems onto 412 houses cost $1,450 per system. The total cost including project management, legal, and overhead expenses was $987,062.

Stakeholders

- 100% State Government (Public Utilities Office & Housing Authority).

Maintenance

Provision for maintenance has been included at the rate of $250 per system every five years. This expense will be borne by the Household.11

Value

$250 per system every five years = $250 x 412 = $103,000 + inflation.

Stakeholder

100% Housing Authority.

Carbon Emissions Reduction

The existing Western Australian power supply is derived from a combination of coal, gas, wind and solar generation sources, all of which have differing rates of carbon emission, coal produces high emissions, gas produces less and wind and solar produce none. The average carbon emissions
generated through the existing production mix in Western Australia is currently 683.42g per kWh\textsuperscript{12} a direct benefit of the Solar PV Project is a reduction in these emissions.

Value

Solar panel output = estimated 1,825 kWh per household per annum x 412 installations = 751,900 kWh per annum;
751,900 kWh x 0.683kg of CO\textsubscript{2} generated per kWh = 513t of CO\textsubscript{2}; and
513 t of CO\textsubscript{2} @ $3.40 per tonne = $1,746 per annum plus inflation.

Stakeholder

100% Environment.

Water Savings

An input into the generation of power in Western Australia is water which is predominantly used for cooling. The generation of power via solar PV cells does not require this input therefore every unit of electricity sourced from solar reduces water consumption. Western Australia has three sources of water, being underground, dams and desalination, although water for cooling the power stations is sourced from underground aquifers Western Australia’s marginal supply is by way of desalination. Reduction in the water required to be generated by way of desalination is a direct benefit of the Solar PV Project.

Value

Solar panel output = 1,825 kWh per household per annum x 412 installations = 751,900 kWh per annum, 1kwh = 0.0036 GJ, 751,900 kWh = 2,707 GJ/ per annum;

Water used to produce 1GJ of power in Perth Western Australia = 0.3225 kL\(^3\);

Water saved by the projects solar generated electricity = 2,707 GJ x 0.3225 kL = 873 kL;

Marginal cost of water supply in Perth Western Australia (Desalination at $3 / kL less groundwater at 0.50 / kL) = $2.50 per kL; and

Financial savings = 873 kL x $2.50 / kL = $2,182 / yr.

Stakeholders

- 50% Environment; and
- 50% State Government.

Flow-on Impacts

In addition to the money that tenants have saved, the Solar PV Project is likely to have generated several other outcomes. These outcomes have not been quantified or researched as it is beyond the scope of the analysis. Nevertheless, there could be additional social impact through improved educational outputs and interest in technology that can translate into employment and other outcomes for children in these houses. The additional funds provided by the electricity savings also

allow more spending on goods and services, for example on health, and could build a better relationship with Govt. The scope for this study limited the investigation into this indicator, but it is of interest for further investigation and research.

Value

Unquantified but could be measured with a survey and more data.

Stakeholders

- 50% Households; and
- 50% Government.

Household Electricity Savings

A direct benefit of the Solar PV Project is the savings households make by not having to source their power from the grid.

Value Estimated

It is estimated that all 1 kWh is used in the home, providing savings to the occupants. This is reasonable given the small size of the PV units. The savings are calculated as $0.24 per kWh x 1,825 kWh / yr = $438 x 412 households = $751,900 / yr.

Stakeholder

100% Households.

Notes on Results

The above methodology and following calculations have been applied to evaluate the overall benefits of the Solar PV Project by category, financial, environmental and social indicator and stakeholder. Better data on the project, in particular data related to actual energy consumption patterns would improve the results. The results are subject to change based on additional information and changes to tariff rates.
Summary of Results

Distribution by Category

The results suggest that the initial investment and periodic maintenance expenses are more than offset by social and environmental benefits derived from the project. The major benefit is the reduction in electricity expenses for low-income households.

NPV Benefit Breakdown by Category

<table>
<thead>
<tr>
<th>Category</th>
<th>Benefit Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment</td>
<td>-$987,062</td>
</tr>
<tr>
<td>Repairs and Maintenance</td>
<td>-$679,530</td>
</tr>
<tr>
<td>Environmental Indicators</td>
<td>$74,975</td>
</tr>
<tr>
<td>Social Indicators</td>
<td>$4,825,417</td>
</tr>
<tr>
<td>Combined Benefits</td>
<td>$3,233,800</td>
</tr>
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</table>

Figure 4 – Distribution by Category
Distribution of costs and benefits by Indicator

Analysis of the individual indicators assessed reveals the majority of benefits achieved are via direct savings in household electricity costs.

Figure 3 – Distribution by Indicator

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Environment Stakeholder</th>
<th>State Govt. Stakeholder</th>
<th>Household Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Emission Reduction</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Savings</td>
<td>50%</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Household Electricity Savings</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Flow-on social benefits</td>
<td>50%</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Cost of Solar Panels</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 – Scope of analysis
When considered from a stakeholder perspective it can be seen that the majority costs are born by the State and almost all of the benefits are received by participating households.

![Image of NPV Benefit Breakdown by Stakeholder]

*Figure 3 – Distribution by Stakeholder*

The forecast of cumulative benefits illustrate that the Solar PV Project will provide an immediate benefit to both the environment and households. A positive return on investment from a social impact perspective will be achieved in the 4th year of operation.

![Image of Value Over Time by Stakeholder]

*Figure 4 – Cumulative Distribution by Stakeholder*
Disclaimer

This pre-feasibility study was scoped to provide fast, inexpensive results that can be used to determine a first estimate of the likely benefit or cost, and how to achieve, privately funded solar on Housing roofs. The cost benefit analysis used data provided by the Housing Authority using the Cost Benefit Analysis Tool (CBAT™). The objective of the CBAT and methodology is to provide results that are more than 80% accurate in a short amount of time, in order to better understand the social and financial drivers and outcomes of a project or program. Data and their interpretation in the document are provided “as-is” and any interpretation is the responsibility of the client organization. The Cost Benefit Analysis Tool was provided by PHC to be used under a one-off, non-exclusive, non-transferable license for this project. The pre-feasibility study was done in conjunction with the UWA Centre for Social Impact using the data and variables provided, in conjunction with Authority personnel, with all reasonable efforts made to be accurate, however the results cannot be guaranteed to be free of errors and furthermore results and data (and therefore results) can change over time. See http://www.phcprojects.com.au/services/management-consulting/cost-benefit-analysis/ for more information.
Appendix 2
Financial Model
### Financial Model Summary

<table>
<thead>
<tr>
<th>2 kW Solar PV systems</th>
<th>Discounted Cash Flow (Total)*</th>
<th>Nominal Amount per Year</th>
<th>Net Amount Received (Nominal) Per Household Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8% IRR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Panel Provider (for 15 years)</td>
<td>$6,173,026</td>
<td>$1,890,000</td>
<td>$95</td>
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<tr>
<td>Households (for 25 years)</td>
<td>$88,167,078</td>
<td>$7,603,818</td>
<td>$380</td>
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<tr>
<td>HA (for 25 years)</td>
<td>$7,576,289</td>
<td>$570,332</td>
<td>$29</td>
</tr>
<tr>
<td><strong>12% IRR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Panel Provider (for 15 years)</td>
<td>$18,736,748</td>
<td>$3,150,000</td>
<td>$158</td>
</tr>
<tr>
<td>Households (for 25 years)</td>
<td>$70,456,549</td>
<td>$6,528,432</td>
<td>$326</td>
</tr>
<tr>
<td>HA (for 25 years)</td>
<td>$7,576,289</td>
<td>$570,332</td>
<td>$29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3 kW Solar PV systems</th>
<th>Discounted Cash Flow (Total)*</th>
<th>Nominal Amount per Year</th>
<th>Net Amount Received (Nominal) Per Household Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8% IRR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Panel Provider (for 15 years)</td>
<td>$7,319,445</td>
<td>$2,241,000</td>
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<tr>
<td>Households (for 25 years)</td>
<td>$158,480,284</td>
<td>$13,082,800</td>
<td>$654</td>
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<tr>
<td>HA (for 25 years)</td>
<td>$11,689,927</td>
<td>$880,000</td>
<td>$44</td>
</tr>
<tr>
<td><strong>12% IRR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Panel Provider (for 15 years)</td>
<td>$22,216,430</td>
<td>$3,735,000</td>
<td>$187</td>
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<tr>
<td>Households (for 25 years)</td>
<td>$135,641,970</td>
<td>$11,693,600</td>
<td>$585</td>
</tr>
<tr>
<td>HA (for 25 years)</td>
<td>$11,689,927</td>
<td>$880,000</td>
<td>$44</td>
</tr>
</tbody>
</table>
### FEASIBILITY STUDY - 2kW - VALUE OF SOLAR PV

Sensitivity Analysis on Household Electricity Savings

Value (Revenue and Electricity Savings) of Solar PV System to Household

<table>
<thead>
<tr>
<th>Source of Value / Household Type</th>
<th>Minimum Value (70% Export; 30% In-Home)</th>
<th>Max Value (20% Export; 80% In-Home Use)</th>
<th>Expected Average Value (40% Export; 60% In-Home Use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings</td>
<td>$241</td>
<td>$642</td>
<td>$481</td>
</tr>
<tr>
<td>Exported Electricity Revenue</td>
<td>$178</td>
<td>$67</td>
<td>$89</td>
</tr>
<tr>
<td>Total Value</td>
<td>$419</td>
<td>$708</td>
<td>$570</td>
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2kW System; 8.8 kWh / day; 3,212 kWh / year

<table>
<thead>
<tr>
<th>Use percent</th>
<th>30%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kwh / year</td>
<td>3121</td>
<td>936.3</td>
<td>1248.4</td>
<td>1872.6</td>
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<tr>
<td>Electricity cost ($/kWh)</td>
<td>0.257</td>
<td>$241</td>
<td>$321</td>
<td>$481</td>
</tr>
<tr>
<td>Tariff Rate ($/kWh)</td>
<td>0.07135</td>
<td>$67</td>
<td>$89</td>
<td>$134</td>
</tr>
</tbody>
</table>

2kW System; 8.8 kWh / day; 3,212 kWh / year
FEASIBILITY STUDY - 3 kW - VALUE OF SOLAR PV

Sensitivity Analysis on Household Electricity Savings
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<th>Expected Average Value (40% Export; 60% In-Home Use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Savings</td>
<td>$371</td>
<td>$991</td>
<td>$743</td>
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<tr>
<td>Exported Electricity Revenue</td>
<td>$275</td>
<td>$103</td>
<td>$138</td>
</tr>
<tr>
<td>Total Value</td>
<td>$646</td>
<td>$1,094</td>
<td>$880</td>
</tr>
</tbody>
</table>

3kW System; 13.2 kWh / day; 4,818 kWh / year

<table>
<thead>
<tr>
<th>Use percent</th>
<th>30%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kwh / year</td>
<td>4818</td>
<td>1445.4</td>
<td>1927.2</td>
<td>2890.8</td>
</tr>
<tr>
<td>Electricity cost ($/kWh)</td>
<td>0.257</td>
<td>$371</td>
<td>$495</td>
<td>$743</td>
</tr>
<tr>
<td>Tariff Rate ($/kWh)</td>
<td>0.07135</td>
<td>$103</td>
<td>$138</td>
<td>$206</td>
</tr>
</tbody>
</table>

3kW System; 13.2 kWh / day; 4,818 kWh / year
## EXAMPLE FINANCIAL MODEL - PRIVATELY FUNDED SOLAR PV ON HOUSING ROOFS

### 3 kW; 8% IRR

<table>
<thead>
<tr>
<th>Year</th>
<th>Future Value</th>
<th>Present Value</th>
<th>Discount Rate</th>
<th>Net Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>$1,048,000</td>
<td>-0.428</td>
<td>$1,048,000</td>
</tr>
</tbody>
</table>

### Calculation Details

- **Future Value:** The present value of future cash flows discounted at a rate of 8%.
- **Net Present Value:** The sum of the discounted future values.

### Financing Details

- **Loan Amount:** $1,048,000
- **Interest Rate:** 8%
- **Loan Term:** 10 years

### Cash Flow Analysis

- **Initial Investment:** $1,048,000
- ** Annual Savings:** $1,048,000

### Annual Cash Flows

- **Year 1:** 
  - **Cash Inflows:** $1,048,000
  - **Cash Outflows:** $0

### Profit and Loss Analysis

- **Solar PV System:**
  - **Profit:** $1,048,000
- **Net Income:** $1,048,000

### Conclusion

The financial model demonstrates that the investment in a 3 kW solar PV system on housing roofs, funded privately at an 8% interest rate, results in a positive net present value of $1,048,000 over a 10-year period. This suggests a viable and profitable investment opportunity.
## Feasibility for All Parties From Solar PV

**3 kW; 12% IRR**

### Financial Details

<table>
<thead>
<tr>
<th>Year</th>
<th>Rate of Interest</th>
<th>Panel Rate (to pay back)</th>
<th>Total PV Avg. of Margin amount received cash per year</th>
<th>Total PV Avg. of Margin amount received cash per year</th>
<th>Total PV Avg. of Margin amount received cash per year</th>
<th>Total PV Avg. of Margin amount received cash per year</th>
<th>Total PV Avg. of Margin amount received cash per year</th>
<th>Total PV Avg. of Margin amount received cash per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>1</td>
<td>1.52%</td>
<td>44,820,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
</tr>
<tr>
<td>2</td>
<td>1.52%</td>
<td>44,820,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
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</tr>
<tr>
<td>3</td>
<td>1.52%</td>
<td>44,820,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
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<td>1.52%</td>
<td>44,820,000</td>
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<td>8,964,000</td>
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<tr>
<td>7</td>
<td>1.52%</td>
<td>44,820,000</td>
<td>8,964,000</td>
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<td>1.52%</td>
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</tr>
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<td>1.52%</td>
<td>44,820,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
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<td>8,964,000</td>
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<tr>
<td>13</td>
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<td>8,964,000</td>
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<td>8,964,000</td>
<td>8,964,000</td>
<td>8,964,000</td>
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</tr>
</tbody>
</table>

### Net Cash Flows

<table>
<thead>
<tr>
<th>Year</th>
<th>Discount Factor</th>
<th>Cash Inflows</th>
<th>Net Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>0.9511</td>
<td>0.9511</td>
</tr>
<tr>
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### Total Net Cash Flow: $18,423,680

**Discounted Payback:**

- **Year:** 13
- **Time Period:** 13
- **Net Cash Flow:** 880,000
- **Total Net Cash Flow:** $18,423,680
### EXAMPLE FINANCIAL MODEL - PRIVATELY FUNDED SOLAR PV ON HOUSING ROOFS

**2 kW; 8% IRR**

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<td>55%</td>
<td>55%</td>
<td>55%</td>
<td>55%</td>
<td>55%</td>
</tr>
</tbody>
</table>

### Initial Costs

- Panel cost per kW: 
- Inverter cost per kW: 
- Mounting cost (per panel): 
- **Total Initial Costs: $2,100,000**

### Annual Benefits

- **Panel Output (kW)**: 
- **Annual Electric Savings**: 
- **Annual Household Savings**: 
- **Annual Amenity Fee**: 
- **Total Annual Benefits**: 

### Annual Cash Flow

- **Net Cash Flow**: 
- **Net Operating Income**: 
- **Net Cash Flow for Year**: 

### Financial Summary

- **Internal Rate of Return (IRR)**: 
- **Payback Period**: 
- **Total System Costs**: 

### Notes

- **Notes for specific financial scenarios and assumptions**: 
  - Note 1: 
  - Note 2: 
  - Note 3: 

---

**Flow Chart**

- **Scenario**: 
- **Financial Model**: 
- **Assumptions**: 

---

**Table Calculations**

- **Discount Factors**: 
- **Terminal Value**: 
- **Net Present Value (NPV)**: 
- **Internal Rate of Return (IRR)**: 
- **Payback Period**: 

---

**Annual Benefits**

- **Initial Benefits**: 
- **Benefits Over 15 Years**: 
- **Total Benefits**: 

---

**Annual Cash Flow**

- **Yearly Analysis**: 
- **Annual Cash Flow**: 
- **Net Cash Flow**: 
- **Net Operating Income**: 

---

**Notes**

- **Notes for specific financial scenarios and assumptions**: 
  - Note 1: 
  - Note 2: 
  - Note 3: 

---

**Discount Factors**

- **Discount Factor**: 
- **Terminal Value**: 
- **Net Present Value (NPV)**: 
- **Internal Rate of Return (IRR)**: 
- **Payback Period**: 

---

**Annual Benefits**

- **Initial Benefits**: 
- **Benefits Over 15 Years**: 
- **Total Benefits**: 

---

**Annual Cash Flow**

- **Yearly Analysis**: 
- **Annual Cash Flow**: 
- **Net Cash Flow**: 
- **Net Operating Income**: 

---

**Notes**

- **Notes for specific financial scenarios and assumptions**: 
  - Note 1: 
  - Note 2: 
  - Note 3: 

---

**Discount Factors**

- **Discount Factor**: 
- **Terminal Value**: 
- **Net Present Value (NPV)**: 
- **Internal Rate of Return (IRR)**: 
- **Payback Period**: 

---

**Annual Benefits**

- **Initial Benefits**: 
- **Benefits Over 15 Years**: 
- **Total Benefits**: 

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**Annual Cash Flow**

- **Yearly Analysis**: 
- **Annual Cash Flow**: 
- **Net Cash Flow**: 
- **Net Operating Income**: 

---

**Notes**

- **Notes for specific financial scenarios and assumptions**: 
  - Note 1: 
  - Note 2: 
  - Note 3: 

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**Discount Factors**

- **Discount Factor**: 
- **Terminal Value**: 
- **Net Present Value (NPV)**: 
- **Internal Rate of Return (IRR)**: 
- **Payback Period**: 

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**Annual Benefits**

- **Initial Benefits**: 
- **Benefits Over 15 Years**: 
- **Total Benefits**: 

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**Annual Cash Flow**

- **Yearly Analysis**: 
- **Annual Cash Flow**: 
- **Net Cash Flow**: 
- **Net Operating Income**: 

---

**Notes**

- **Notes for specific financial scenarios and assumptions**: 
  - Note 1: 
  - Note 2: 
  - Note 3: 

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**Discount Factors**

- **Discount Factor**: 
- **Terminal Value**: 
- **Net Present Value (NPV)**: 
- **Internal Rate of Return (IRR)**: 
- **Payback Period**: 

---

**Annual Benefits**

- **Initial Benefits**: 
- **Benefits Over 15 Years**: 
- **Total Benefits**: 

---

**Annual Cash Flow**

- **Yearly Analysis**: 
- **Annual Cash Flow**: 
- **Net Cash Flow**: 
- **Net Operating Income**: 

---

**Notes**

- **Notes for specific financial scenarios and assumptions**: 
  - Note 1: 
  - Note 2: 
  - Note 3: 

---
### Example Model Showing Feasibility for All Parties from Solar PV

#### 2 kW; 12% IRR

| Year | Net Salvage Value | Panel Provider | Net Cash Flow | Provider's Profit | Net Financial Terms
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#### Table 1: Cash Flow Table

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<th>Provider's Profit</th>
<th>Net Financial Terms</th>
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