# Stand-by Rates for Distributed Generation

Michigan Public Service Commission

*Stand-by Workgroup*

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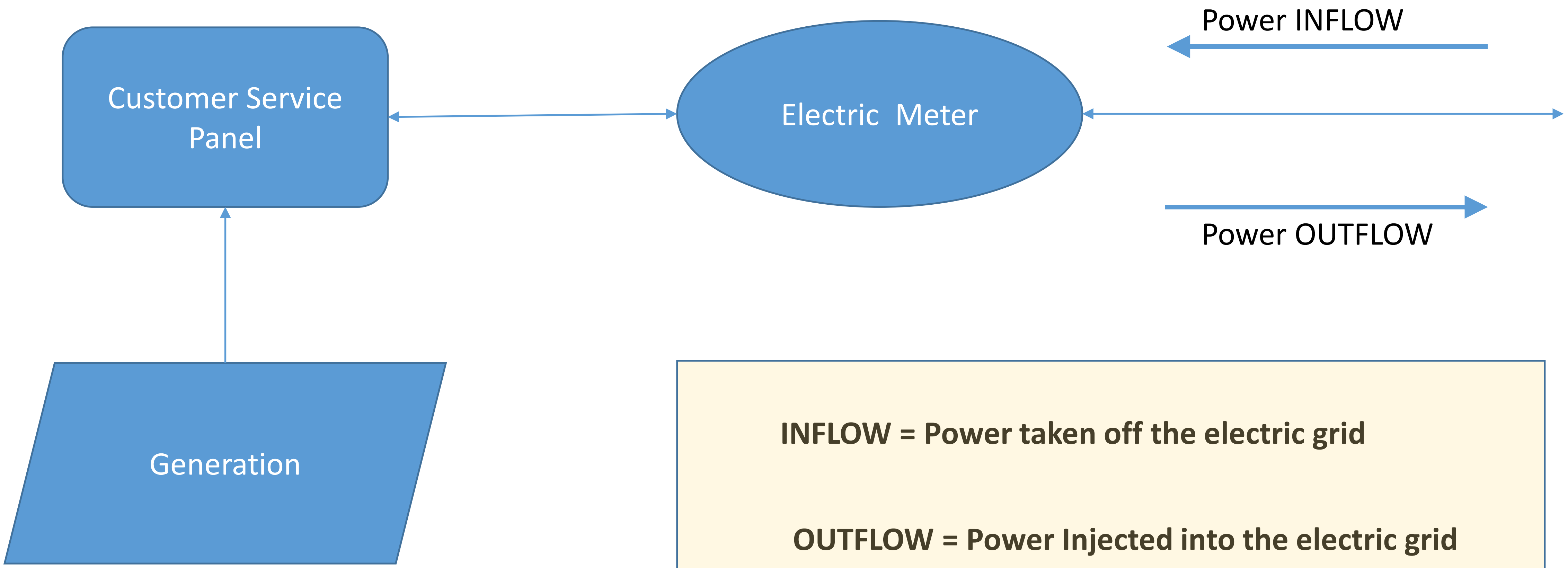
# Prerequisite for Stand-by Rate Design
## Distributed Generation

- Underlying rate structure for DG customers should be cost-of service based
  - Retail rates should recover **actual grid-usage**
  - Any DG rate mechanism can be adjusted to recover actual grid-usage costs
    - May require a bi-directional meter
    - Complex tariffs may result
    - May induce sub-optimal price signals
  - Not all rate mechanisms can take full advantage of:
    - Behind the meter generation as DR
    - Customer-sited energy-storage
  - Simplest mechanism is preferred
  - Must be future-proof

# Distributed Generation Program Design Alternatives

- **Net Energy Metering** (NEM): *understates* Cost-of-Service
- **Buy-all Sell-all** (BASA): *overstates* Cost-of-Service
- **Inflow & Outflow** (I&O): *true* Cost-of-Service mechanism

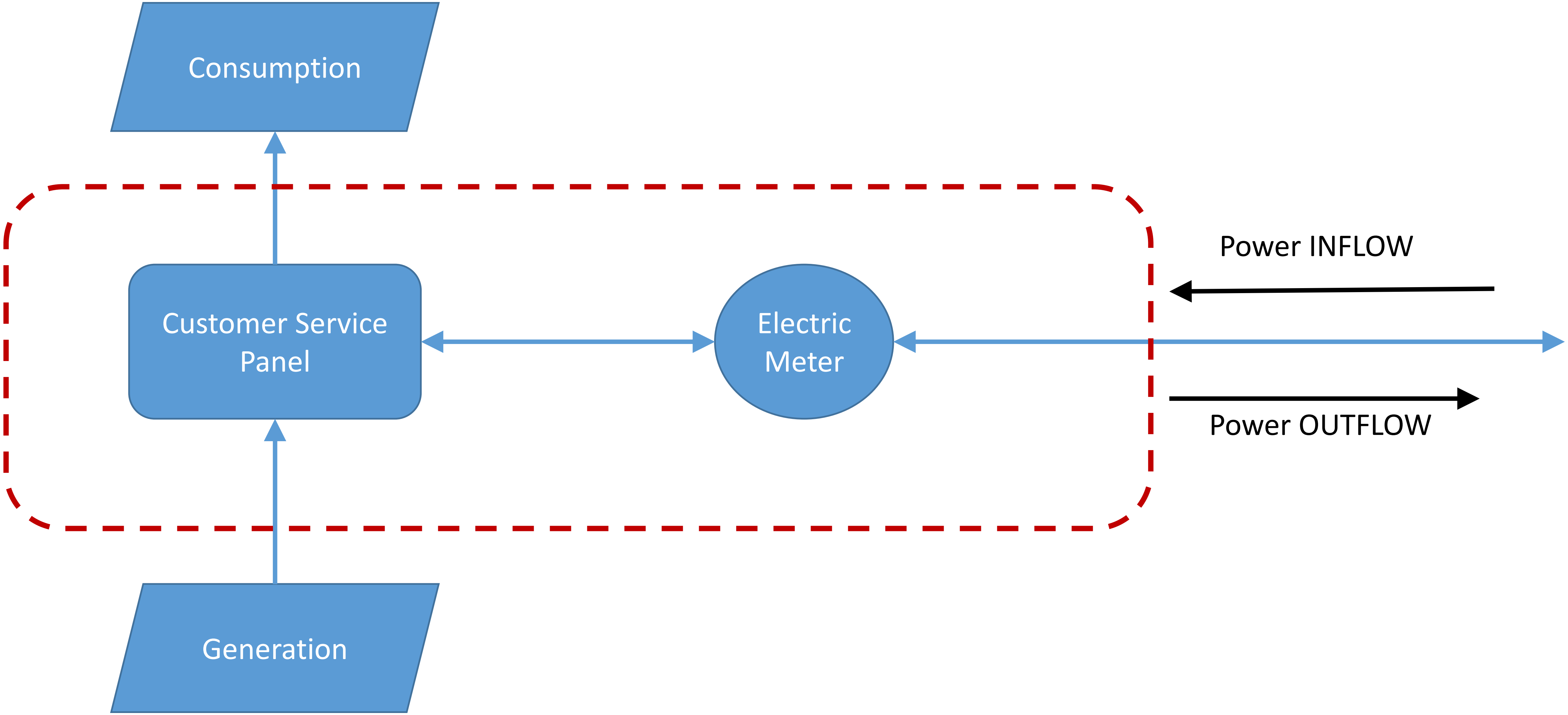
# What is INFLOW and OUTFLOW?




**INFLOW = Power taken off the electric grid**

**OUTFLOW = Power Injected into the electric grid**

# Distributed Generation Customer Energy-Balance Needed for Analysis



# Energy Balance Basis for DG Customer Analysis

**Energy Balance: Energy In = Energy out**

Inserting all energy flows intersecting the energy balance boundary [dashed line in Chart (2)] yields an exact relationship between the variables: generation, consumption, inflow and outflow; i.e.

**[Generation + Inflow = Consumption + Outflow]**

Or alternately stated;

**[Inflow – Outflow] = [Consumption – Generation]**

**Metered Quantities:**
Inflow
Outflow
Generation

**Calculated Quantity**
Consumption

# Using the Energy Balance

Rearranging Energy Balance [Slide 6] yields two terms representing an identity:

**[Generation – Outflow] = [Consumption – Inflow]**

These mathematical identities are recognized as representing the "onsite-usage" portion of the generation output.

The identities provide a means to derive onsite-usage from hourly inflows and outflows. Thus, in any given hour:

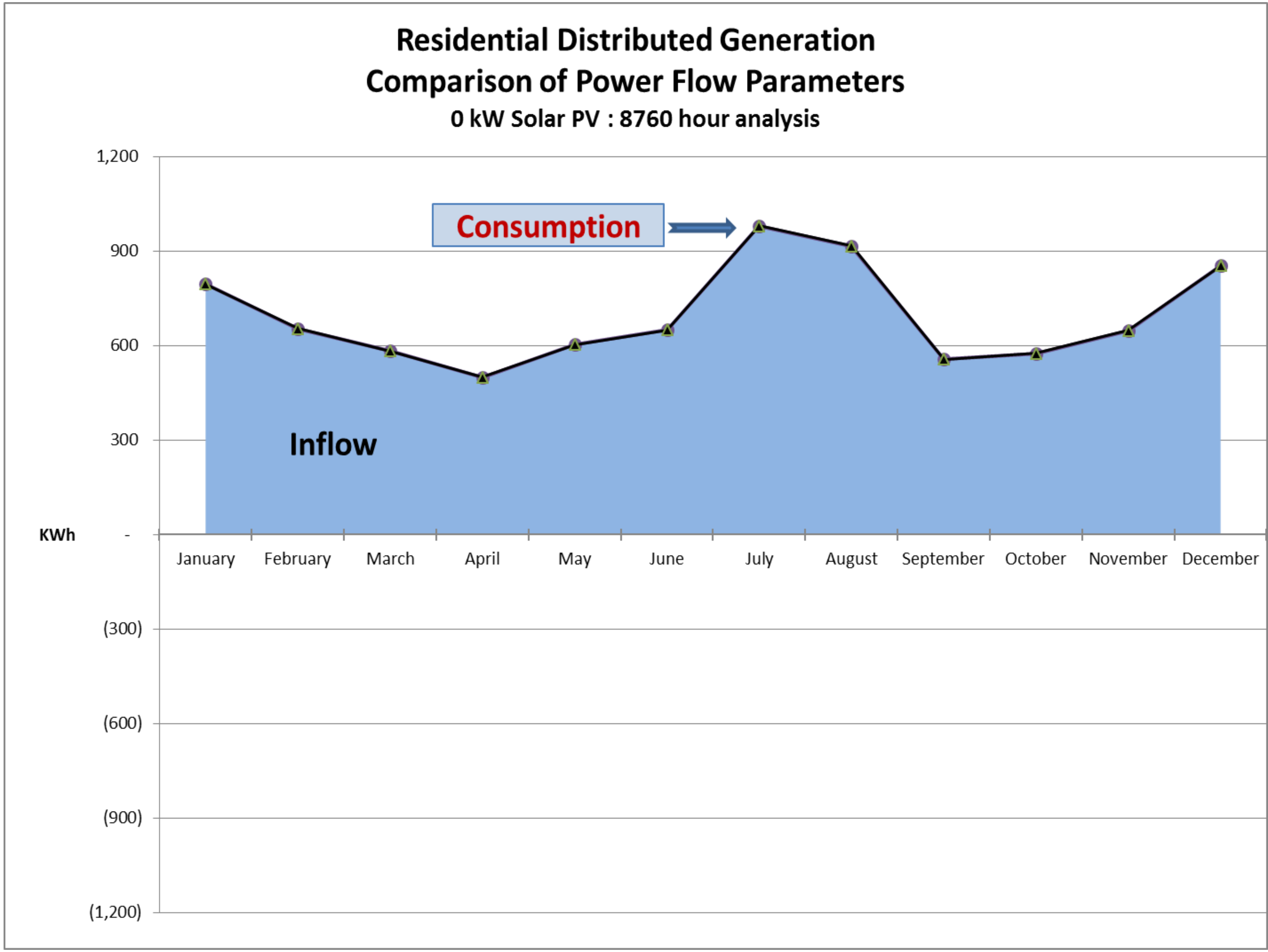
**Onsite generation usage = [Generation – Outflow]**

or:

**Onsite generation usage = [Consumption – Inflow]**

**Full Requirements Customer**

**Inflow = Consumption**

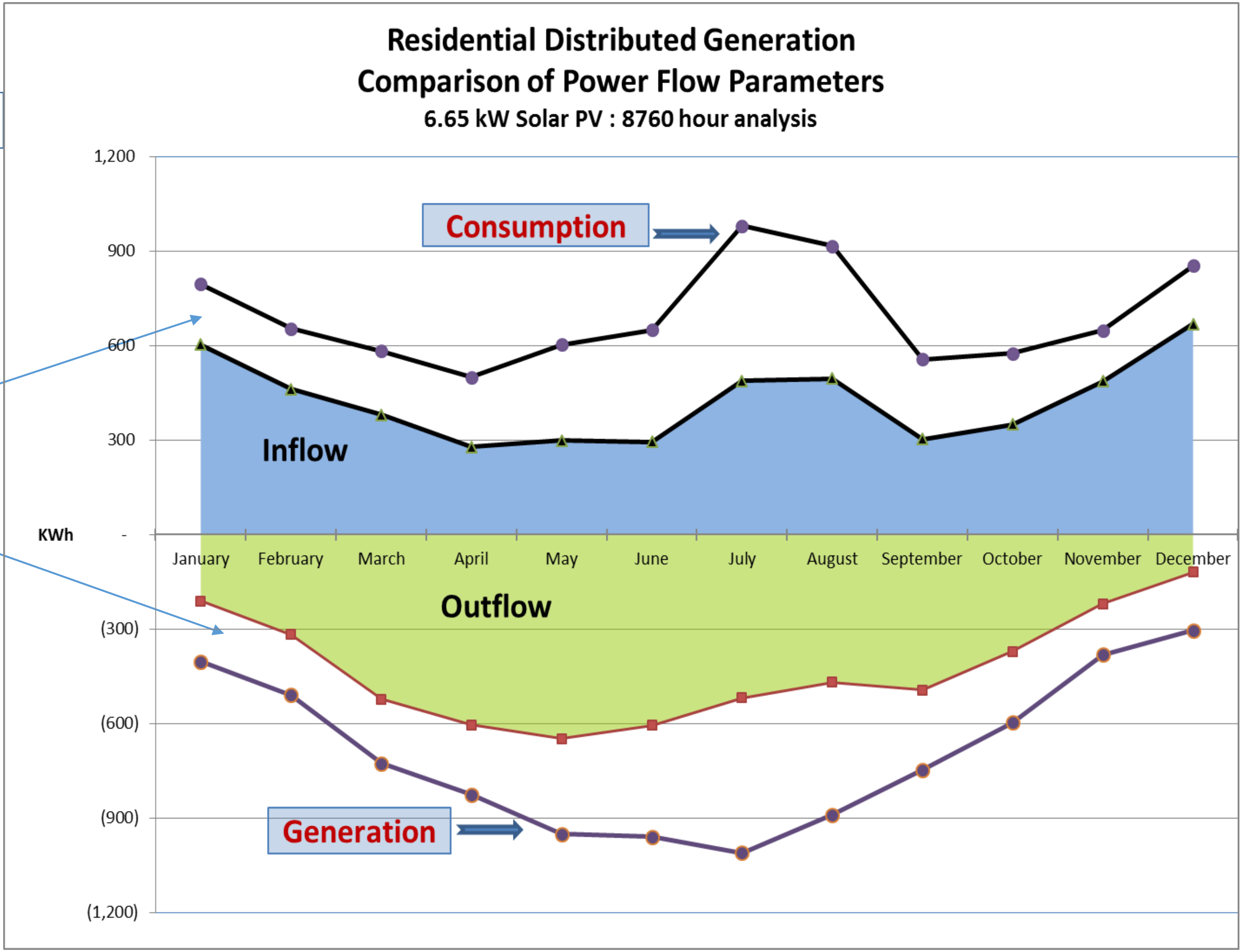


## DG Customer

**Inflow = Consumption – Onsite Usage**

**Outflow = Generation – Onsite Usage**

Onsite Generation Usage



# Energy Balance Tells Us

- Inflow represents **actual grid-usage**
  - Natural billing determinant for DG customers
  - Apply the same retail rates as a full-requirement's customer [demand & commodity]
  - No additional "grid usage" charge is required
- Onsite generation-usage constitutes a load-loss to the utility
  - Like energy efficiency
  - Is the reason why customers operate DG
    - Use as much generated power (& heat) as possible onsite
- "Inferred" consumption as a billing determinant is equivalent to billing back the customer for lost revenues
  - Implications for supplemental grid-usage or stand-by charges
- Outflow does not represent grid-usage by a DG customer
  - It's value is a function of the timing of generation, e.g. on-peak outflow $$

# What is the Inflow & Outflow Mechanism

- Requires a single meter that can measure power flows in both directions: i.e. INFLOW and OUTFLOW
- Uses Inflow and Outflow to calculate the bill

$$Customer\ Bill = \left[(kWh)_{Inflow} \times \left(\frac{\$}{kWh}\right)_{Retail\ Rate}\right] - \left[(kWh)_{Outflow} \times \left(\frac{\$}{kWh}\right)_{Value\ of\ Generation}\right]$$

# Stand-by Rates for Distributed Generation

- Stand-by rates should not recover grid-usage costs (inflow)
- Stand-by rates should not recover DG-related lost-revenues
- Stand-by charges should represent a fair cost for utility resources required to serve a customer's load, in the case of a forced-outage of a DG system
    - Generation
    - Transmission
    - Distribution

# A method to Quantify the Standby Capacity Requirements of Distributed Generation

## *The Generation Portfolio Approach*

- A DG program should be viewed as a *"virtual"* generation plant that is part of the utility's capacity resource portfolio
- The utility's standby requirements are defined by the ISO's resource reliability construct - *minimum unforced capacity requirement* – UCAP
- The stand-by capacity for distributed generation should be no different than the standby requirements of the utility's own generation

# Benefits of Using the Generation Portfolio UCAP Method

- A Load Serving Entity's (LSE's) UCAP is defined from a *total system perspective*
- A system perspective recognizes generator diversity; that the probability of simultaneous forced outages, at any given time, is lower than the probability of a single generator outage.
  - Reliability can be met without duplicating each capacity resource
- The DG program benefits from diversity provided by the utility's total generation portfolio.
- Likewise, the utility's capacity resource portfolio benefits from a robust DG program
- Win/Win: recognize that all customers benefit from the increased generator diversity provided by a DG program

# Resource Adequacy Requirements can Guide Stand-by Charge Design

## For Generation and Transmission Capacity

- Load Serving Entity - ICAP
- $ICAP_{LSE} = Forecasted\ Peak\ Load_{LSE} * (1 + IRM)$
  - ICAP = Installed Capacity Requirement
  - IRM = Installed Reserve Margin; e.g. 15%

- Load Serving Entity - UCAP
- $UCAP_{LSE} = Forecasted\ Peak\ Load_{LSE} * (1 + IRM) * [1 - (EFORd)_{System\ Avg}]$
  - UCAP = Unforced Capacity Requirement
  - EFORD = Equivalent Forced Outage Rate on Demand; e.g. 5%

# *Simple Electric Utility* Example of UCAP Calculation

Unforced Capacity Requirement:

*LSE Forecasted Peak Load* = 1,074.7 MW

*Installed Reserve Margin* = 14.8%

$EFORd_{System} = 7.6\%$

- $\boldsymbol{UCAP_{LSE} = Forecasted\ Peak\ Load_{LSE} * (1 + IRM) * [1 - (EFORd)_{System\ Avg}]}$

=1,074.7 MW * (1+0.148)*(1-0.076) = 1,140 MW

- $\boldsymbol{Unforced\ Generation\ Capacity_{LSE} = \sum_i^n ICAP_i * (1 - EFORd)_i}$
  - Where the summation is over all LSE generation units

= 1,140 MW

# What is the Unforced Capacity Requirement Associated with a DG Customer's Onsite Generation Usage?

- Recognize that for every DG customer, the **maximum incremental demand on peak** (standby demand) is equal to that generator's UCAP

$$UCAP_i = ICAP_i * (1 - EFORd_i) = NPC_I * (1 - EFORd_i)$$

  - Where NPC = Nameplate Capacity
- Thus: $Incremental\ Peak\ Load_i = NPC_i * (1 - EFORd_i)$
- Since the  Incremental Peak Load is factored into the calculation of the total LSE UCAP, we could break-out the subtotal unforced capacity associated with onsite generation usage:
- $\boldsymbol{UCAP_{LSE-DG} = [\sum_i^n Incremental\ Peak\ Load_i *](1 + IRM_{System})(1 - EFORd_{System})}$
- Or

- $\boldsymbol{UCAP_{LSE-DG} = [\sum_i^n NPC_i * (1 - EFORd_i) *](1 + IRM_{System})(1 - EFORd_{System})}$

# What is the Unforced Capacity Required to "Stand-by" the DG Program

- Recognize that the customer provides the base generation (UCAP) needed to serve its onsite generation usage
  - Thus: $UCAP_{DG\ customers} = \sum_i^n NPC_i * (1 - EFORd_i) * \frac{1}{(1-Line\ Loss\ Factor)}$
  - Note that UCAP is grossed up to reflect system-average avoided line-losses
- The utility provides the balance of the required unforced capacity requirement
- Thus, subtract the DG customers' base generation (UCAP) from the LSE's UCAP requirement. The difference is the capacity needed to "stand-by" the DG customers.
- $UCAP_{Stand-by} =$
- $\{\sum_i^n \boldsymbol{NPC_i} * (\mathbf{1} - \boldsymbol{EFORD_i})\} * [(\mathbf{1} + \boldsymbol{IRM_{System}})(\mathbf{1} - \boldsymbol{EFORd_{System}}) - \frac{\mathbf{1}}{(\mathbf{1} - \boldsymbol{Line\ Loss\ Factor})}]$

# Example: Customer (A) Installs a Distributed Generation System: 2 MW Solar PV

- Customer (A) maximum demand reduction at the system peak (onsite generation usage):

- $Solar\ Capacity_{Customer\ A} = NPC * ELCC_{Solar}$
  = (2 MW)*(0.45) =0.9 MW
  - NPC = *Nameplate capacity*
  - $ELCC_{Solar}$ = *Effective Load Carrying Capacity of Solar PV, e.g. 45%*
- The 0.9 MW DG on peak represents 0.9 MW of load that factored into the calculation of the utility's $UCAP_{LSE}$ of 1,140 MW
- The incremental Unforced Capacity Requirement is:

- $\boldsymbol{UCAP_{Incremental} = [Incremental\ Peak\ Load_{Customer\ A}] * (1 + IRM) * (1 - EFORd_{System\ Avg})}$
- UCAP = (0.9 MW) * (1 + 0.148) * (1 - 0.0758) = 0.9549 MW

# Is the Incremental UCAP Requirement the Stand-by Capacity (MW)?

- No…The customer's DG provides the bulk of the Incremental UCAP

What the customer provides

$$UCAP_{DG\ System\ A} = [ICAP_A * (1 - EFORd_A)] * \frac{1}{(1 - Line\ Loss\ Factor)}$$

Or for Solar PV

$$UCAP_{DG\ System\ A} = [NPC * ELCC_{Solar\ Pv}] \frac{1}{(1 - Line\ Loss\ Factor)}$$

- NPC = *Nameplate Capacity, 2 MW*
- $ELCC_{Solar\ PV}$ = *Effective Load Carrying Capacity (peak-capacity factor), 45%*
- *Line Loss Factor = From PSCR, 7%*

$UCAP_{DG\ Generator\ A}$ = [2 MW * 0.45]*[1/(1-.07)] = 0.9678 MW on peak

# Simple Electric Utility With DG Program

What the utility provides (to meet the LSE's Minimum UCAP)

$$Standby\ Capacity = UCAP_{Incremental\ Load} - UCAP_{DG\ Generator\ A}$$

= (0.9549– 0.9678) = -0.0129 MW

Note: in this case the gross-up for system-average line loss results in a negative standby capacity.

# So…

- Distributed generators are an integral part of a the utility generation network.
- Very little generation & transmission capacity is required to provide standby to DG customers
- DG customer’s provide the base generation
- Utility standby-capacity is approximately equal to the reserve margin carried on DG capacity on system-peak
- Grossing up the customer’s generation to recognize avoided line losses can result in a negative stand-by UCAP.

# Thank You