Raising the Roof: Making Contemporary Housing Developments Solar Ready

By

Charles Riddell, MBSc, BA

Co-author Dr. Miljana Horvat

Ryerson University

Outline

* Introduction:
  * Growth, urban development, climate change and energy
  * Decentralized vs centralized energy distribution
  * What is Solar Ready?
* Methods:
  * Simulations/Drawings used/Neighbourhood/Model Homes
* Results
* Limitations
* Conclusion

Growth, development, climate change and energy

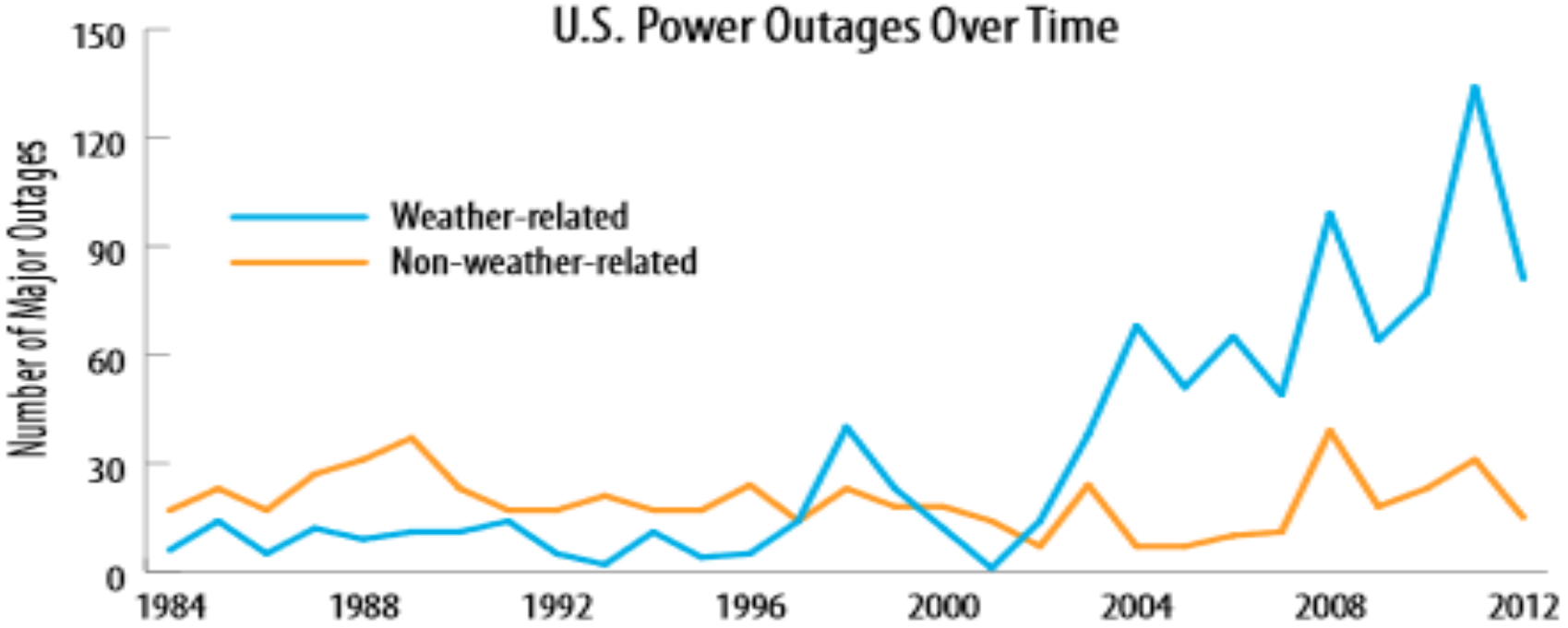
* Ontario 13.5 million in 2013 to 17.8 million in 2041 (Ontario Ministry of Finance, 2015)
  * More development = more energy demand

* Majority of electricity comes from centralized power stations
  * Inefficient, costly and can be environmentally damaging
  * Located far from the end users
  * Susceptible to climate changes and increase frequency and severity of storms

1998 Ice Storm

Hydro Quebec/via Google images

Weather Related Power Outages



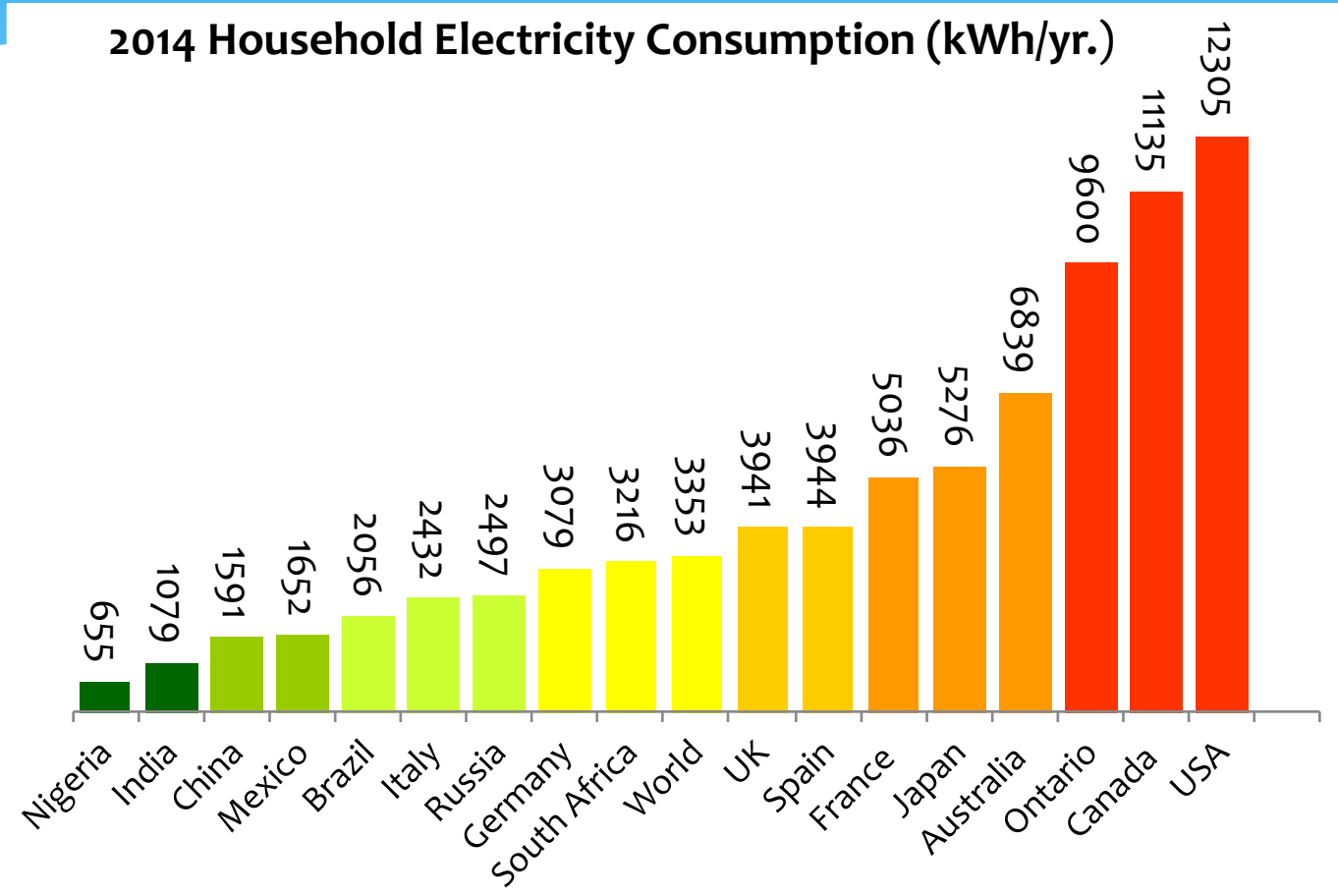
(National Renewable Energy Laboratory, 2014)

Electrical Consumption

* Canadian households consumed 520,250TJ of electricity in 2007
* Electricity represents 30% of Ontario total energy consumption
* Through conservation efforts Ontario reduced household electrical consumption from:
  * 12,000 kWh/yr. in 1990 to 9,600 kWh/yr. in 2013

(Government of Canada , 2012)

Cont. electrical consumption

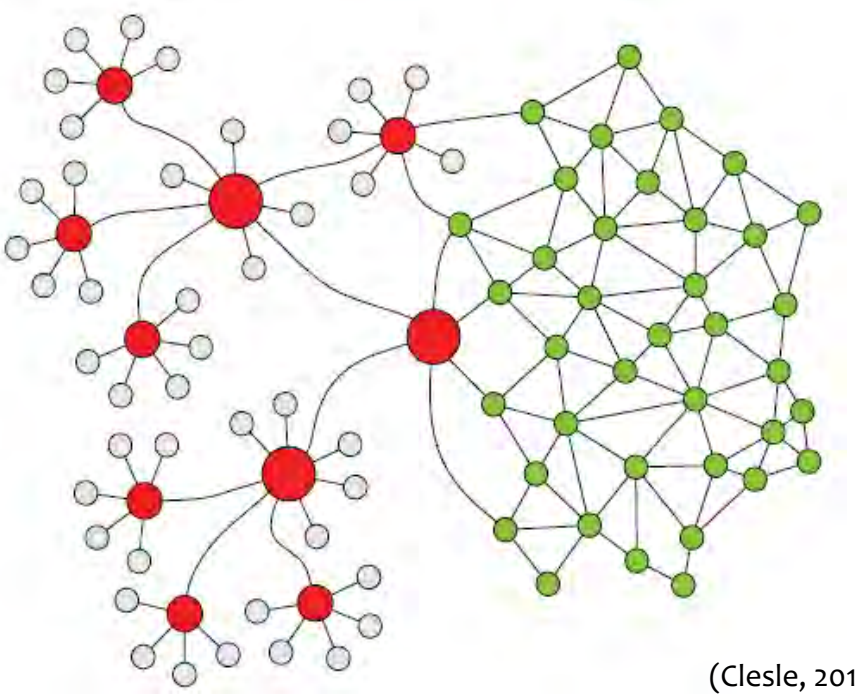


Average electricity consumption per electrified household (World Energy Council, 2016)

Why Solar?

* The Sun's Energy is:
  * Clean
  * Renewable
  * Free
* Can be used electricity or thermal (heat)
* Local green jobs, reduce GHGs
* Alleviates peak demand periods
* Helps establish a decentralized distribution system

Benefits Decentralizing the Distribution Network



(Clesle, 2010)

* Localized energy generation
* Reconnects the energy source with energy consumer
* Democratize energy distribution
* Increases energy security and community resiliency
* More efficient than centralized grid distribution
  * Smart grid technology
  * Utilizing a two-way distribution rather then the traditional one-way

(Clesle, 2010)

98 % Canadian power outages originate in the transmission and distribution grid (City of Toronto, 2007)

What is solar ready?

* "To enable installation of solar photovoltaic and heating systems sometime after the building is constructed" (L. Lisell, 2009).
  * Incorporate a solar system without having to:
    * Change roof structure
    * Open walls for conduit
    * Creating a location for electrical components
      * or
    * Storage tank components
* Its a form energy infrastructure resiliency

Solar as a 'Reserve'

"solar energy is a community resource and should, therefore, be treated as such" (Morley, 2014)

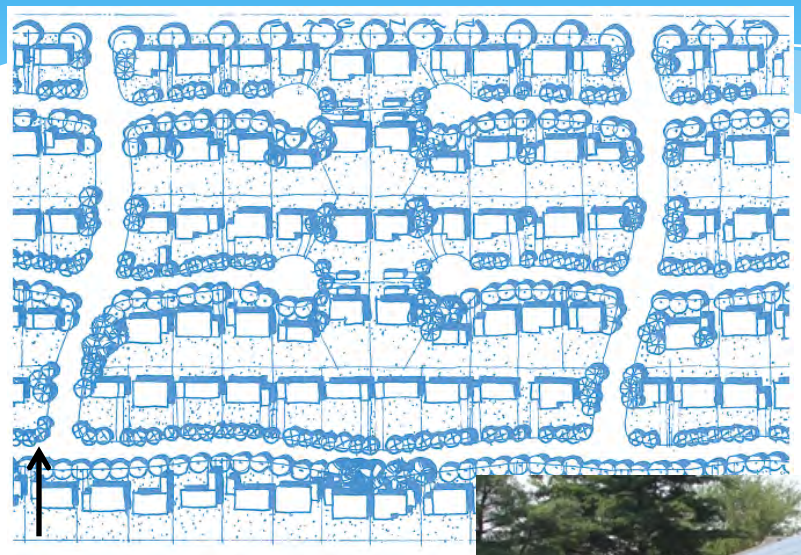
* Roughly 60,000 housing starts a year in Ontario alone (Environmental Commissioner of Ontario, 2010)

* Solar ready homes on a large development scale could be seen as a communities' solar energy "reserve" (Morley, 2014)

Barriers

* Financial
  * Upfront cost for the system themselves
* Energy Subsidies
  * $5.3 trillion post-taxed subsidies worldwide (IMF, 2015)
  * Distorts the true cost of fossil fuel production
* Policy and Regulations
  * Grid connectivity
  * Building Codes
  * Solar Ready made mandatory in 2010 for 2017 but called "ill advised" in 2013 (OHBA Technical committee, 2013)

Net Zero Neighbourhoods and Passive House Design

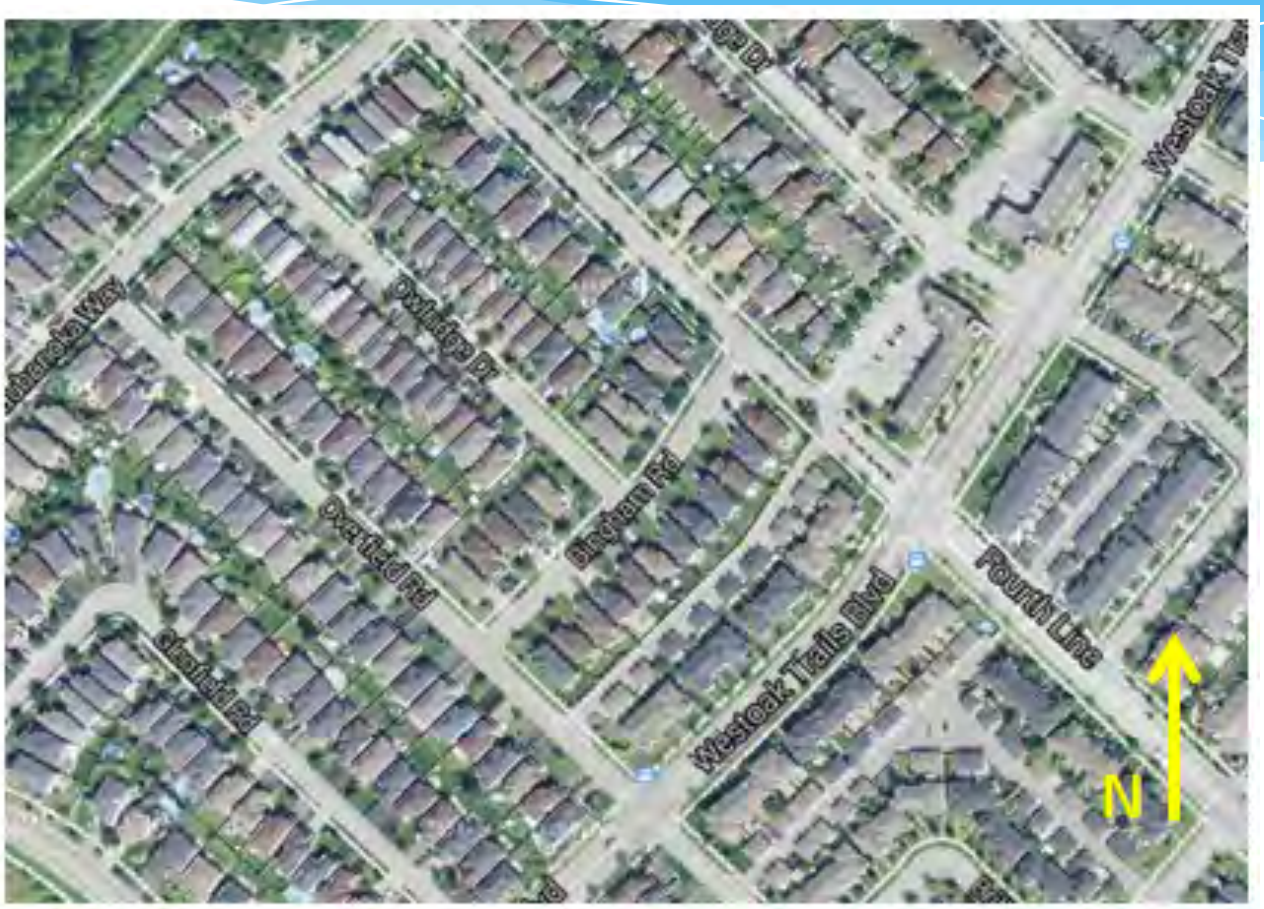


Streets on a east-west axis to maximise solar exposure
(Morley, 2014)

Freiburg, German Solarsiedlung (Google Images 2015)

Net zero energy Home (Google Images, 2015)

Contemporary Neighbourhood

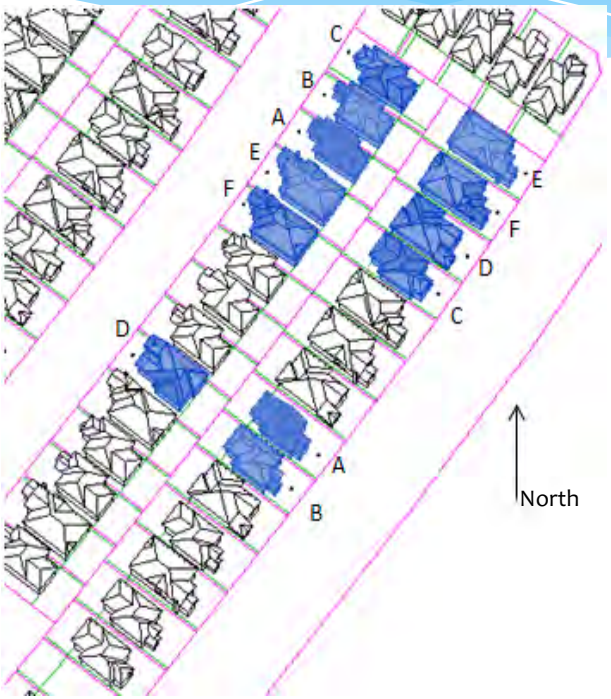


Subdivision in South Ontario (Google Earth)

Modern Roofing examples

"Simplicity is the key to brilliance" – Bruce Lee

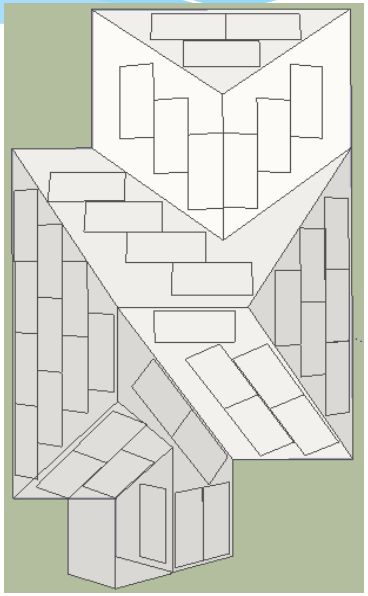
Neigbourhood



Housing Development,
2014

Methods

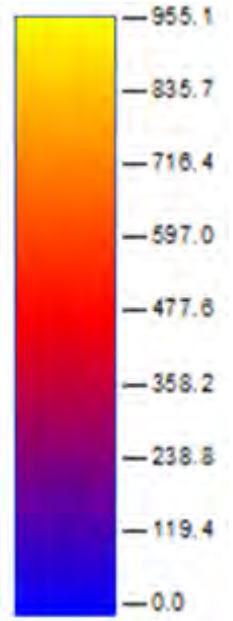
* Modelled 6 drawings from a Ontario home developer into Revit
* Redesigned
  * Solar Ready guidelines
* Illustrated how many 1m x 2m panels can be placed on each roof surface
* Simulated Solar potential of:
  * Original and redesign models layouts in neighbourhood setting
  * Original and redesigned by themselves in N,S, E & W orientations
  * Reversed/mirrored model where obvious solar gains could be seen
* Estimated the collective solar potential of the neighbourhood/block of 24 homes

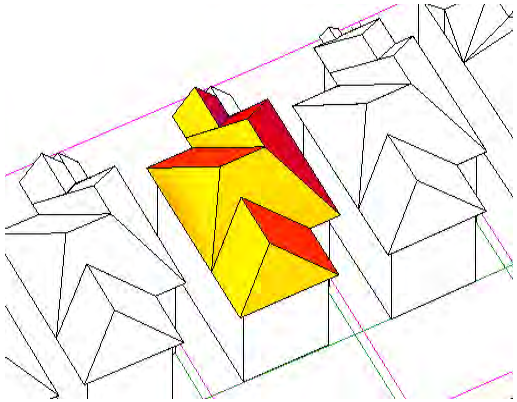


Model B

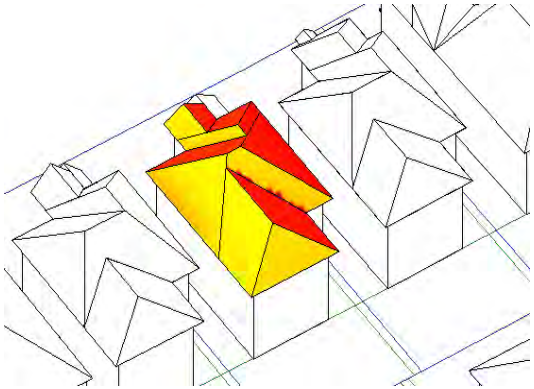
Homes facing Northwest

(kWh/m2/yr.)



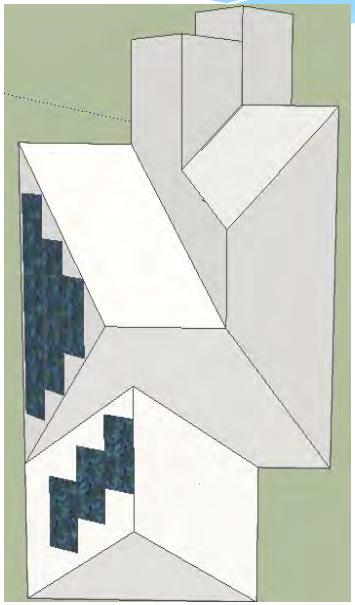


Original



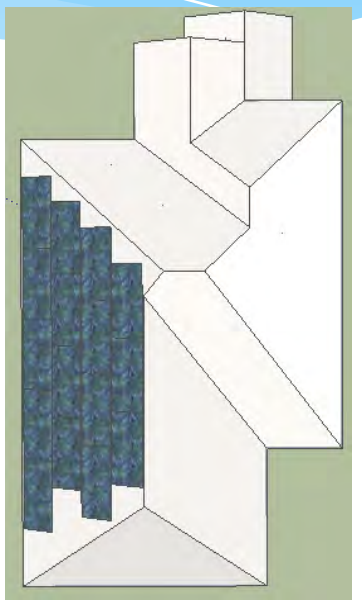
Redesign

Original



2645 kWh/yr.

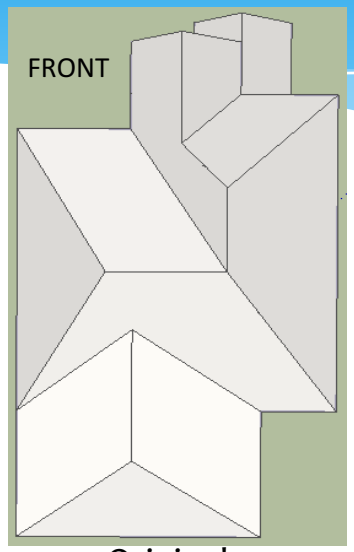
Redesigned



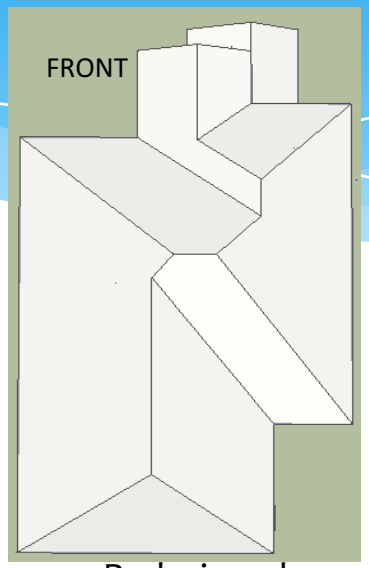
4665 kWh/yr.

43% increase in solar electrical production on that particular roof surface

Model B



Original



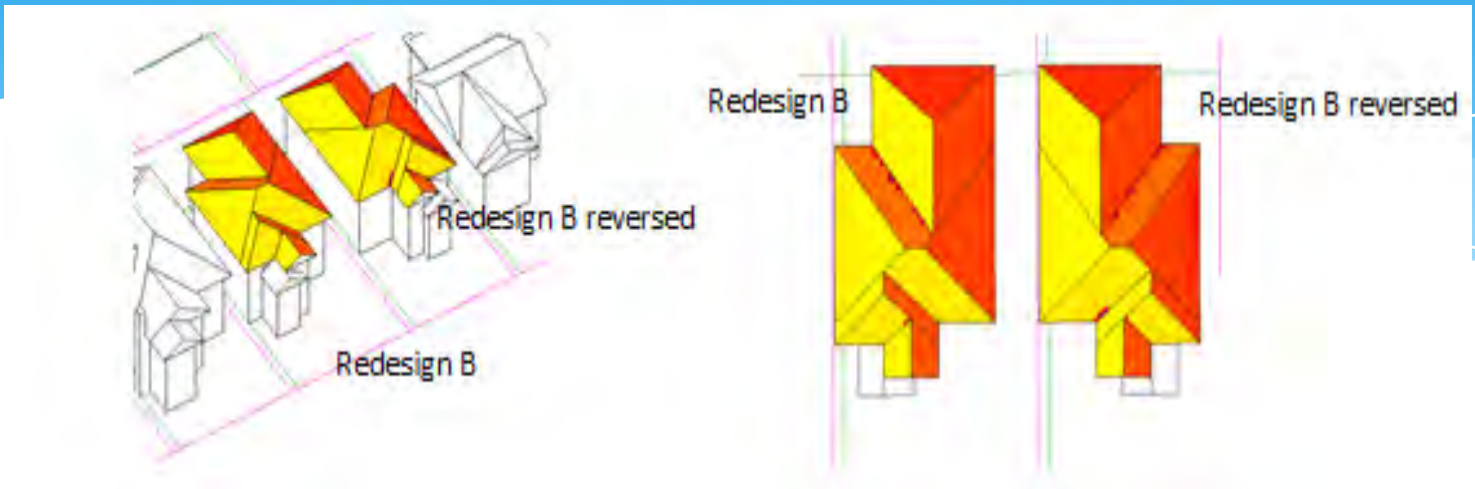
Redesigned

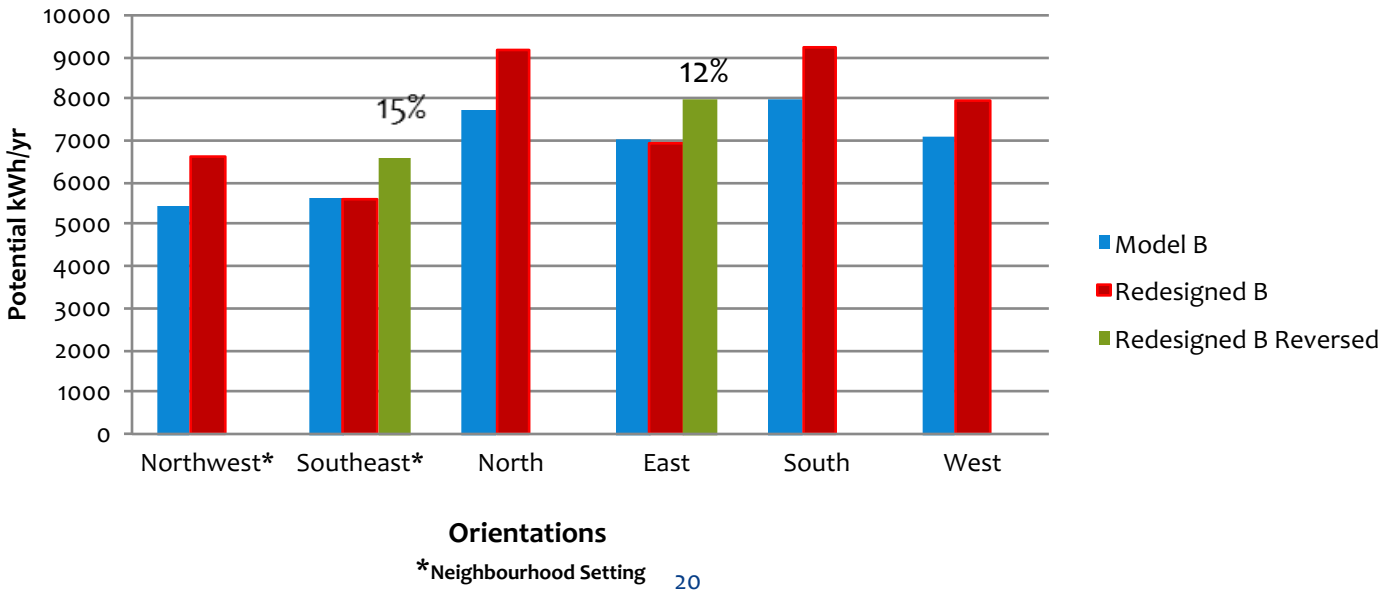
	Northwest*	Southeast*	North	East	South	West
Original (kWh/yr)	5460	5600	7740	7040	7970	7080
Redesigned (kWh/yr)	6590 (+17%)	5620 (+0.4%)	9180 (+16%)	6940 (-1.5%)	9250 (+14%)	7930 (+11%)
Redesigned Reversed (kWh/yr)		6580 (+15%)		7990 (+12%)		

Simulated with neighbouring homes

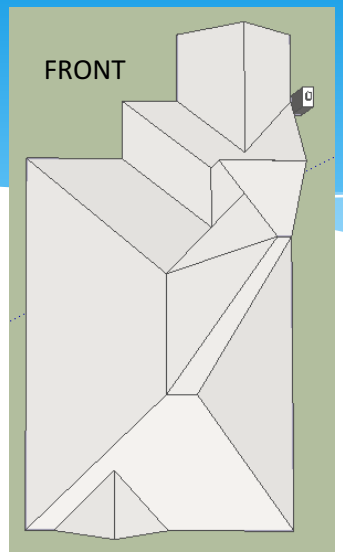
Simulated with NO neighbouring homes

Reverse House Layout

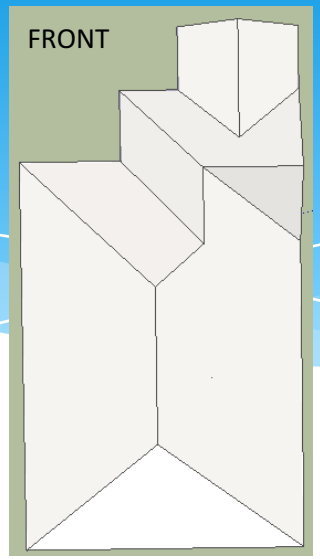




Model F



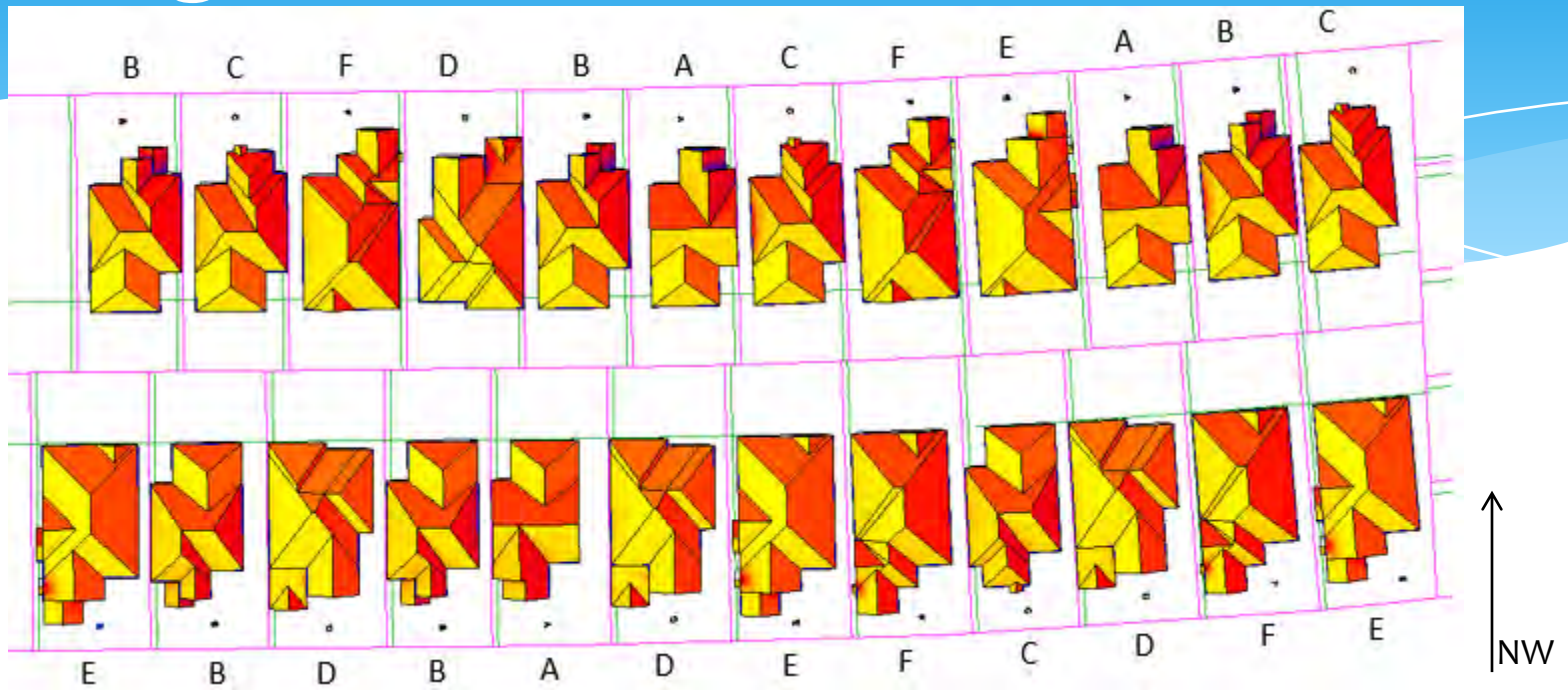
Original



Redesigned

	Northwest*	Southeast*	North	East	South	West
Original (kWh/yr.)	7470	5445	9760	7205	8940	8420
Redesigned (kWh/yr.)	8240 (+9%)	7475 (+27%)	12160 (+20%)	9450 (+24%)	11580 (+23%)	9745 (+14%)
Redesigned Reversed (kWh/yr.)	7980 (+6)	7775 (+30%)				

Neighbourhood scale outputs



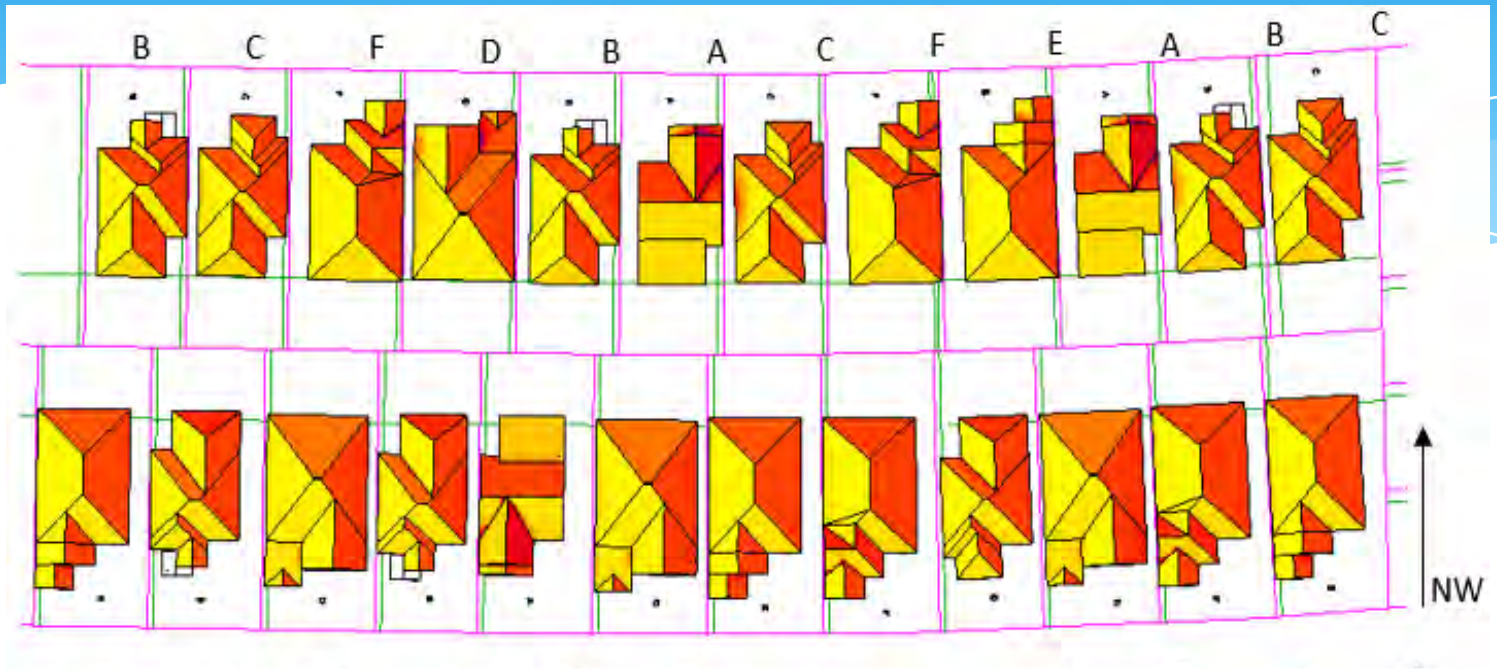
Total kWh/yr. production of 24 homes **148,780 kWh/yr.**

Average consumption 9,600 kWh/yr. of each home **230,400 kWh/yr.**

65% of total electrical consumption

Original Design

Neighbourhood scale outputs



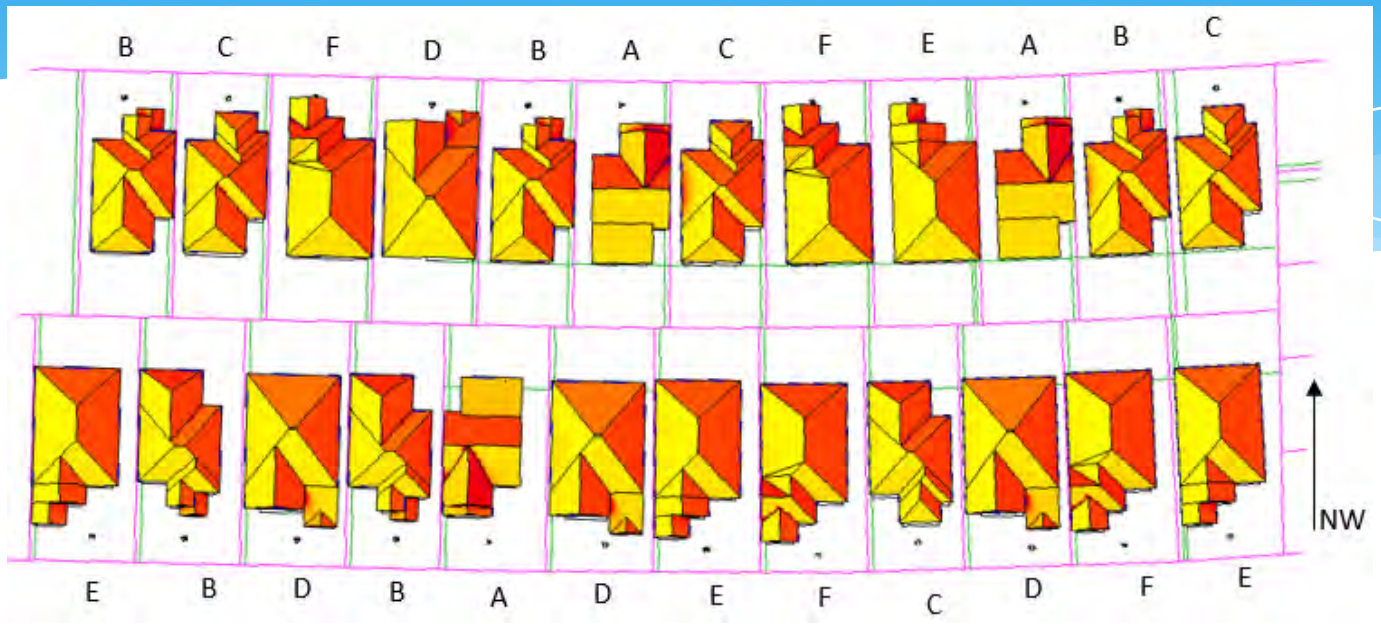
Total kWh/yr. production of 24 homes **178,030 kWh/yr.**

Average consumption 9,600 kWh/yr. of each home **230,400 kWh/yr.**

77% of electrical consumption

Redesigned **19.6% better then original**

Neighbourhood scale outputs



Total kWh/yr. production of 24 homes **184,790 kWh/yr.**

Average consumption 9,600 kWh/yr. of each home **230,400 kWh/yr.**

82% of electrical consumption

Reversed
Redesigned

24% better then original design

Limitations

* Modelling software
  * Numbers may not be exact but represent a comparison
* Localized scenario
* Six house models
  * There are many more homes designs in a development
* PV panels size and efficiency
  * Different size panels with different efficiencies would yield different results

Conclusion

* Even suboptimal orientation can generate significant energy production.
  * Important because production builder can work with this
  * With solar consideration this increases further

* Large developments seen as a communities 'Reserve'
* At a block level, communities can do co-operatives
  * Better purchasing power
  * Micro-grid and storage technologies
  * Community togetherness
  * Resiliency

* Grid still needs a diverse energy generation network
* Conservation of energy is paramount

Thank You!!!