ENERGY CONSUMPTION ANALYSIS AND FUTURE TREND FOR NEWFOUNDLAND

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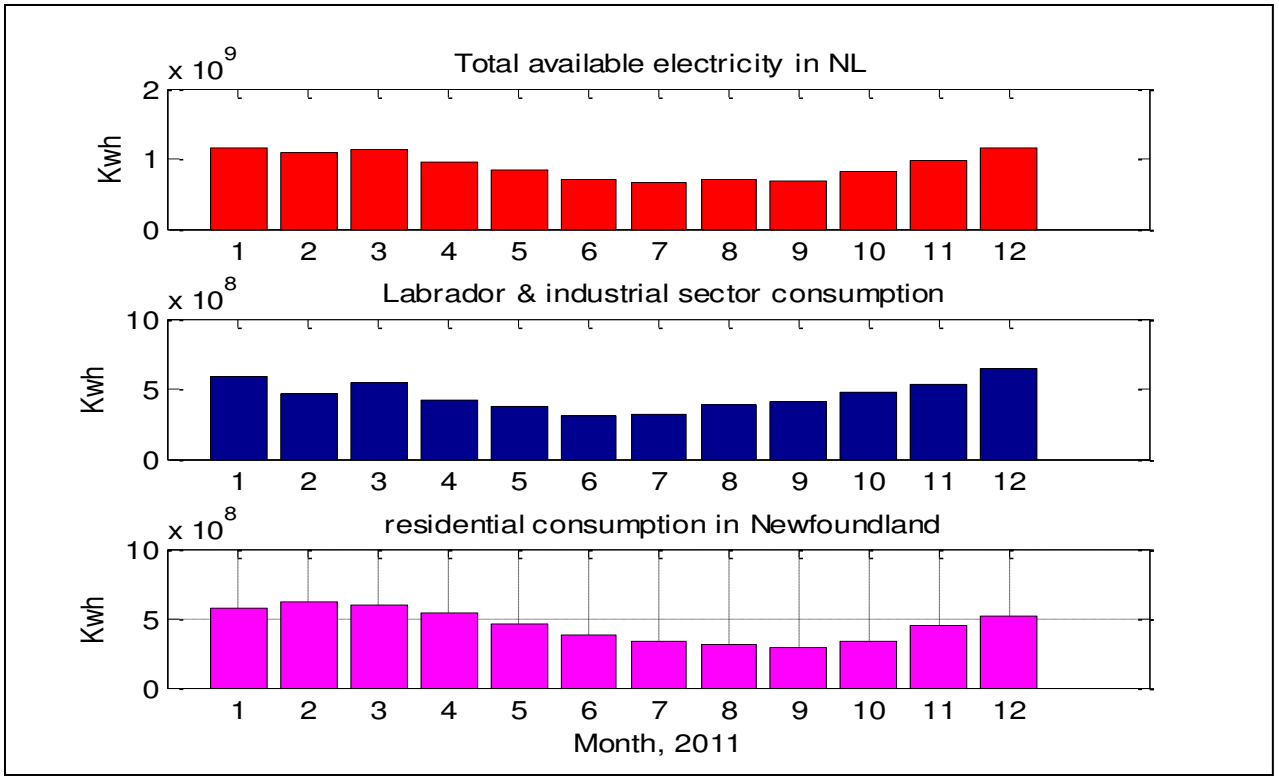
Outline

- ✓ Per person energy consumption
- ✓ Data logger design
- ✓ Energy consumption analysis
- ✓ BEopt analysis
- ✓ Design in EnergyPLAN & LEAP
- ✓ Future work
- ✓ Conclusions

Total electricity consumption data of NL

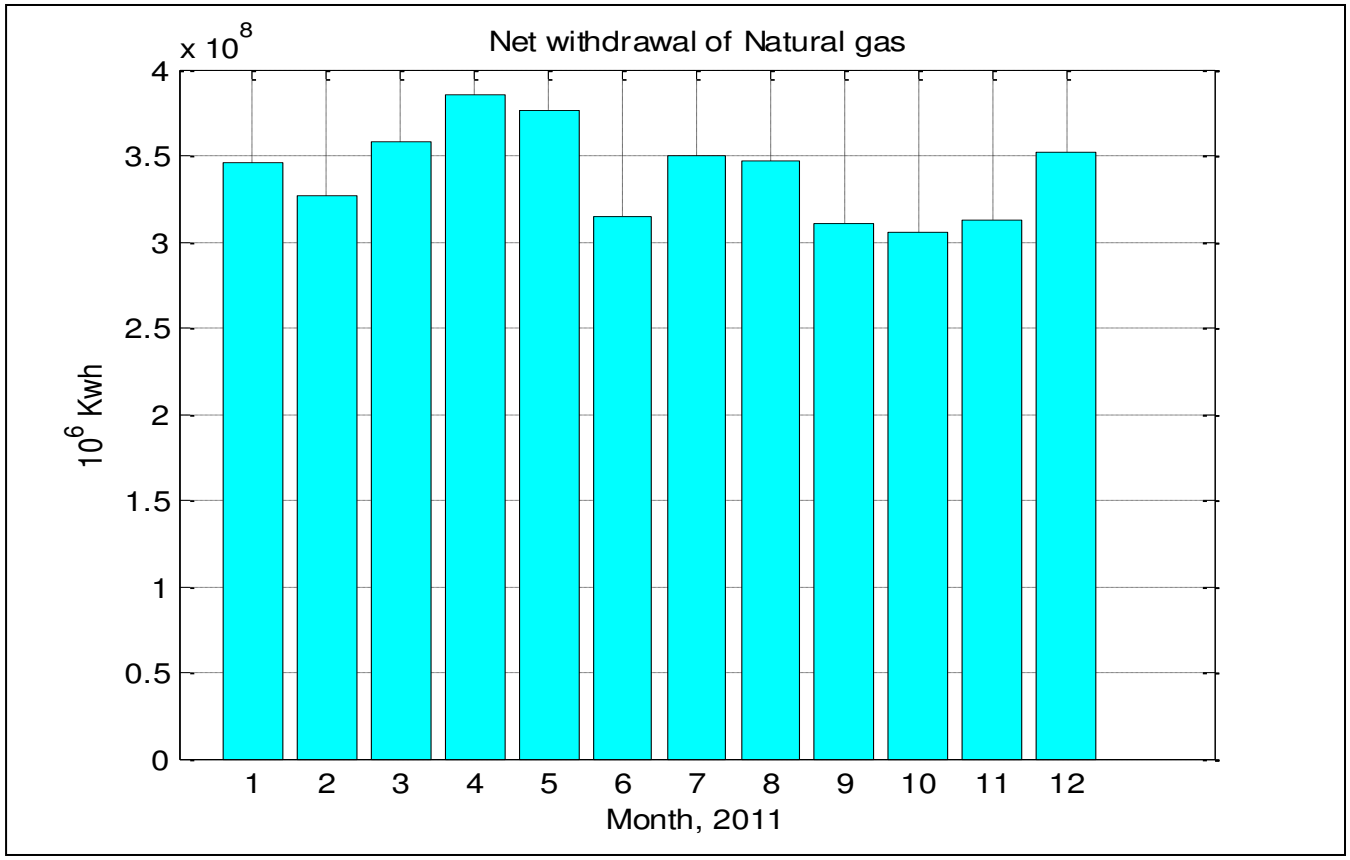


Total electricity consumption=10.91 TWh/year

Residential consumption= 5.43 TWh/year

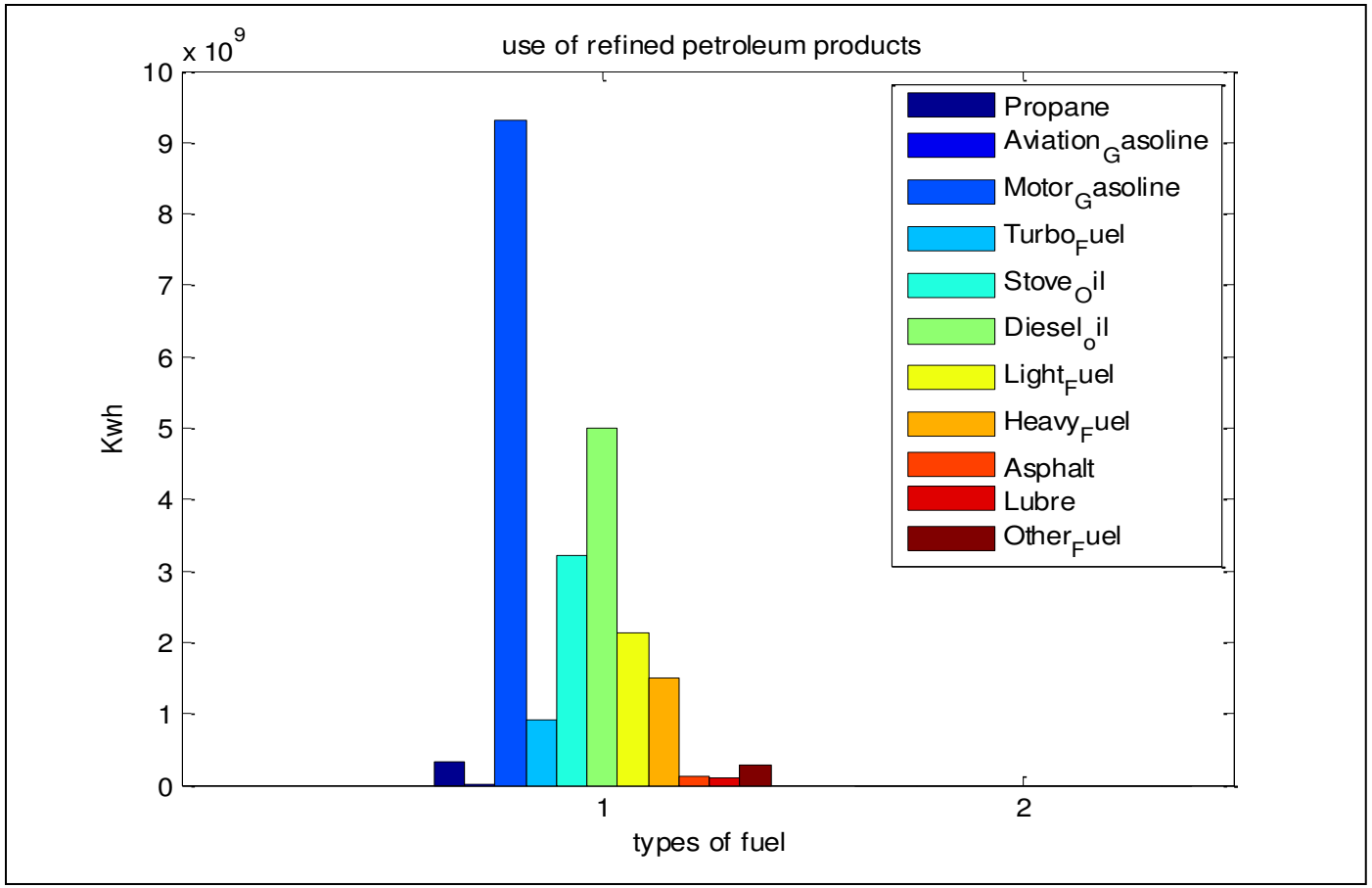
Labrador & industrial sector consumption =5.48 TWh/year

Total available natural gas use



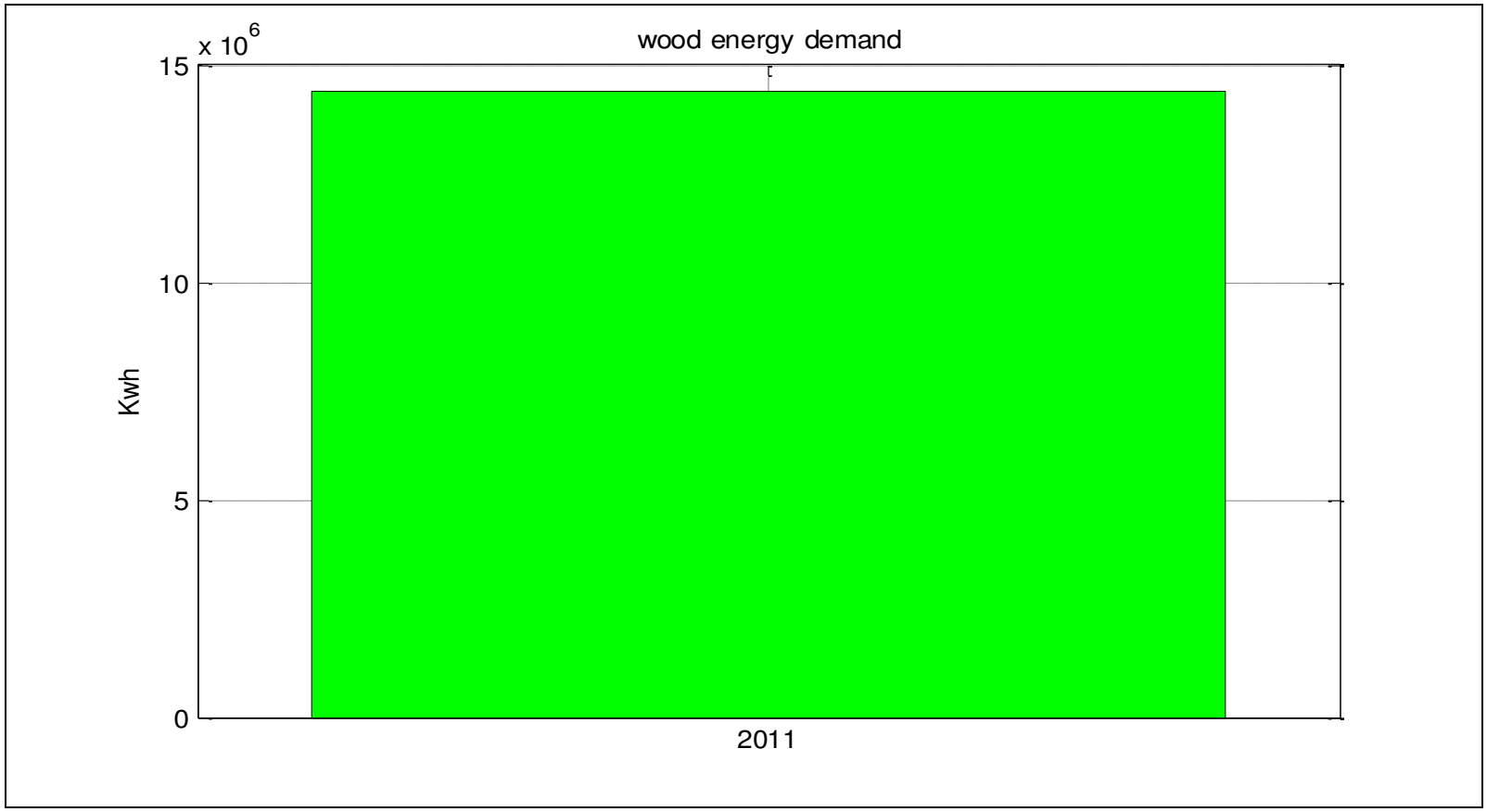
Total available gas to use in NL= 4.08 TWh/yr

Use of different types of petroleum products



Total refined petroleum products=2144.50 thousand cubic meter/yr

Wood energy demand



Wood energy demand=3000 tonnes or 14.4 GWh/year.

Energy demand according to statistic Canada

Total primary and secondary annual energy consumption,2011	
Sectors	TJ
Total industrial	24,643
Total transportation	53,439
Agriculture	483
Residential	20,529
Public administration	6,004
Commercial and other institutional	11,448
Total energy consumption	116,546

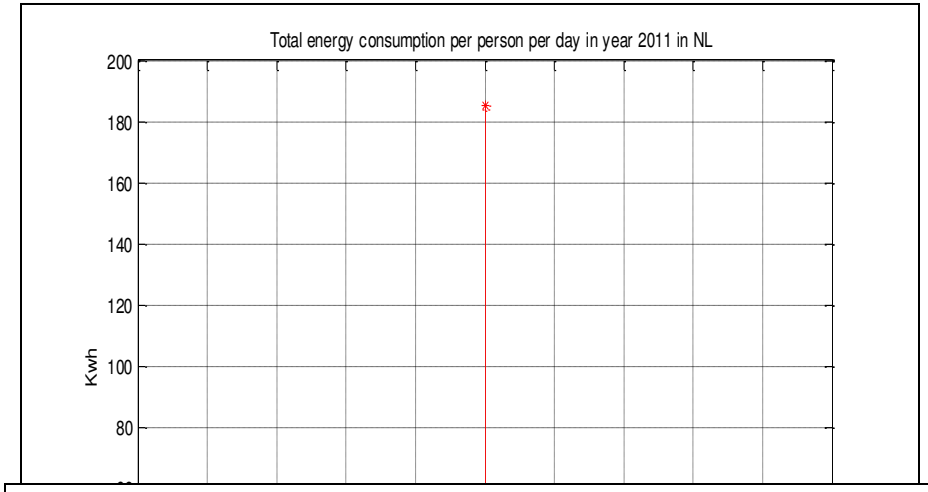
Total demand= 116546 TJ=32.32 TWh/yr

According to the statistics Canada energy consumption per person/day ,

=32.32TWh/(525037*365)

=168.93 kWh/person/day.

Calculated Energy demand



Demand = (E+N+W+RP-H)/ (P*365)

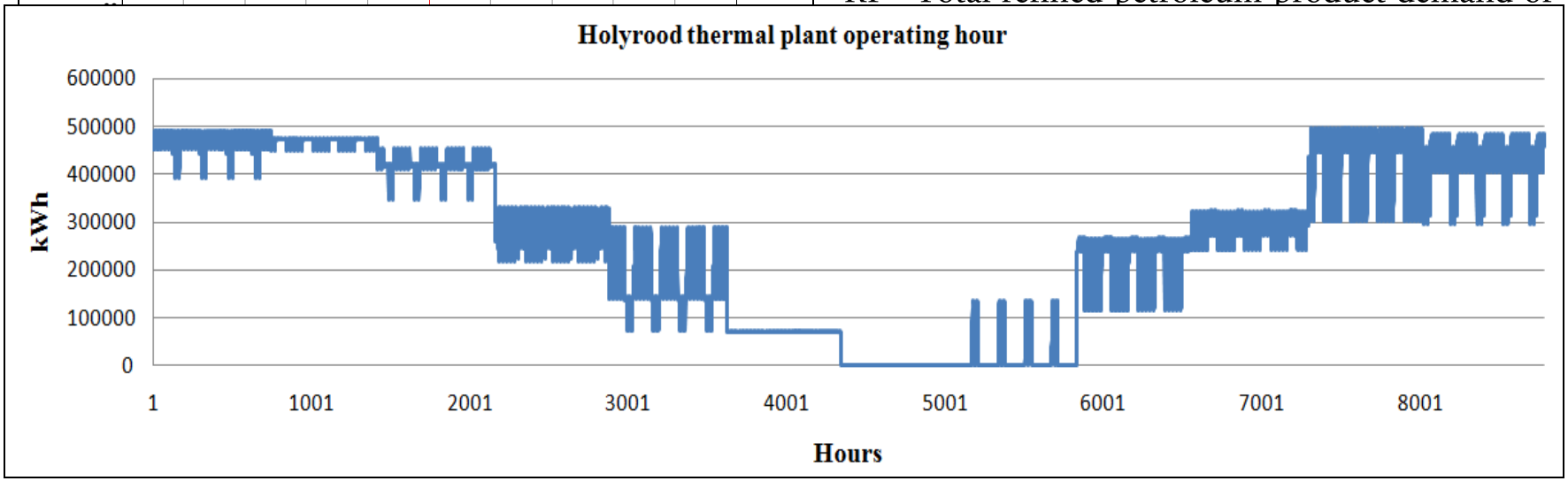
=185.34 kWh/person/day

E= Total electricity consumption of year 2011

N= Total natural gas consumption of year 2011

W= wood Demand

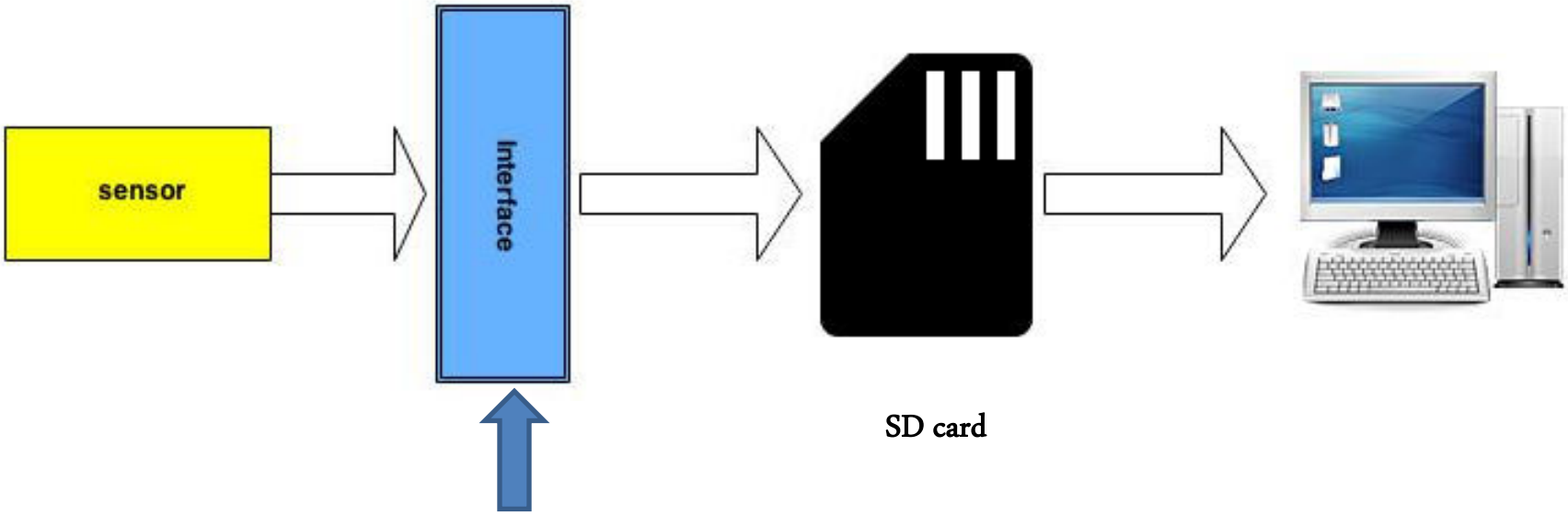
RP= Total refined petroleum product demand of



What is a data logger?

A data logger is an electronic instrument that records different physical or electrical parameters such as temperature, humidity, wind speed, current through an appliance over time.

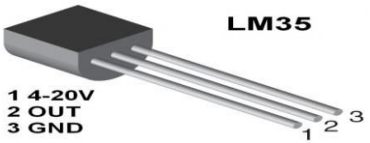
Basic data logger system

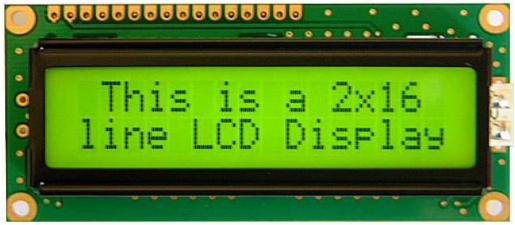


Power supply

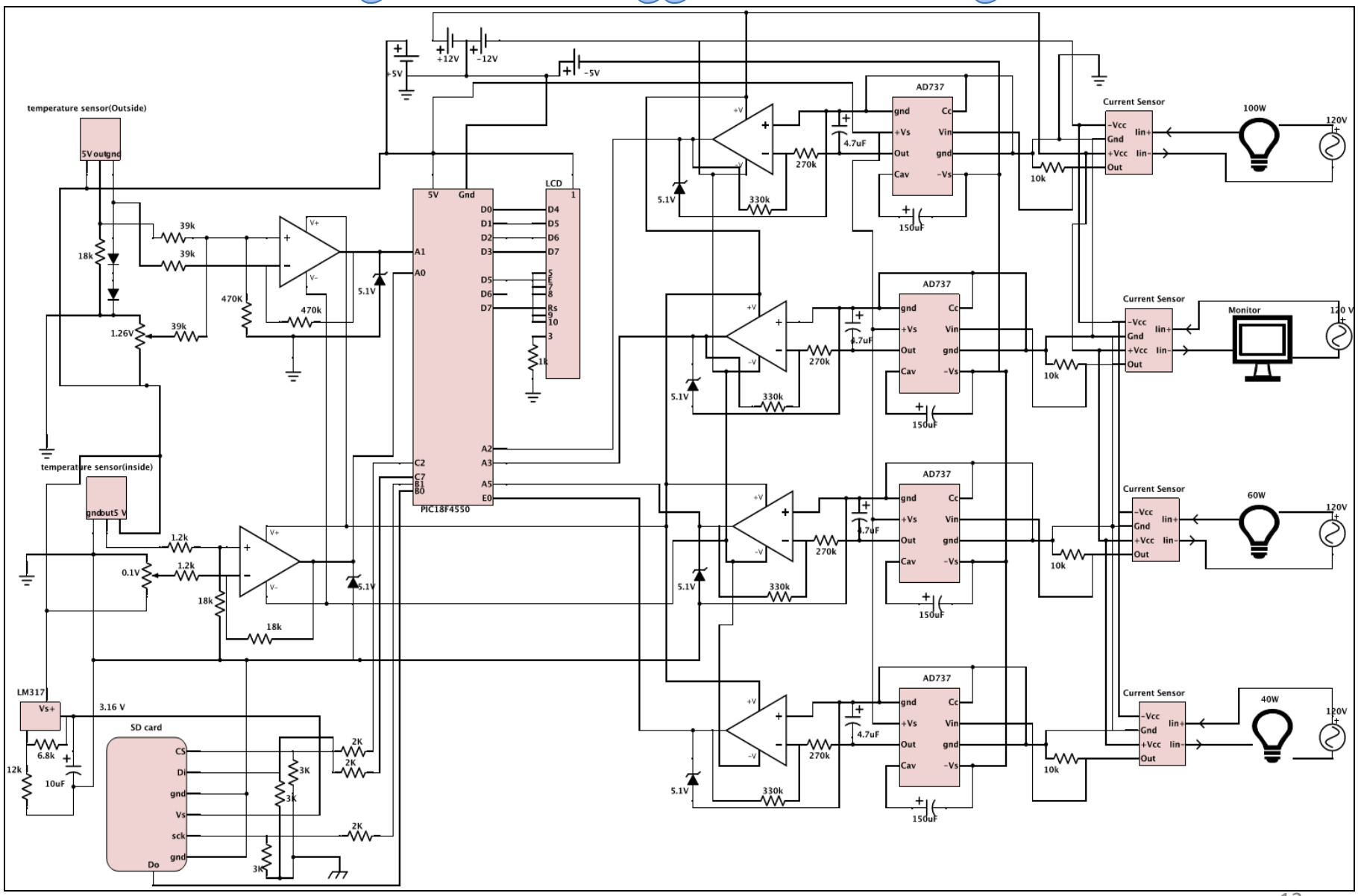
Designed data logger components

- Microcontroller- PIC18F4550
- Temperature sensors -LM35
- Current sensors-L18P003D15
- Display is a 2x16 LCD
- Sd card-2GB
- Circuit: power supply, rms-to-dc converters, amplifiers etc.

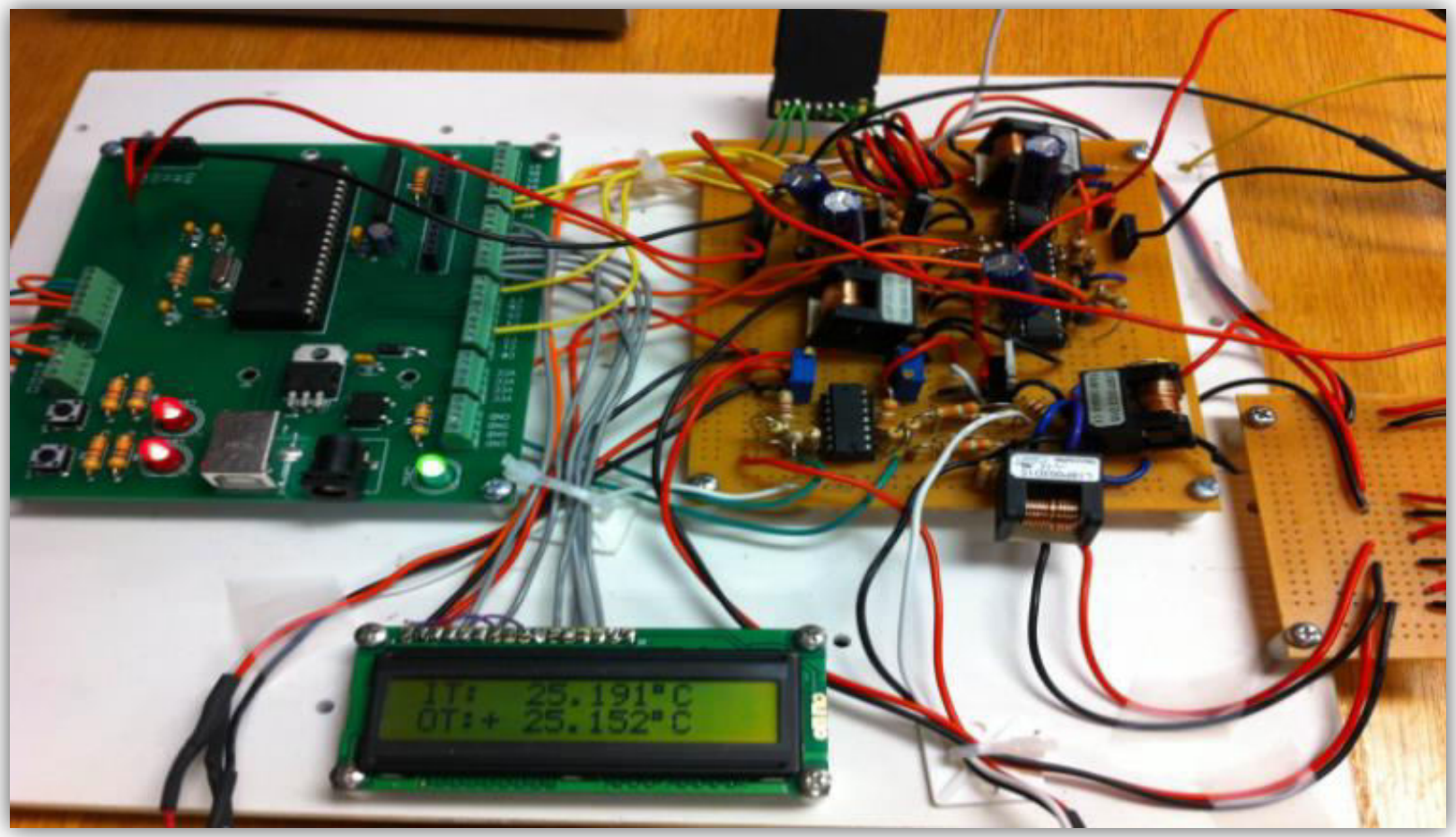




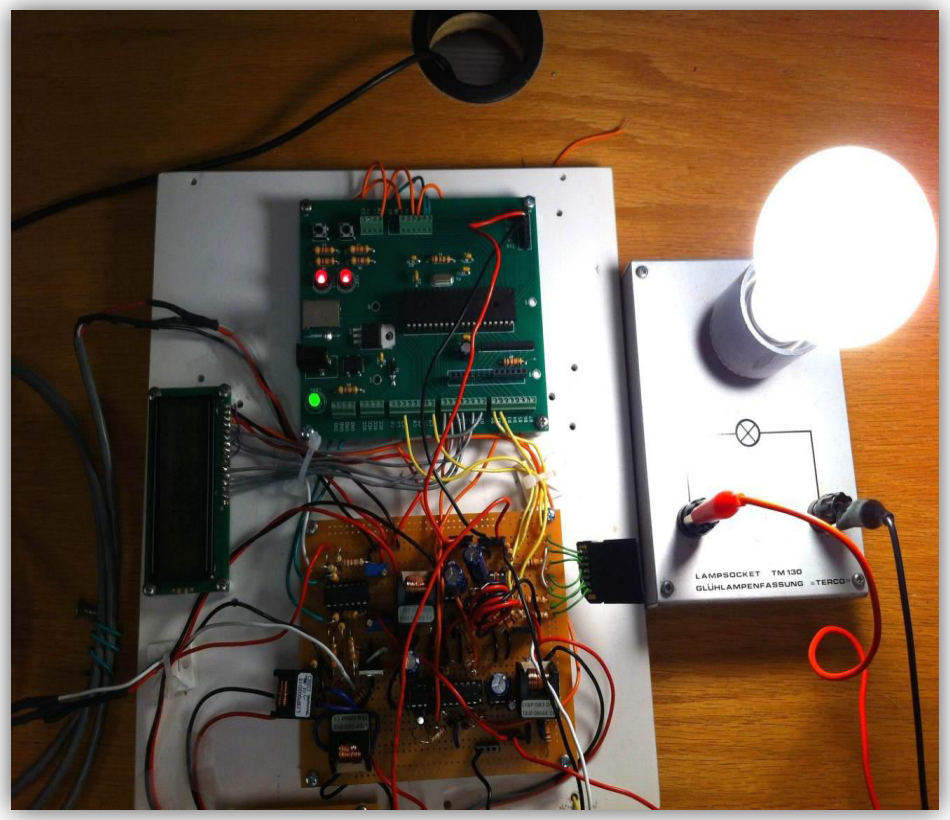
Designed data logger circuit diagram



Designed data logger circuit in the Lab



Actual sensor readings



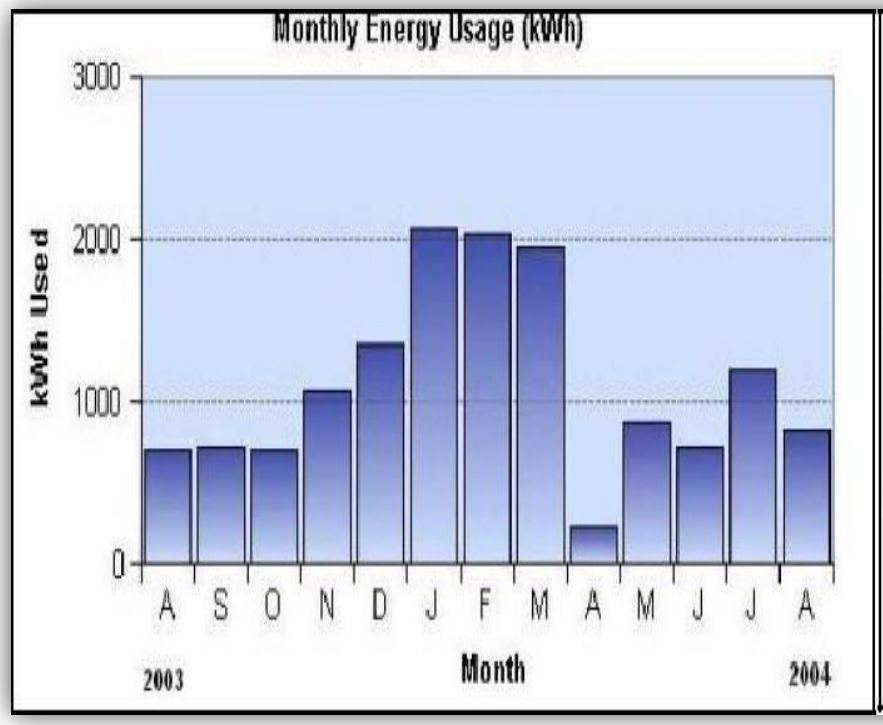
Date	inside temperature C	outside temperature C	current(A)
13/6/14	25.64	26.99	0.834
13/6/14	25.77	27.07	0.834
13/6/14	25.81	27.38	0.834
13/6/14	25.84	29.53	0.834

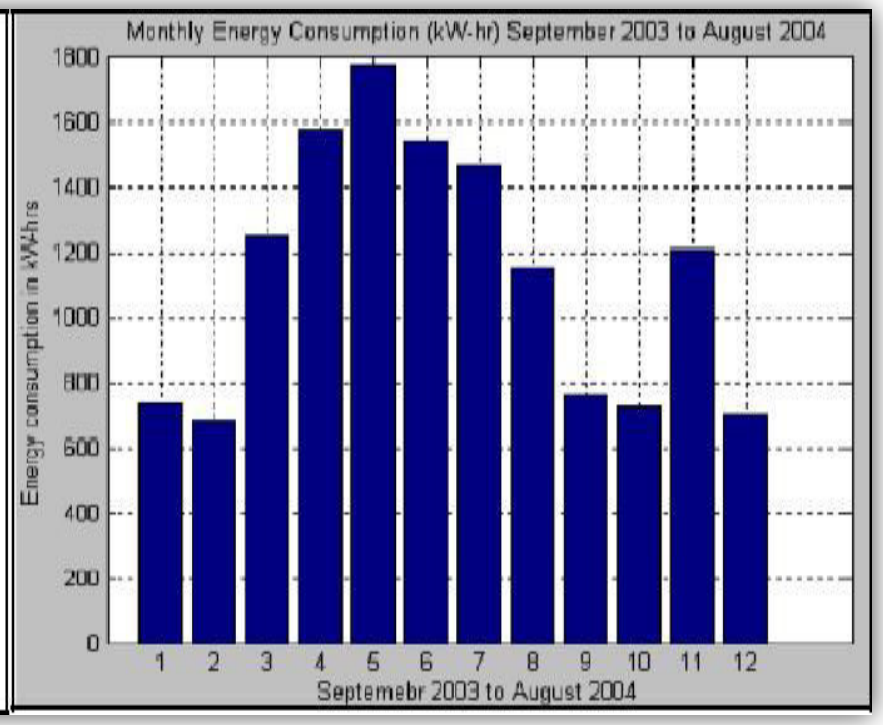
Houses selection for data logging

Two storey building with a semi finished basement and fully finished first floor (house-1).

Two storey house with a two storey garage attached to house (house-2).

House#1

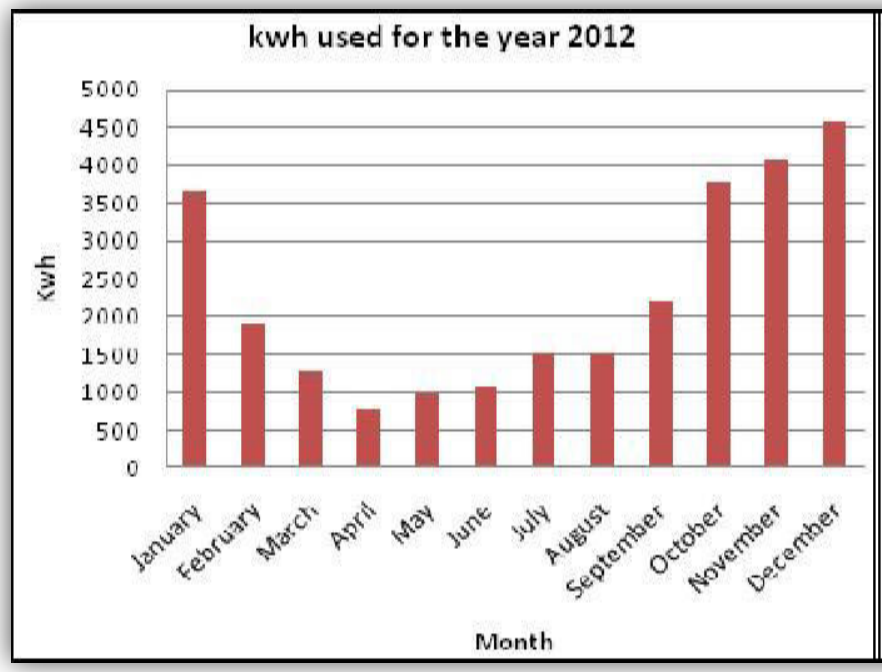


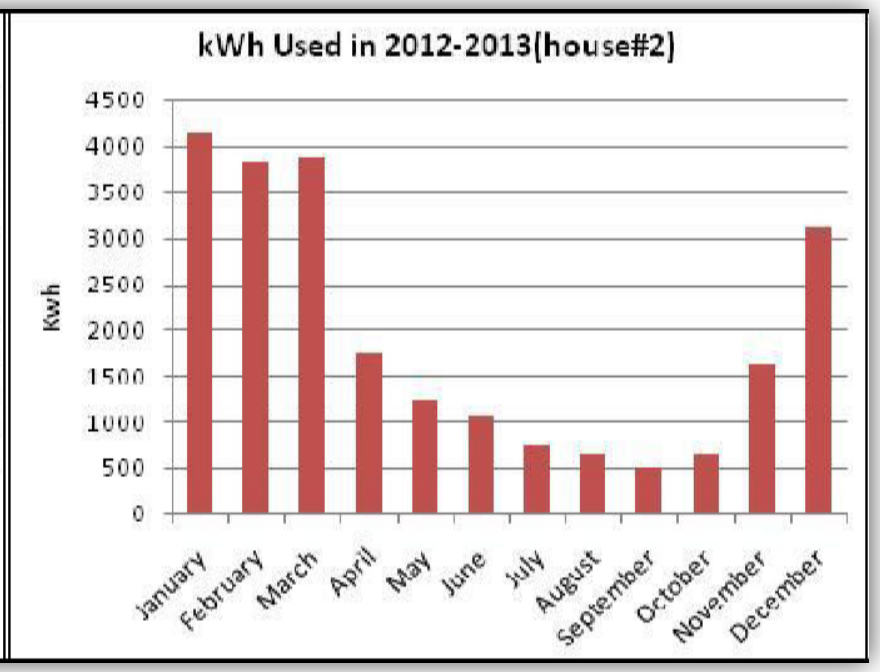


Utility reported House-1 total consumption was 15747 kWh. It was maximum in January 2004 (2084kWhr), while it was minimum in April 2004 (only 237 kWhr)

Logged energy consumption in the year 2003-2004 using a different data logger.

House#2

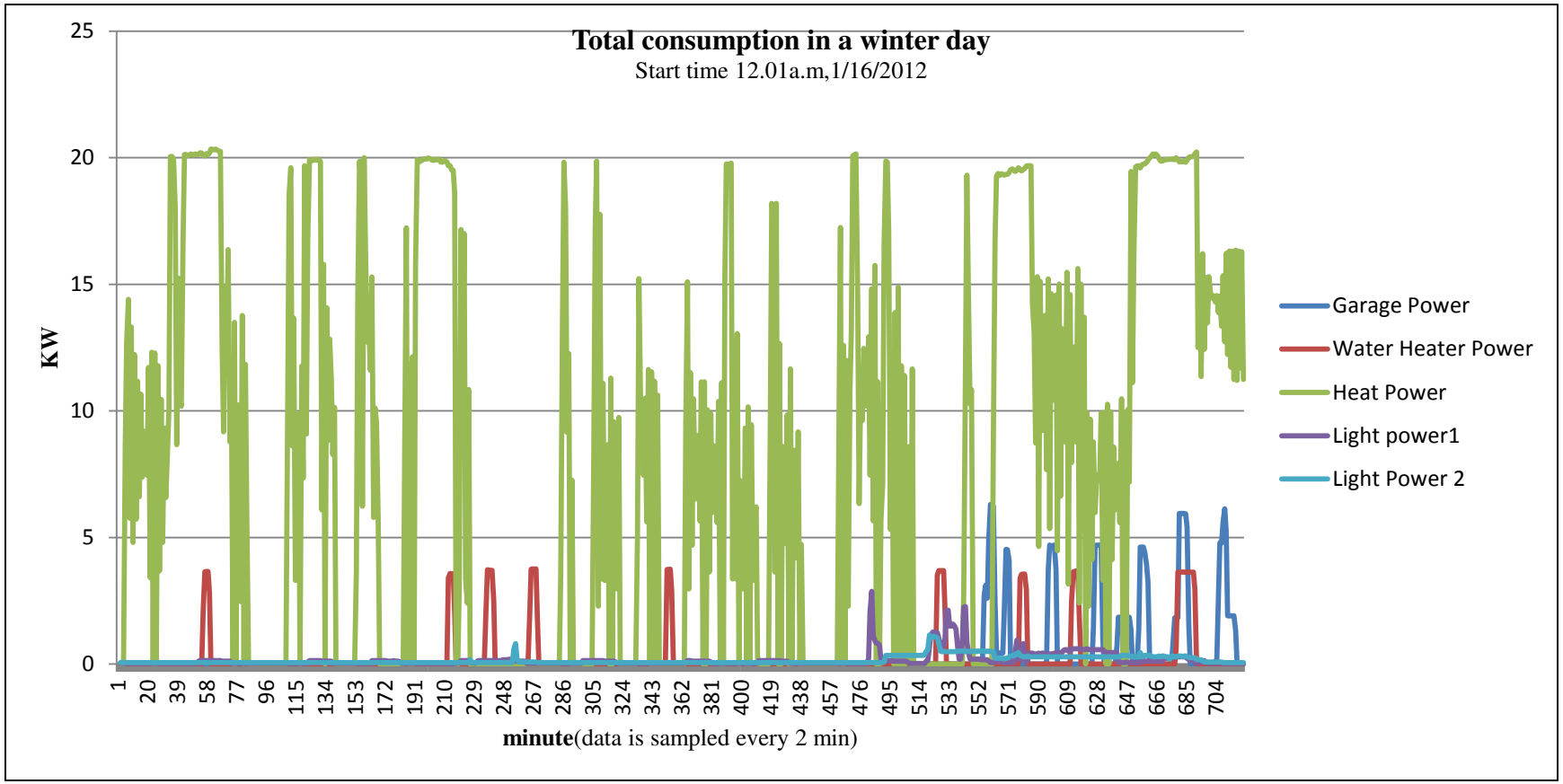




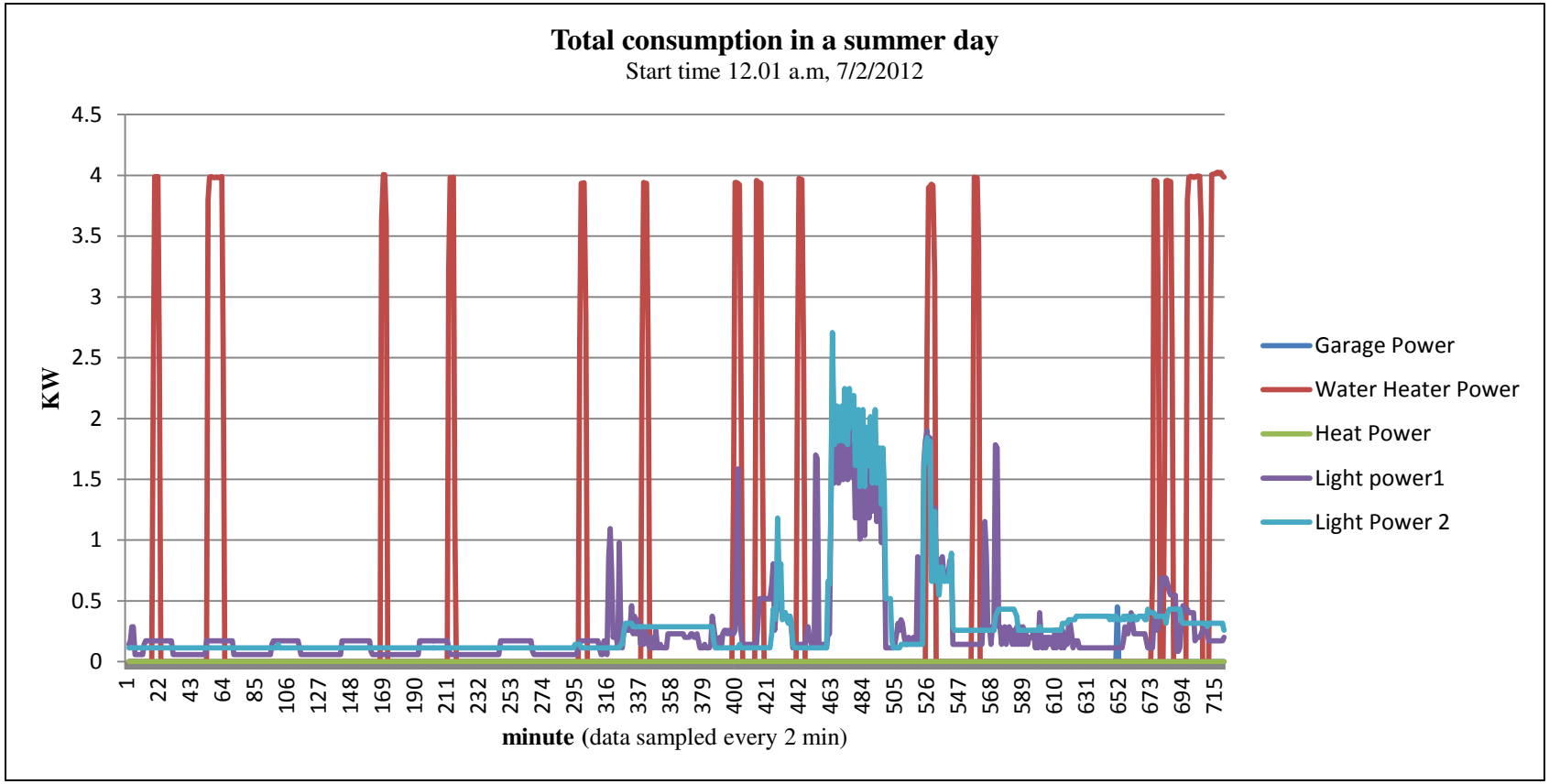
Energy consumption reported by the utility in year 2012, 27300 KWh.

Logger energy consumption of the house is 23116.09 kWh/yr.

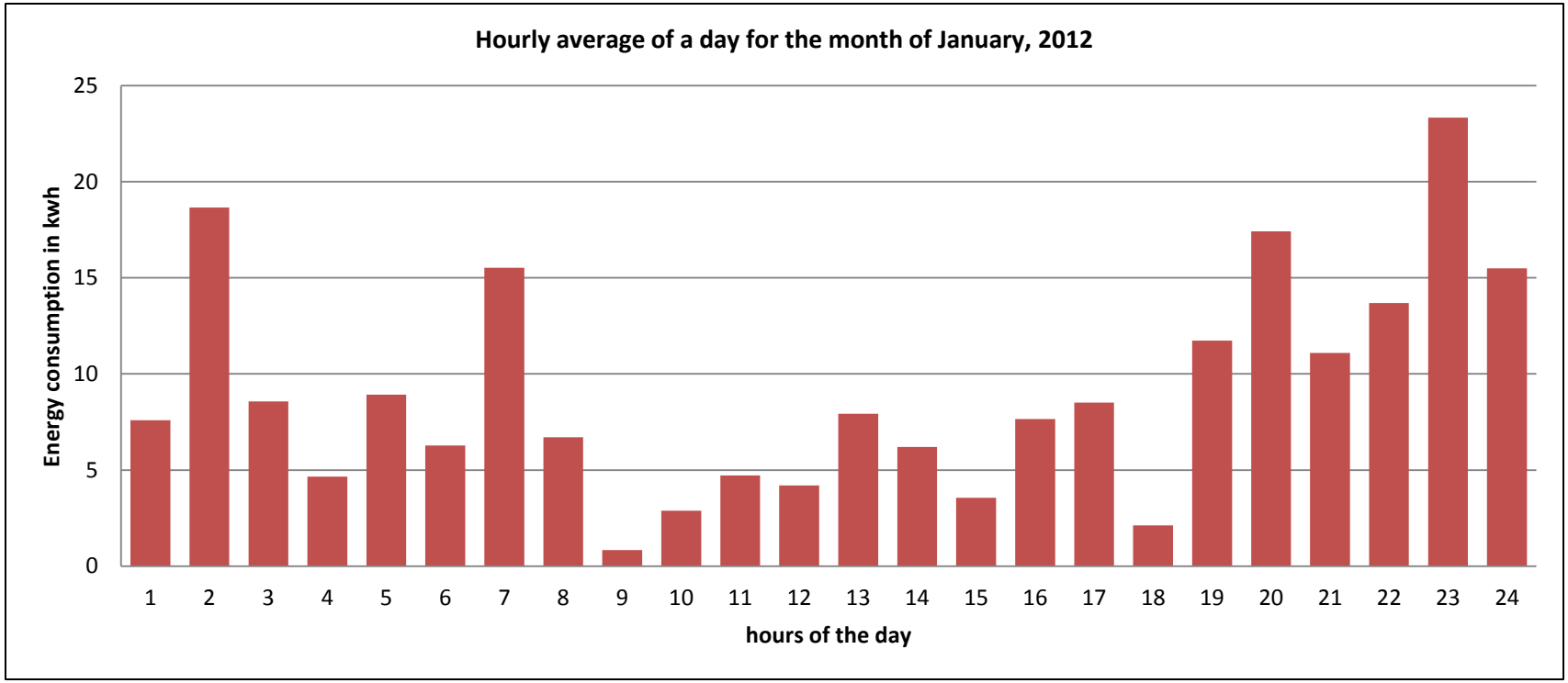
Logged data: Consumption on a typical winter day in house-2



Consumption on a typical Summer day in house-2

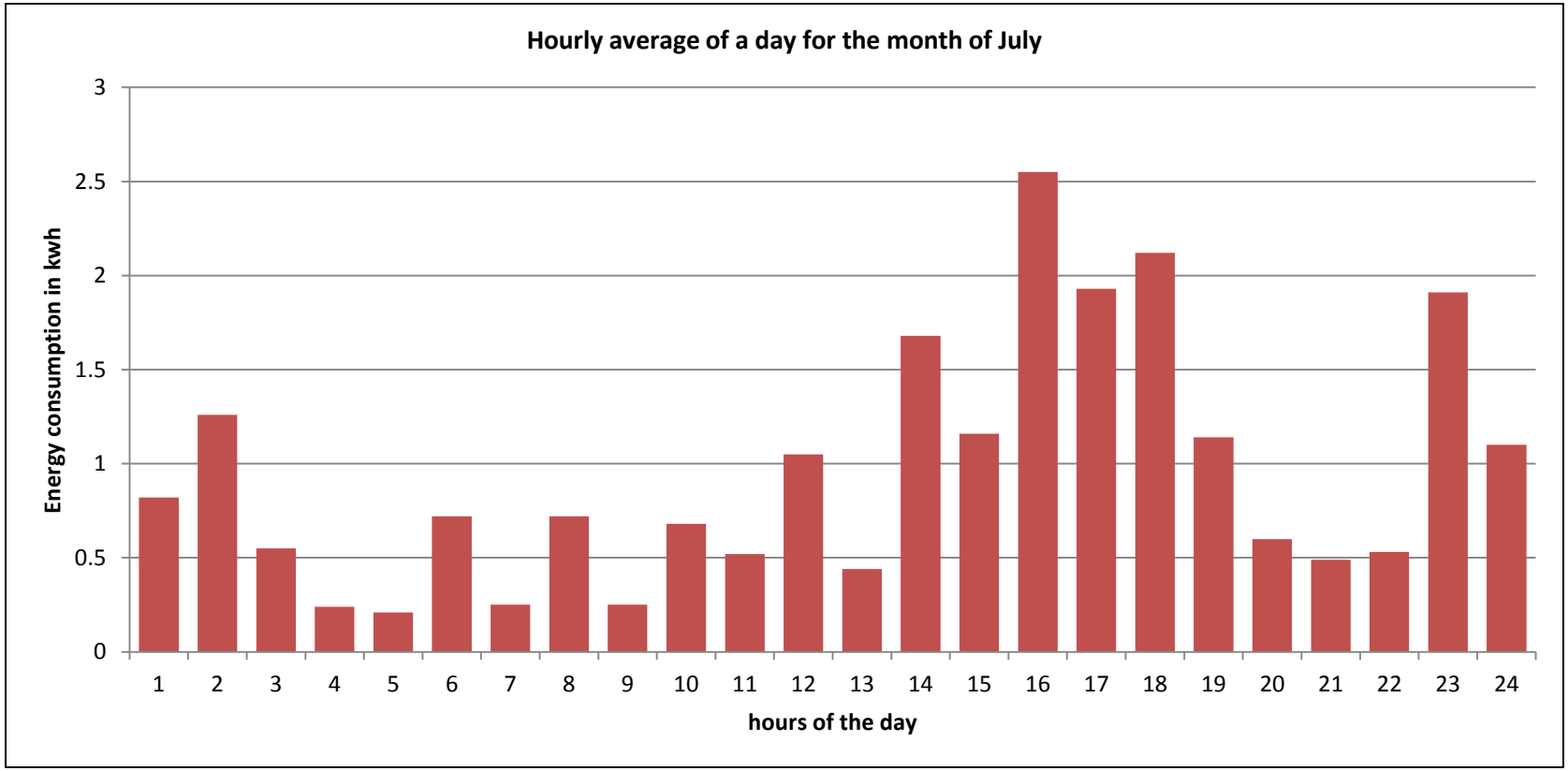


Hourly average of energy consumption in a day for the month of January, 2012



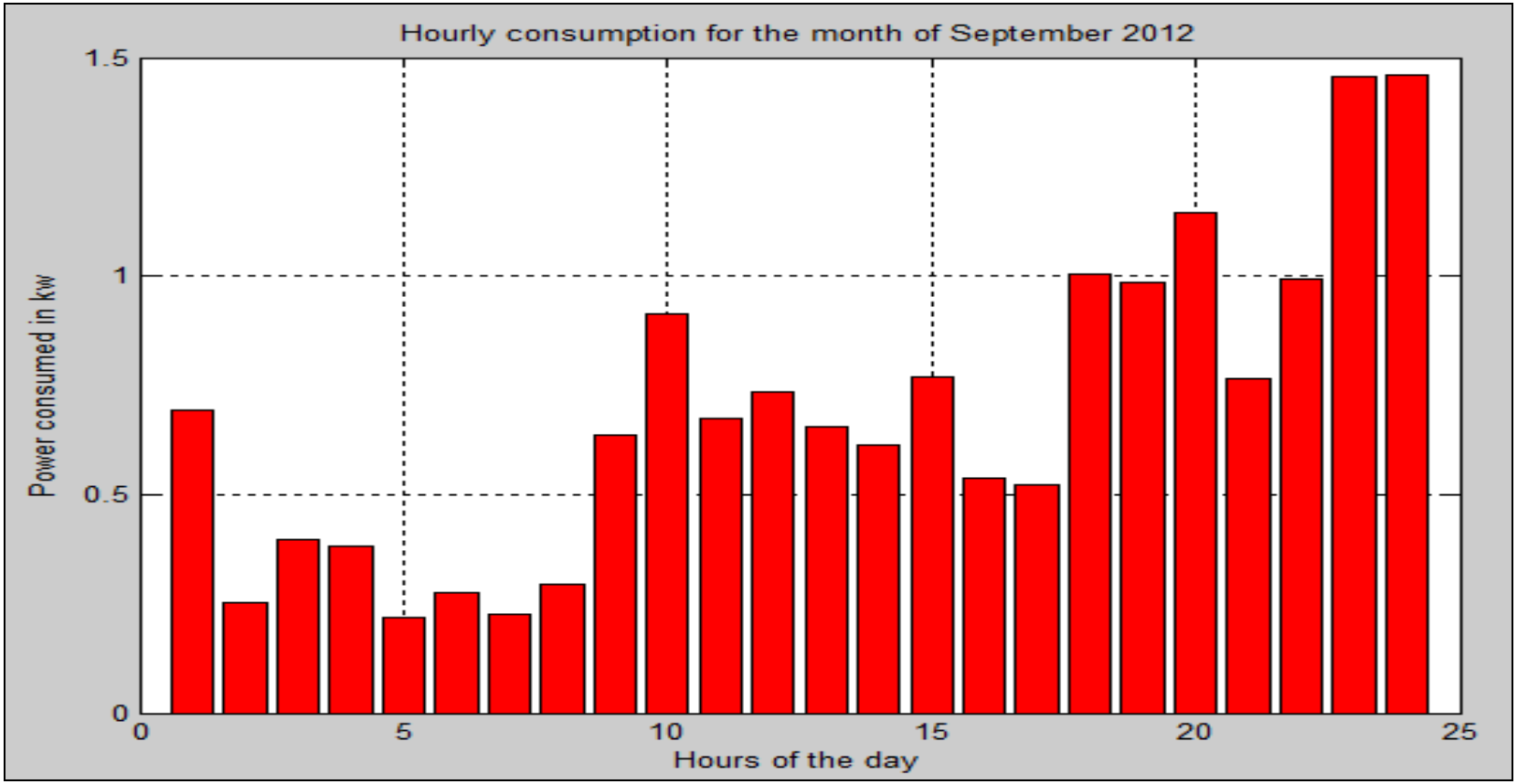
Consumption is high at night, late evening and in early morning

Hourly average of a day for the month of July, 2012



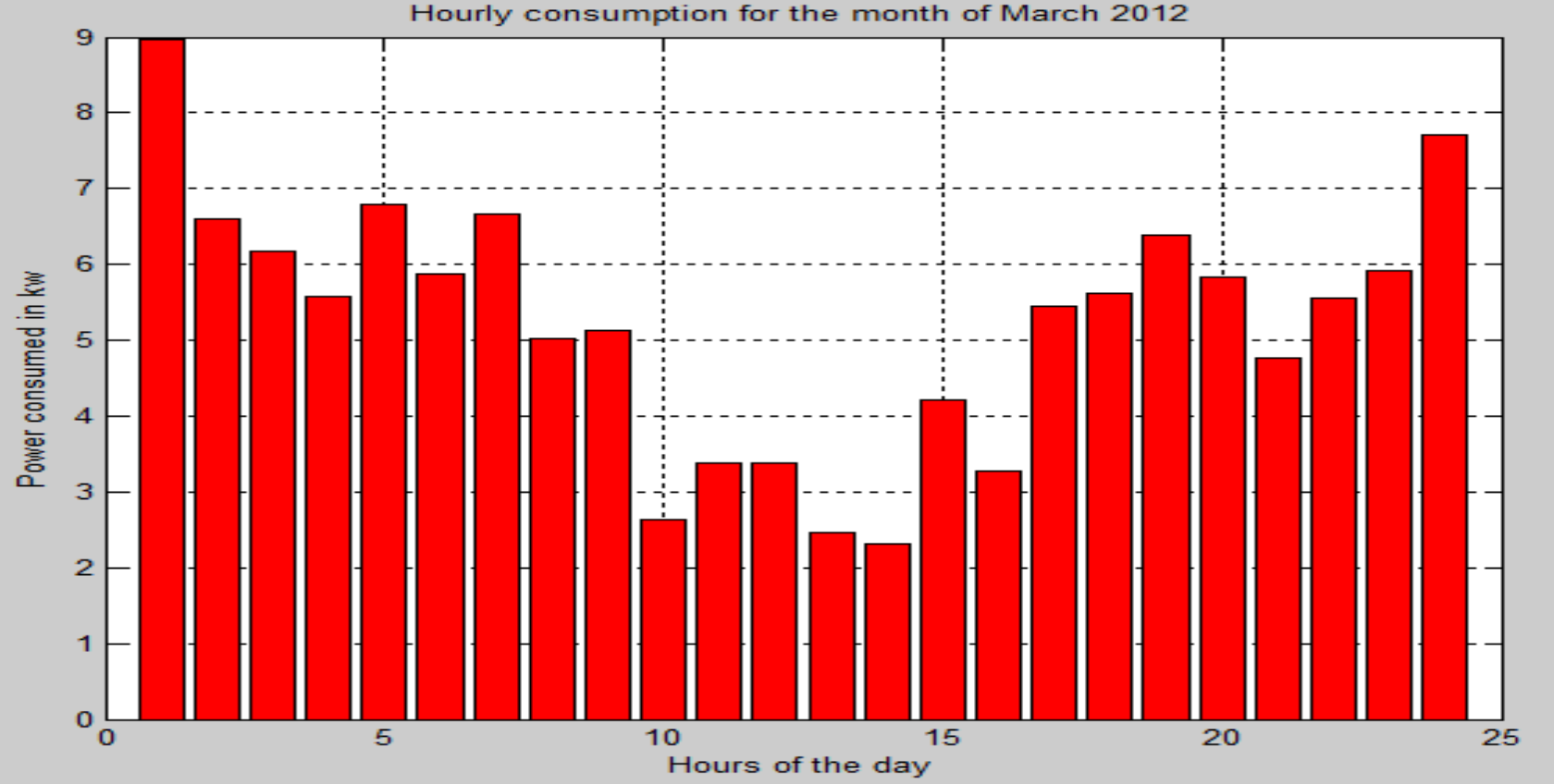
Consumption is high in the afternoon

Hourly average power consumption in September



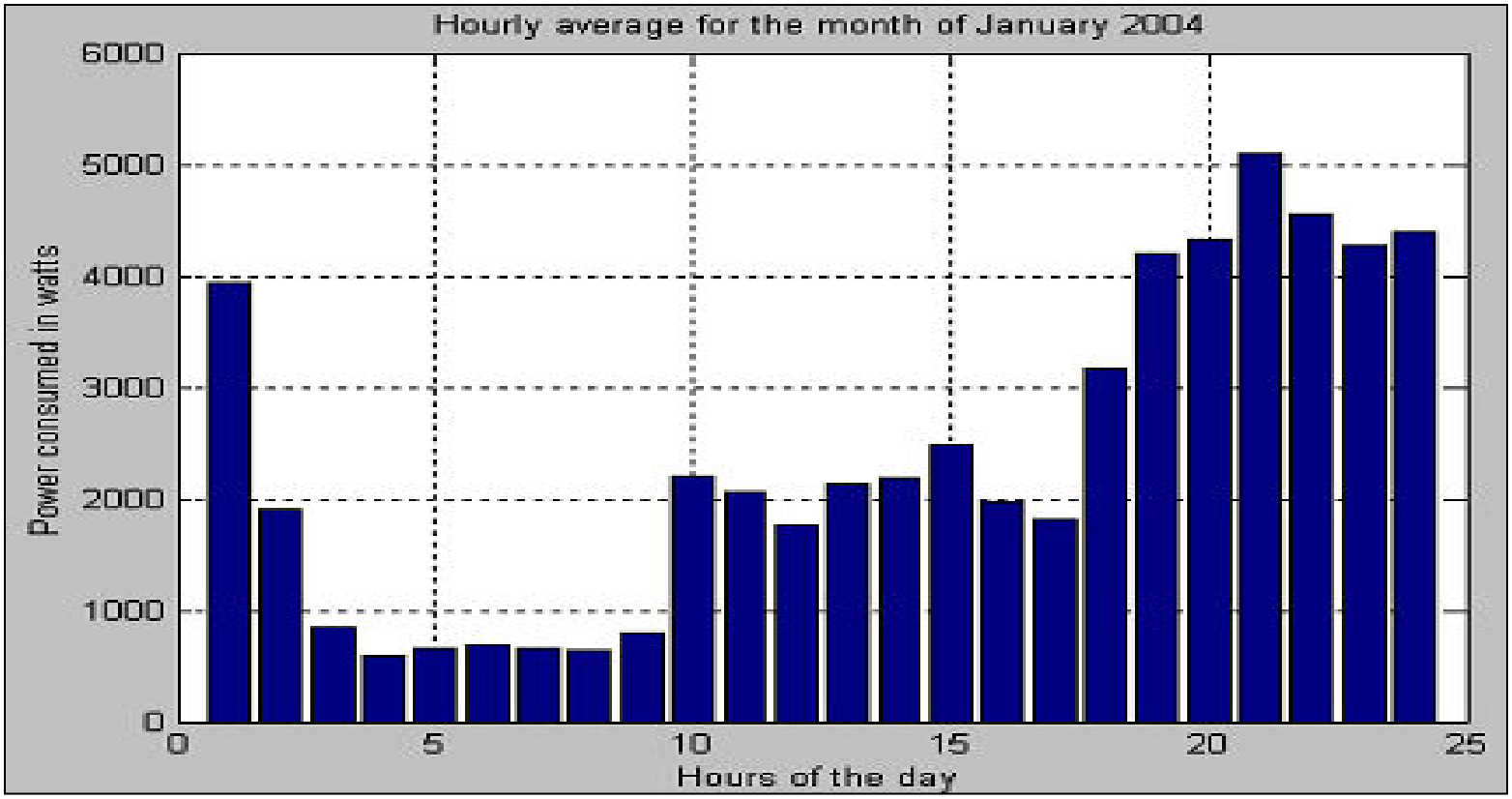
Minimum hourly power consumption was about 0.5 kW in September

Hourly average power consumption in March



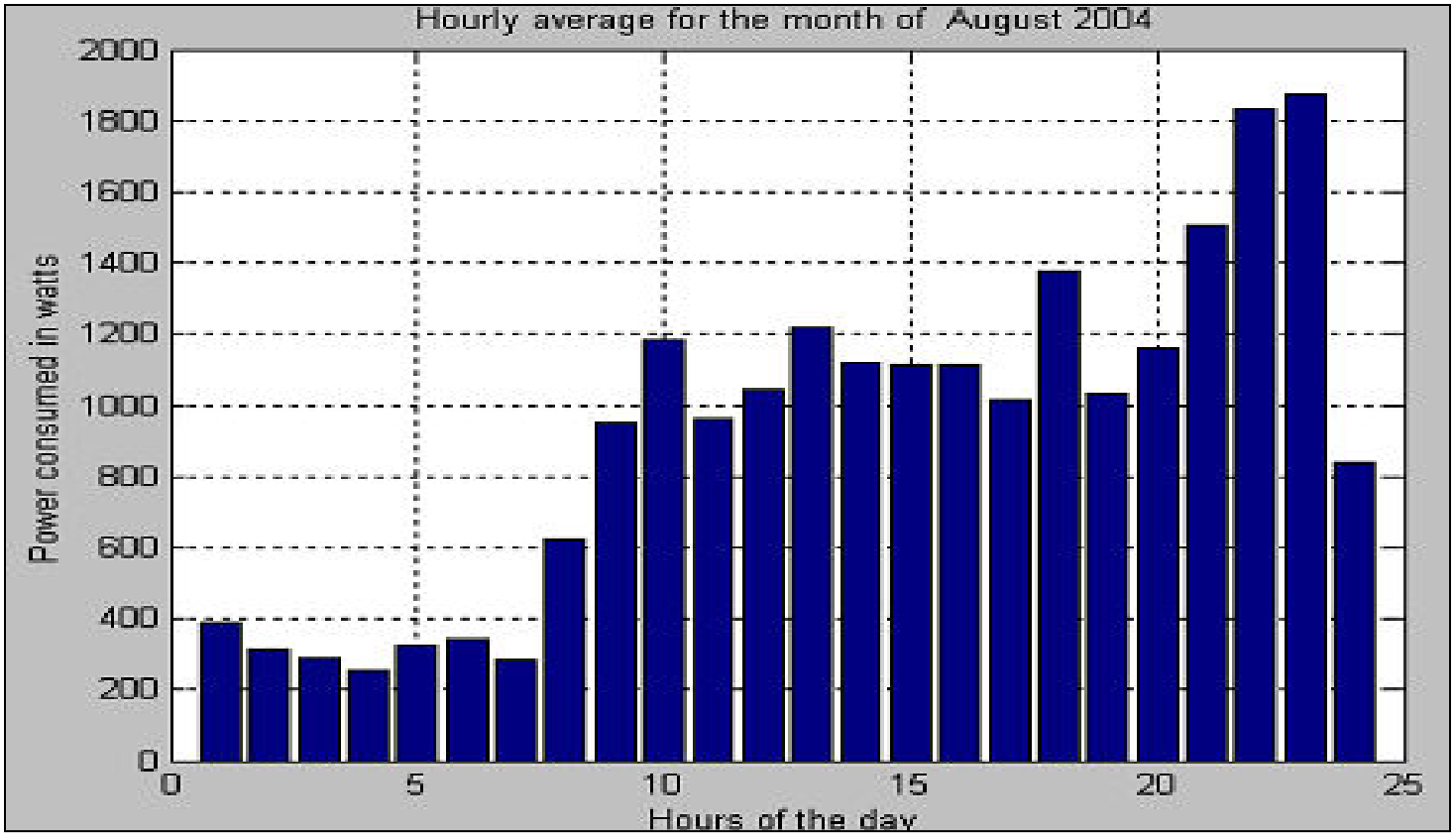
Maximum hourly consumption was about 9kW in the beginning of March in the year 2012

Hourly average power consumption in January (house-1)



Maximum average hourly power consumption was in January 2004, which exceeded 5kW level.

Hourly average power consumption in August.

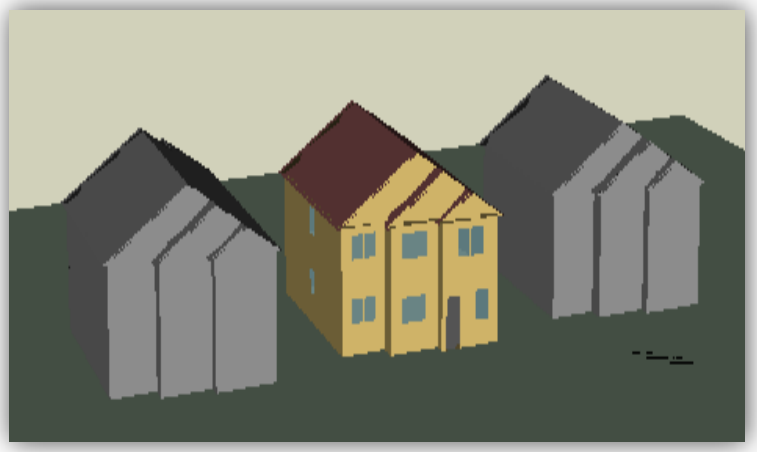


Minimum hourly power consumption was only 250W in early hours of the day in August.

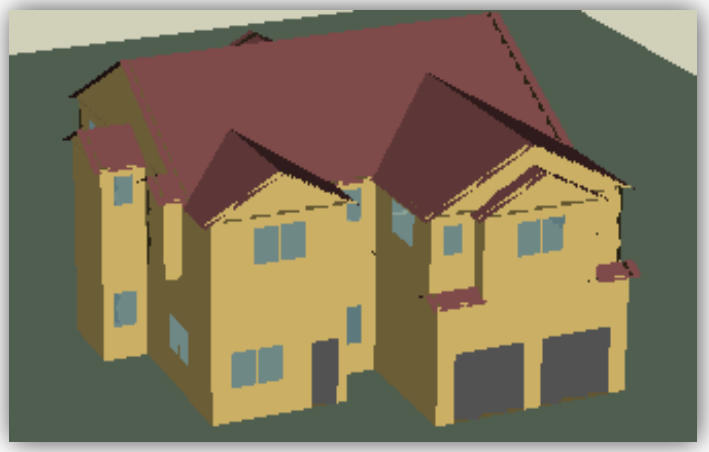
BEopt Software

- The BEopt™ (Building Energy Optimization) software provides capabilities to simulate & evaluate residential buildings energy consumption.
- It calculates the maximum energy saving case or minimum cost case according to the user's requirement.
- BEopt can be used to analyze both new construction and existing home retrofits.
- For designing purpose there are three screen
    - ✓ Geometry screen
    - ✓ Site screen
    - ✓ Input screen

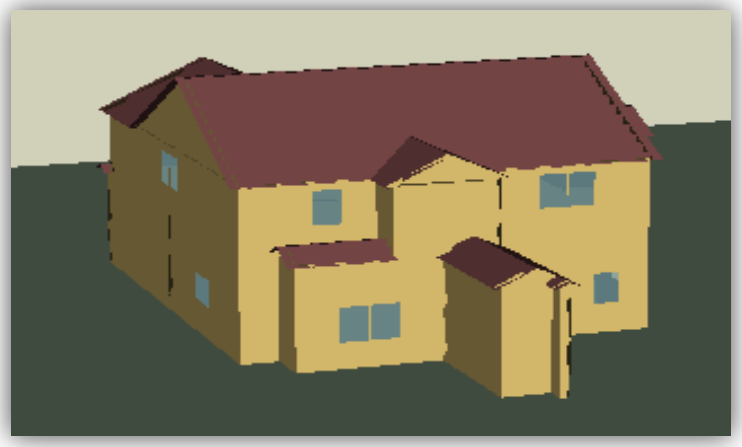
House designs in BEopt-(Geometry screen)



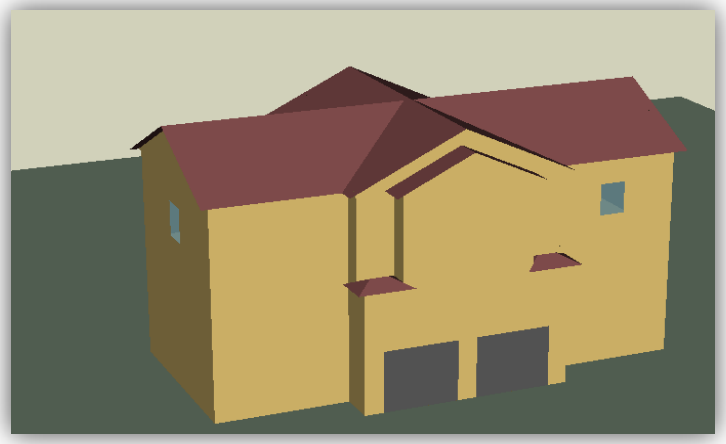
House#1



House#2(Front view)

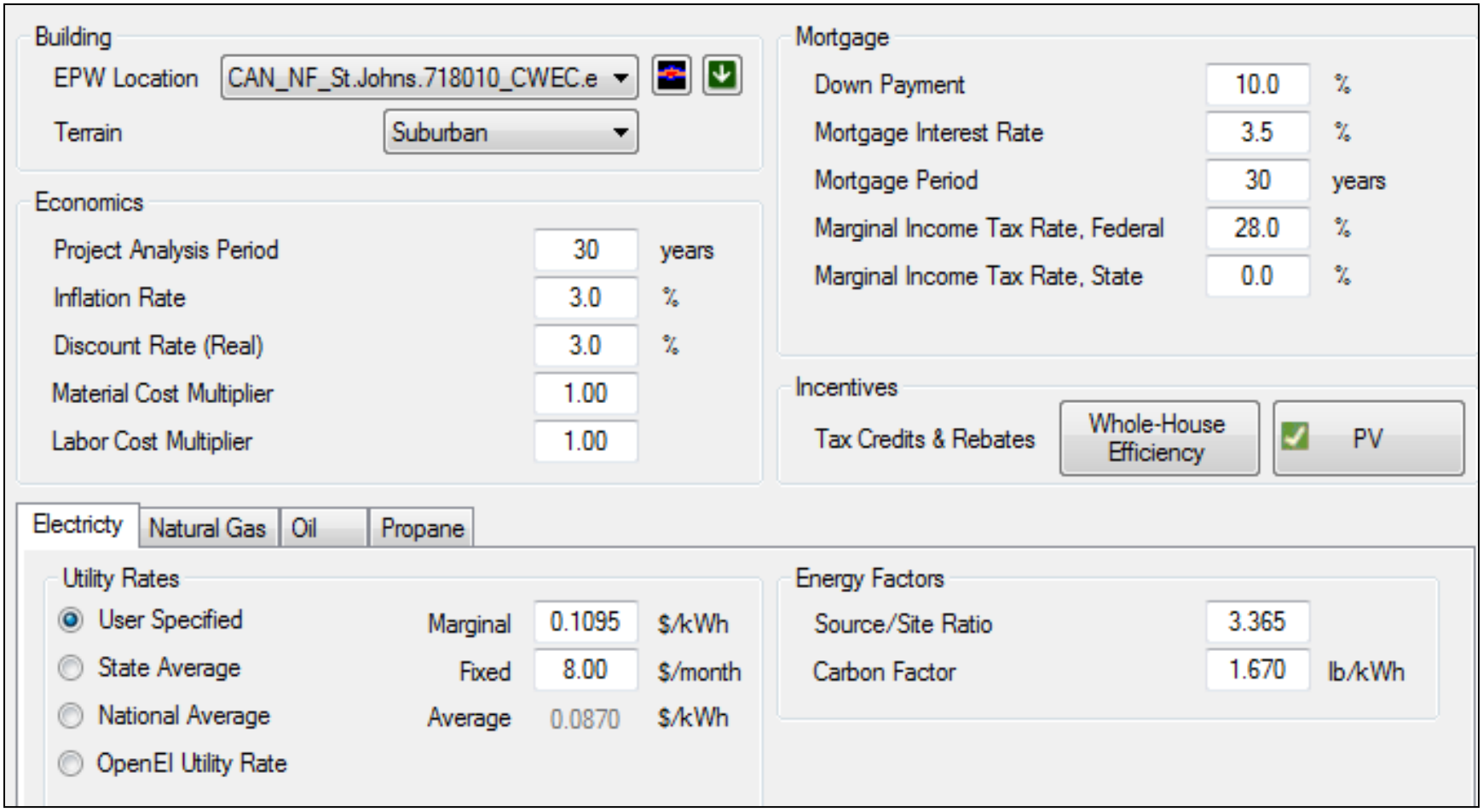


House#2(Back view)



House#2 Garage section

BEopt-(Site screen)



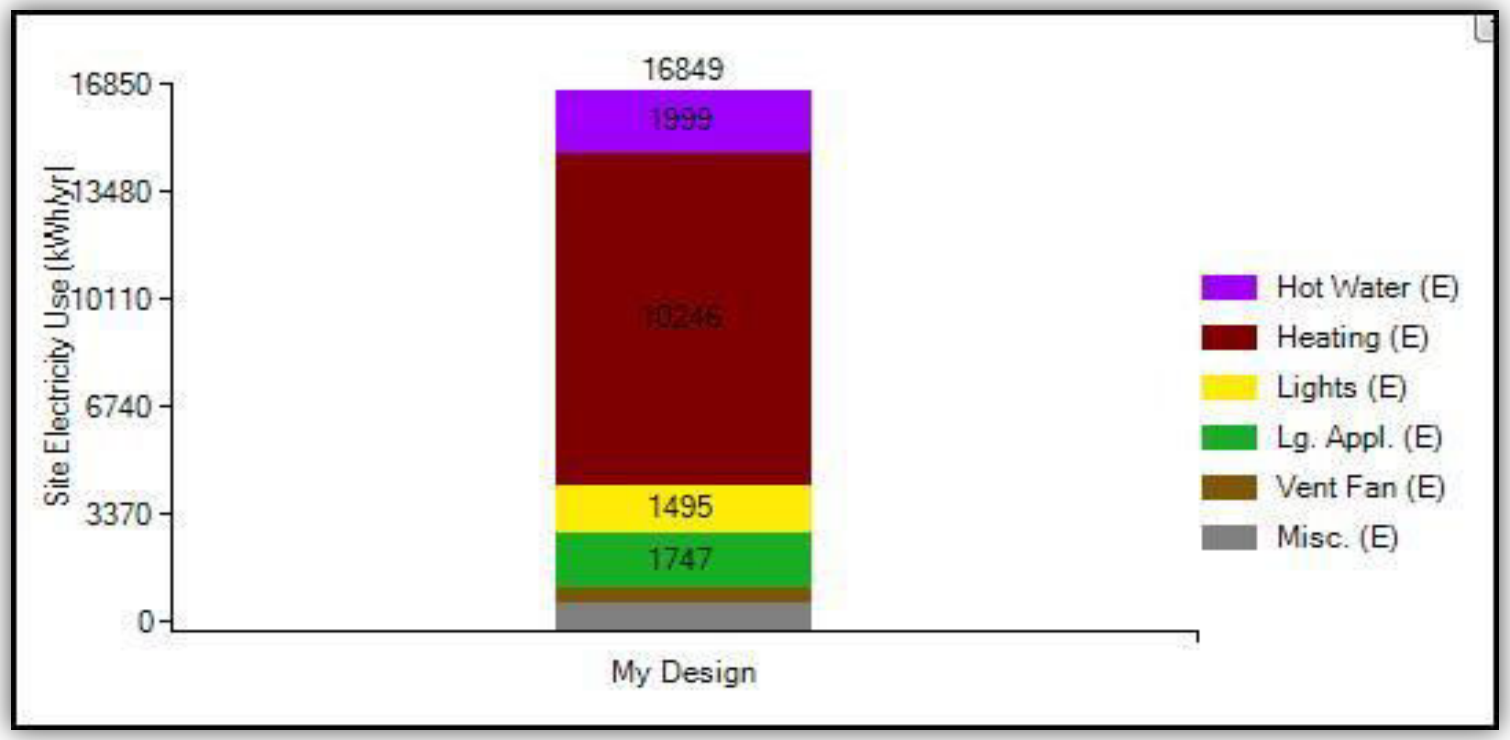
Input parameters used in BEopt

	Option screen	House#1	House#2
Operation	Heating set point	60F, at night time it remains off	
	Cooling set point		100 F
	Humidity set point	65% RH	
	Misc electrical load		0.25
	Misc hot water load	12.5 gal/day/person	
	Natural ventilation	Cooling months only	None.
Walls	Wood stud	R-21 Fiberglass batt, gr-1, 2*6, 24 in o.c	
	Wall sheathing	OSB	
	Exterior finish	Vinyl, light	Vinyl, medium/dark
Ceiling/Roofs	Unfinished attic	Ceiling R-44 Fiberglass, vented	
	Roof Material	Asphalt shingles, dark	
Foundation/Floors	Slab	4ft R-5 perimeter, R-5 gap	2ft R-10 perimeter, R-5 gap
	Interzonal floor	None	R-13 fiberglass batt
Thermal Mass	Floor mass	wood surface	wood surface
	Exterior wall mass	½ inch drywall	½ inch drywall
	Partition wall mass	½ inch drywall	½ inch drywall
	Ceiling mass	1/2 inch drywall	1/2 inch drywall

Input parameters used in BEopt

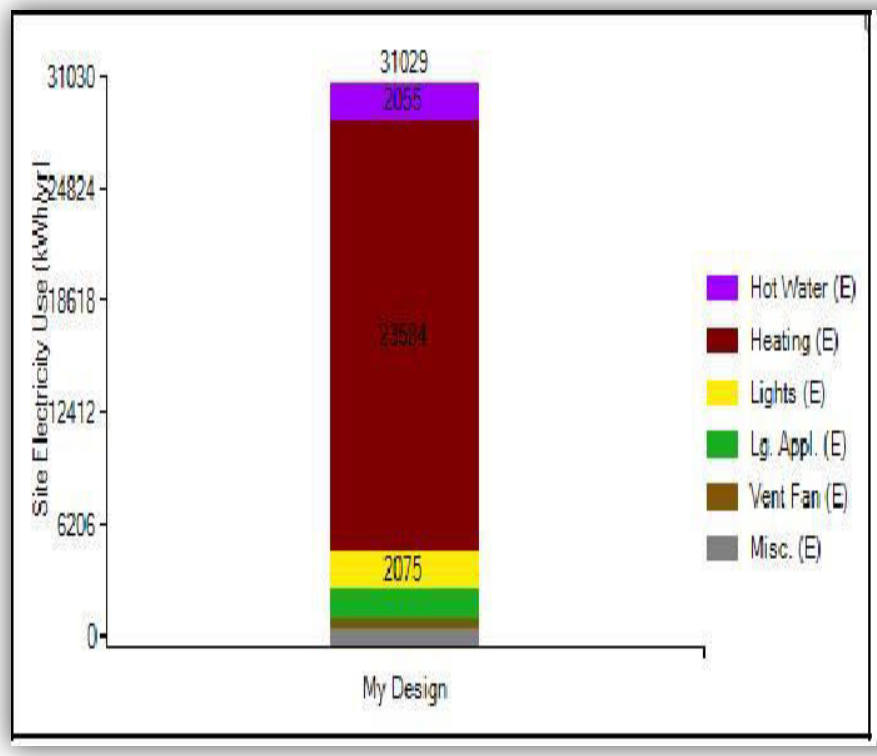
Windows & Doors	Window areas	A new input to the software according to the window area	
	Windows	Double pane, medium gain, low e, non- metal frame, Air fill.	
Air flow	Air leakage	4 ACH50	2 ACH50
	Mechanical ventilation	HRV 70%	
Major Appliances	Refrigerator	18 cu ft, EF=21.9, top freezer	
	Cooking range	Electric	
	Dish washer	290 annual kwh	
	Clothes washer	Energy star, cold only	
	Clothes dryer	Electric	
Lighting	Lighting	80% fluorescent hardwired plugin.	
Space conditioning	Electric baseboard	100% efficiency	
	Duct	7.5% leakage, R-8	
Water heating	Water heater	Electric standard	
	Distribution	Uninsulated, Homerun, PEX	

Simulation results -House#1

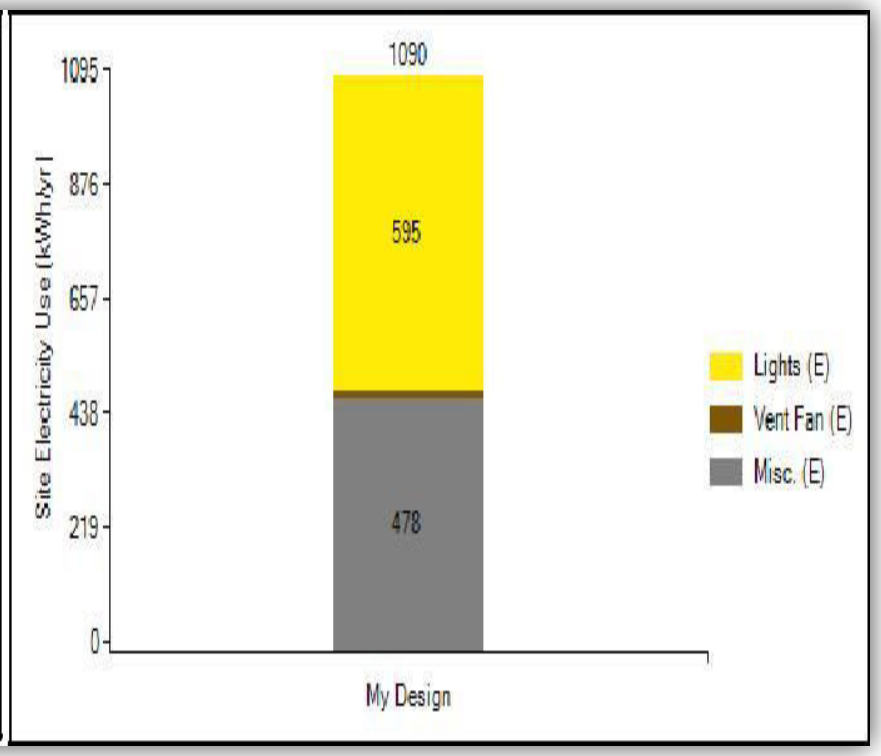


Actual electricity consumption of one year for house#1 is 15747 kWh/yr

Simulation results -House#2



Simulated total house consumption is 31029 kWh/yr



Energy consumption of the garage for one year is 1090 kWh/yr

Simulation results and analysis

- The energy consumption of house-1 for one year came as 16849 kWh/yr, whereas the actual consumption for the house is 15747 kWh/yr.
- House-2 the actual consumption of the house measured from the data logger is 23116.09 kWh/yr. (energy consumption in some plugs / lights is not measured) But the simulation shows the total house consumption is 31029 kWh/yr.
- Three occupants live in house-2 but BEopt Software considers more occupants for such a big house.
- Energy consumption of the garage for one year came as 1090 kWh/yr whereas the actual consumption is 1190.56 kWh/yr.
- BEopt was able to simulate both houses energy consumption with high accuracy.
- BEopt model can be used to study impact of any change and building modification.

Newfoundland Energy System

- Newfoundland Power (NP) and Newfoundland Hydro (NH) are the primary distributors of electricity in the island portion of Newfoundland and Labrador.
- Hydro supplies about 92 per cent of the island's energy requirements and NP supplies the remainder.
- NP purchases approximately 93 percent of its electricity from Newfoundland and Labrador Hydro. NP Serves about 240,000 customers in the island.
- The total population of Newfoundland & Labrador is 526,702 till July, 2013 and only about 30,000 people out of 526,702 live in Labrador.

Newfoundland Energy System

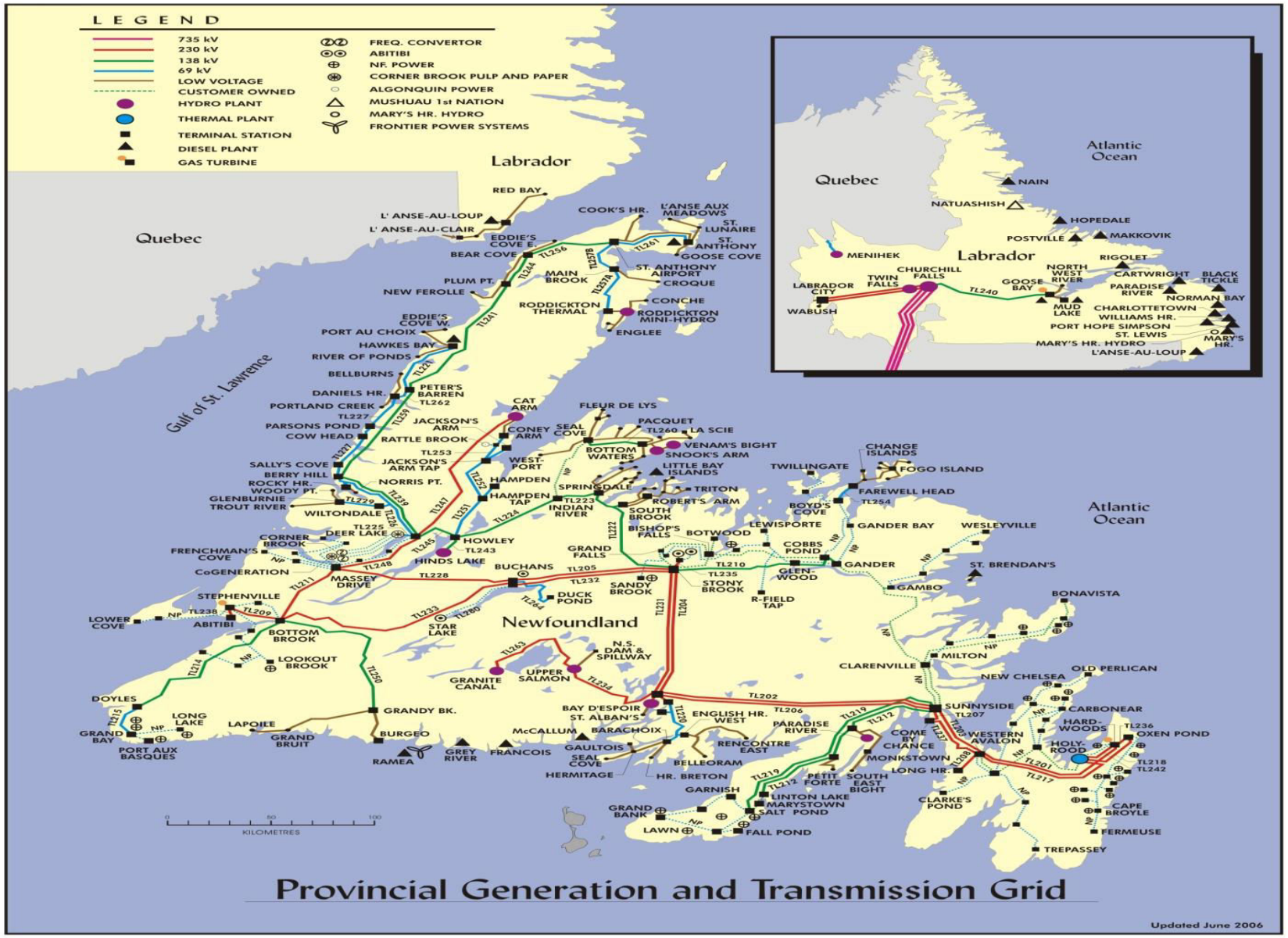
- Total capacity of hydroelectric plants in Island energy system is 1265 MW.
- For island interconnected system Newfoundland hydro includes mainly 6 hydroelectric plants and NL power operates the rest.
- The Holyrood thermal plant capacity is 490MW. Holyrood needs to operate at an average capacity of 50% at the worst winter months. From year 2004-2010 the average dropped to 44%.
- Total installed wind capacity is about 54.7 MW. In 2007, 27 MW was installed in St. Lawrence and later in 2008 another 27 MW was installed in Fermeuse. And In Ramea, wind-hydrogen-Diesel energy system installed wind capacity is 3*100 + 6*65 = 690 kW.

Generating assets

- **Newfoundland Hydro**
  - 6 Hydroelectric plants
  - Thermal plant (+ New 100MW un
  - 50MW Gas turbines(St. John's and
  - diesel plants in Hawke's Bay(5MW
- **Newfoundland power**
  - operates 23 hydro generating plan
  - two diesel plants
  - three gas turbine facilities(4.7MW

Hydroelectric generating station in Newfoundland Island	
Hydro Plant operated by Newfoundland hydro	**Plant capacity(MW)**
bay d espoir	605
Cat arm	128
Upper Salmon	84
Hinds Lake	75
Granite canal	41
Paradise River	8
Snooks Arm and Venams Bight	1
Roddickton	0.4
Grand falls	76
star lake	18.4
Non utility generator	
rattle brook	11.2
Deer lake	130
Hydro Plant operated by Newfoundland power	
Pierrs's Brook	3.4
Morris	1.08
Mobile	10.13
Rocky Pond	3.1
Torris Cove	6.36
Horsechops	7.52
Cape Broyle	5.3
Petty Harbour	4.35
Topsail Pond	2.25
Seal Cove	3.18
hearts content	2.1
Pittman's Pond	0.61
New Chealsea	3.4
Victoria	0.42
Fall Pond	0.32
West Brook	0.545
Lawn	0.6
Lockston	3
Port Union	0.6
Rattling Brook	13.41
Sandy Brook	5.7
Lookout Brook	5
Rose Blanche	5.22
Total capacity	**1265.595**

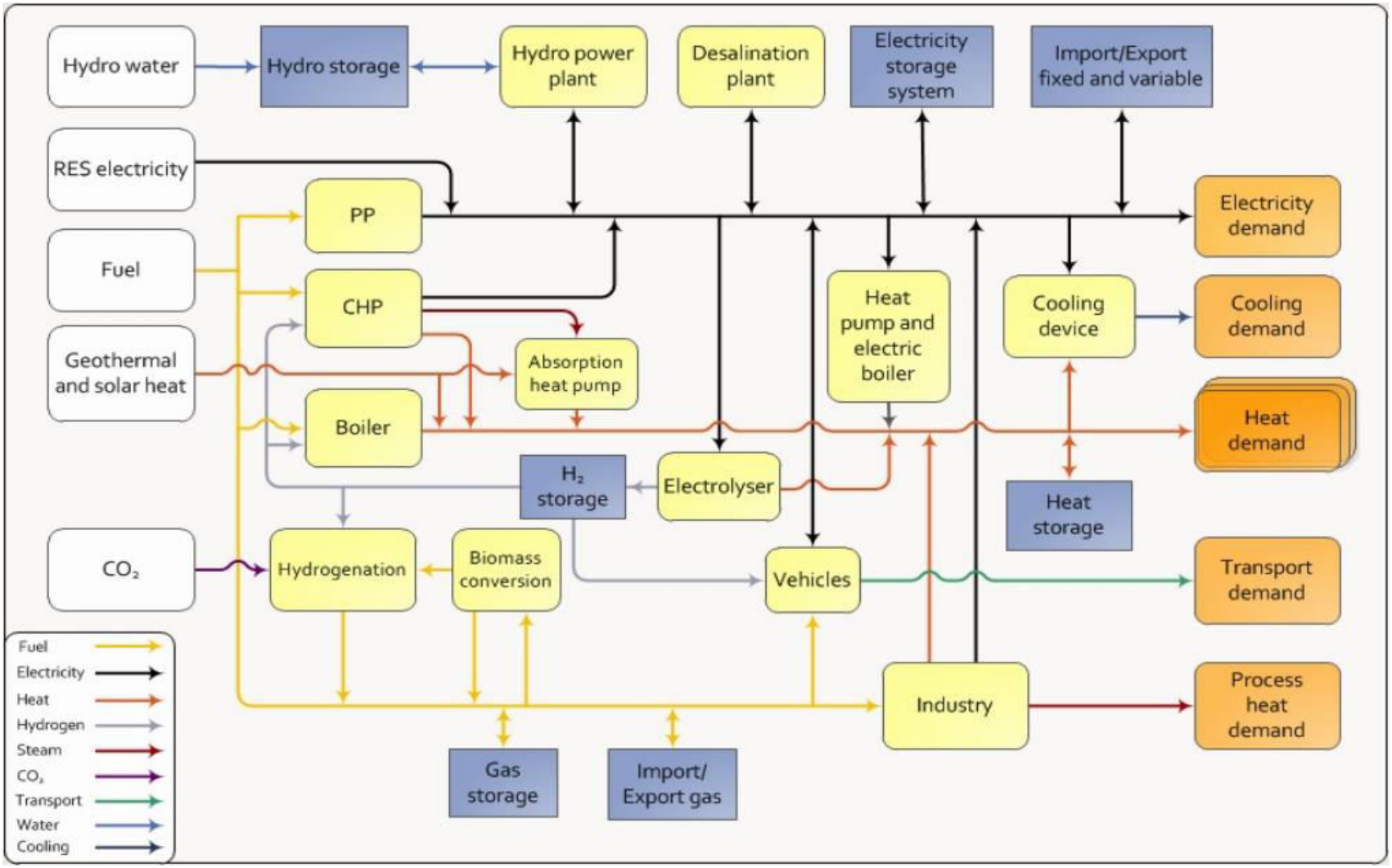
Island interconnected system



EnergyPLAN Software

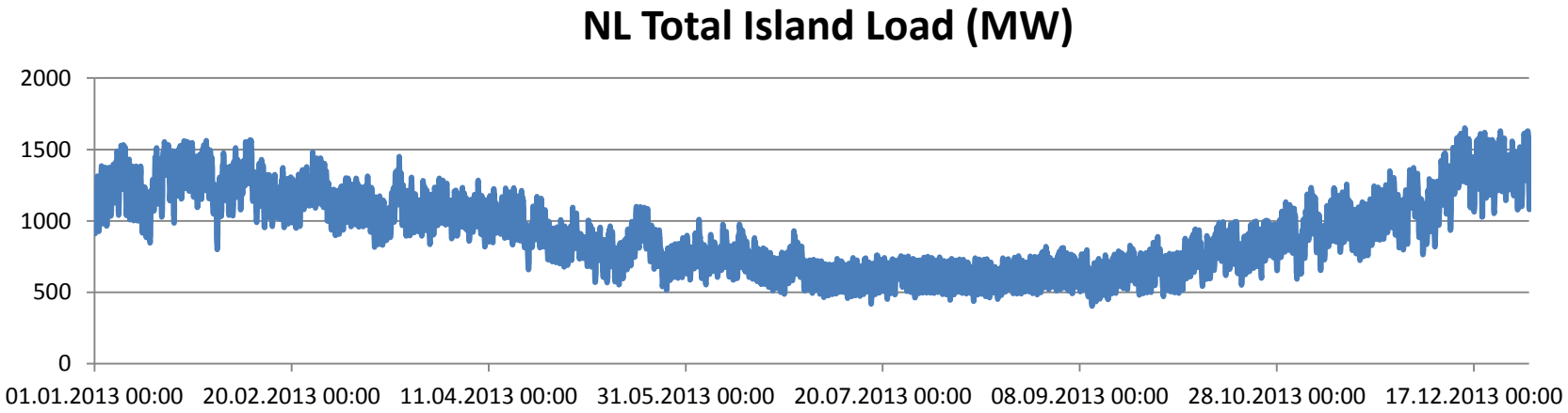
- Developed at Aalborg University, Denmark .
- A simulation tool & computer model that helps to design, analyze, environmental and economic impact of a national energy system.
- Inputs are demand, energy sources, energy plant capacity, cost, regulation strategies etc.
- Outputs are energy balances and resulting annual productions, fuel consumption, import/exports and total costs including income from the exchange of electricity.
- Output is analyzed in hourly steps over a period of one week, month, year.
- Hourly distribution data with 8784 data points are required for the simulation and hourly analysis.
- Specialized in integration of renewable energy sources.

Schematic diagram



Electrical Inputs

- Electricity demand for year 2013, 8.15 TWh.
- Wind capacity 54.7 MW.
- Hydro power capacity 1265 MW
- Thermal plant capacity 490 MW.
- Heat demand per building 5981 KWh/yr.



Energy Inputs (consumption)

Fuel consumption	TWh/yr	Energy Source	USD/GJ
Industry		Fuel Oil	34.21
Coal	1.123	Diesel	34.21
Oil	1.4	Petrol	31
Natural gas	21.005	Natural Gas	4.38
Biomass	0.0144	LPG	25.2
Bunker-C oil	7.32	Biomass	0.26
Various	10.405	**O & M cost**	**USD/MWh**
Transport		Hydro	270
Jet fuel	0.36	Electric heating	123
Petrol	18.51		

EnergyPLAN Inputs

EnergyPLAN 11.4: NL_plan_current_scenario.txt

File Edit Tools Help

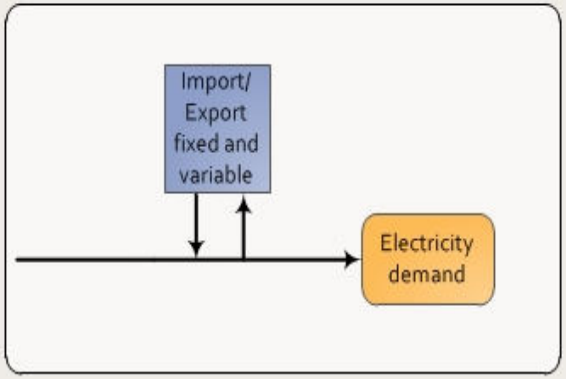
Frontpage | Input | Cost | Regulation | Output | Settings

ElectricityDemand | DistrictHeating | RenewableEnergy | ElecStorage | Cooling | Individual | Industry | Transport | Waste | Biomass Conversion | Synthetic Fuel | Desalination | CCS | Nuclear

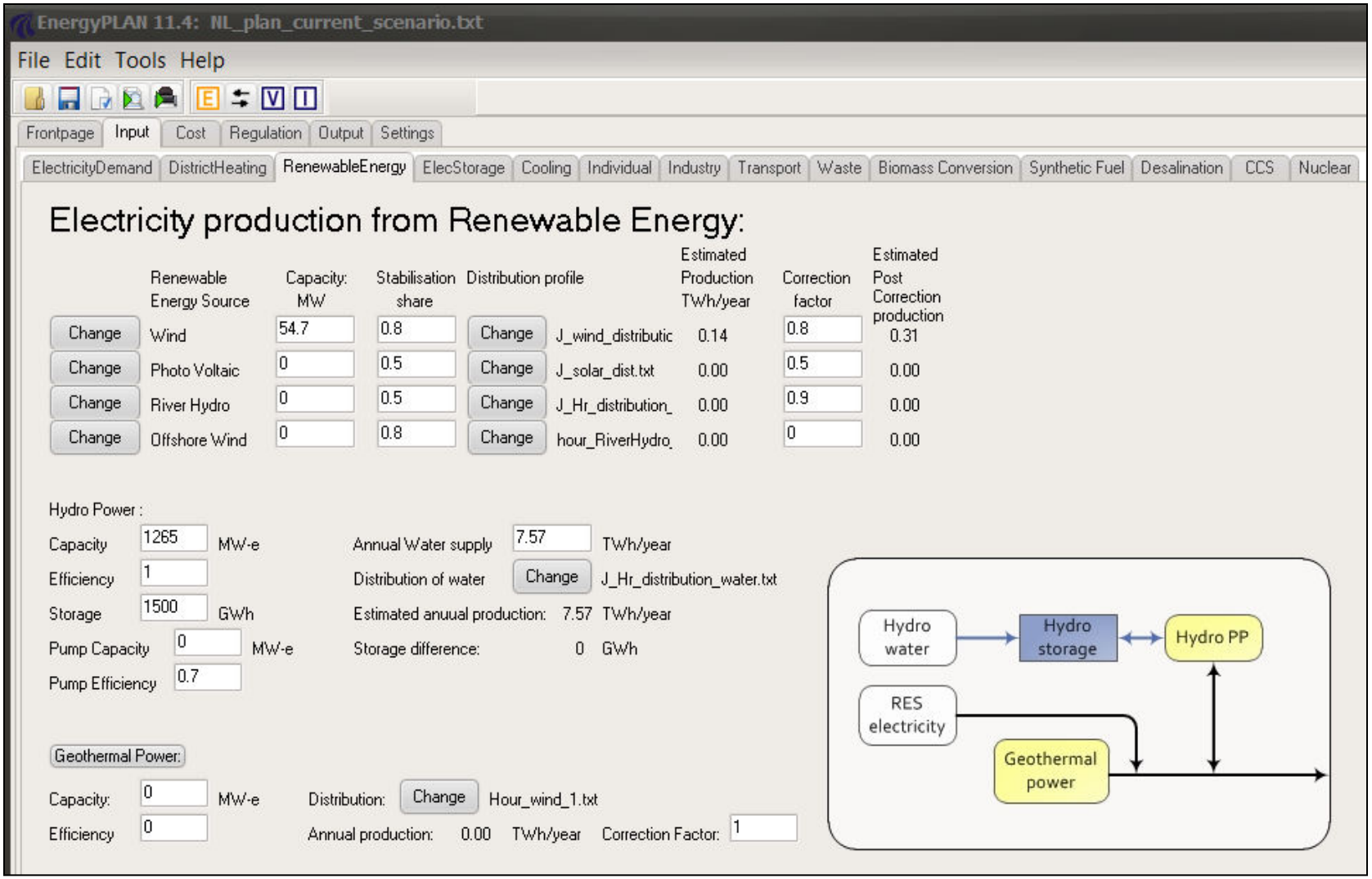
Electricity Demand and Fixed Import/Export

Electricity demand:	8.15	TWh/year	Change distribution	J_Hr_Electricity_dis_Data.txt		
Electric heating (IF included)	– 0	TWh/year	Subtract electric heating using distribution from 'individual' window			
Electric cooling (IF included)	– 0	TWh/year	Subtract electric cooling using distribution from 'cooling' window			
Elec. for Biomass Conversion	0.00	TWh/year	(Transfered from Biomass Conversion TabSheet)			
Elec. for Transportation	0.00	TWh/year	(Transfered from Transport TabSheet)			
Sum (Demand excl. elec. heating)	8.15	TWh/year				
Electric heating (individual)	0.00	TWh/year				
Electricity for heat pumps (individual)	0.00	TWh/year				
Electric cooling	0.00	TWh/year				
Flexible demand (1 day)	0	TWh/year	Max-effect	0	MW	
Flexible demand (1 week)	0	TWh/year	Max-effect	0	MW	
Flexible demand (4 weeks)	0	TWh/year	Max-effect	0	MW	
Fixed Import/Export	0	TWh/year	Change distribution	J_import.txt		
Total electricity demand*	8.15	TWh/year				

*) Demand does not include possible electricity needed for regulating electric boilers (Regulation Tab)



EnergyPLAN Inputs



EnergyPLAN other inputs

- Optimization strategy- I. Technical optimization

  II. Market economic optimization

- Four options in technical regulation

  I. Balancing heat demands.

  II. Balancing both heat and electricity demand.

  III. Balancing both heat and electricity demand (reducing CHP when needed (not applicable to NL)).

  IV. Balancing heat demands using triple tariff. (Not applicable to NL)

EnergyPLAN Outputs

- Outputs can be seen in two ways
  - I. In Clipboard
  - II. In Graphics-3 days, Week, Month, Year
- Screen window-To design which results to view.

```
ANNUAL CO2 EMISSIONS (Mt):
CO2-emission (total)          =    13.248
CO2-emission (corrected)      =    13.248

SHARE OF RES (incl. Biomass):
RES share of PES              =     12.9 percent
RES share of elec. prod.      =     96.5 percent
RES electricity prod.         =     7.88 TWh/year

ANNUAL FUEL CONSUMPTIONS (TWh/year):
Fuel Consumption (total)      =    61.32
CAES Fuel Consumption         =     0.00
Fuel(incl.Biomass excl.RES)   =    53.45
Fuel Consumption (incl. H2)   =    61.32
Fuel Consumption (corrected)  =    61.32
Coal Consumption              =     1.12
Oil Consumption               =    31.30
Ngas Consumption              =    21.00
Biomass Consumption           =     0.01
V2G Pre Load Hours            =        0
```

EnergyPLAN Outputs - Existing Scenario

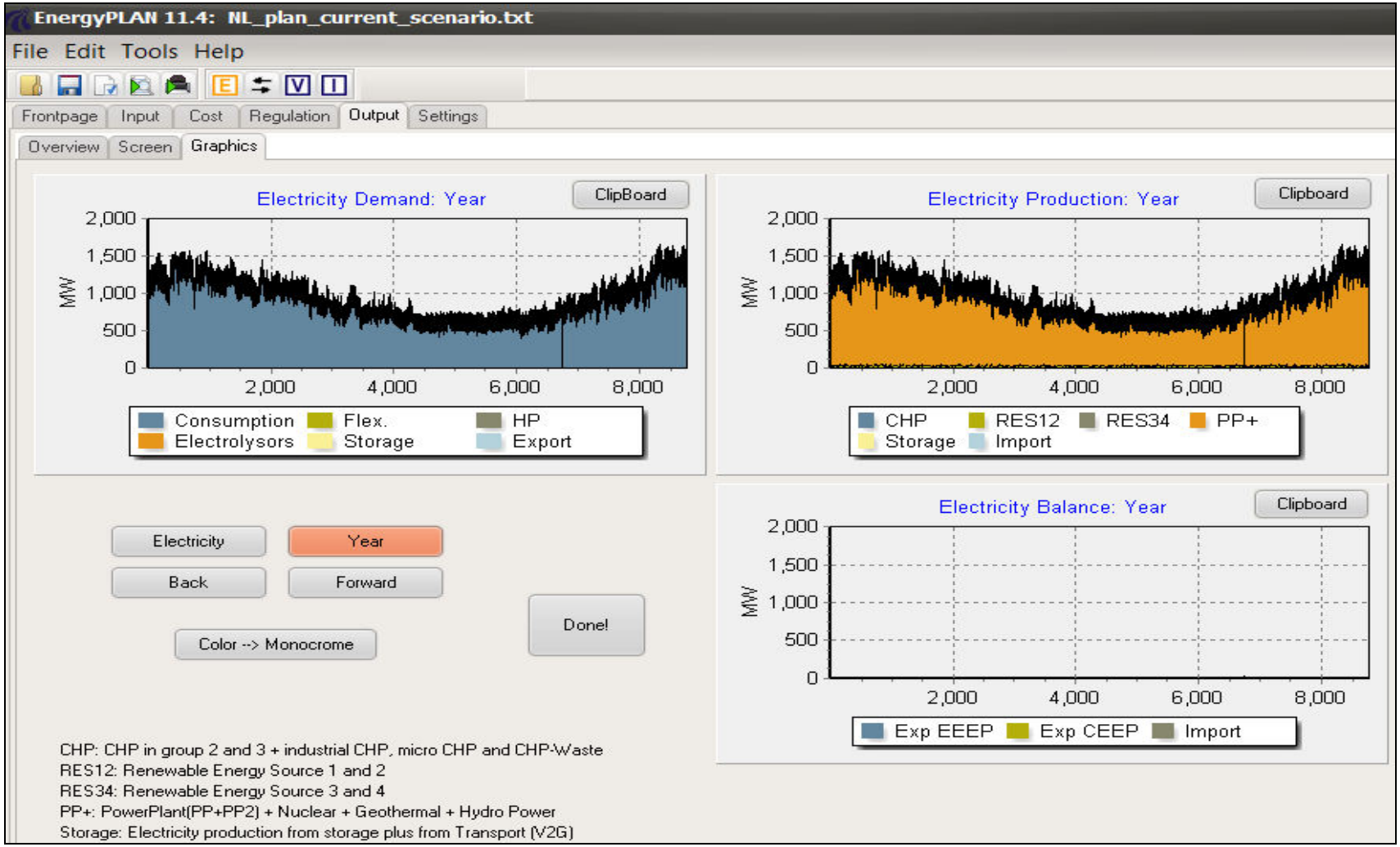
	elec. demand	wind power	PV	River hydro	Offshore wind	Hydro power	Hydro pump	Hydro storage	Hydro Wat-Sup	Hydro Wat-Loss	pp elec.	pp2 elec.	CEEP	EEEP
TOTAL FOR ONE YEAR (TWh/year):														
Annual:	8.16	0.31	0.00	0.00	0.00	7.57	0.00	0.00	7.57	0.00	0.28	0.00	0.00	0.00
MONTHLY AVERAGE VALUES (MW):														
January	1271	37	0	0	0	1129	0	532363	361	0	105	0	0	0
February	1227	38	0	0	0	1117	0	121587	816	0	72	0	0	0
March	1093	36	0	0	0	1024	0	396841	1984	0	32	0	0	0
April	975	34	0	0	0	925	0	1001569	1659	0	16	0	0	0
May	805	35	0	0	0	767	0	1237528	669	0	3	0	0	0
June	728	34	0	0	0	694	0	1020796	215	0	0	0	0	0
July	632	33	0	0	0	600	0	719293	228	0	0	0	0	0
August	634	35	0	0	0	599	0	645164	773	0	0	0	0	0
September	663	34	0	0	0	629	0	909474	1051	0	0	0	0	0
October	816	34	0	0	0	779	0	987169	764	0	3	0	0	0
November	1008	34	0	0	0	952	0	1069686	1049	0	23	0	0	0
December	1303	37	0	0	0	1135	0	950212	787	0	130	0	0	0
Average	929	35	0	0	0	862	0	800813	862	0	32	0	0	0
Maximum	1652	55	0	0	0	1200	0	1276339	15341	0	420	0	0	0
Minimum	1	0	0	0	0	0	0	233	51	0	0	0	0	0

Renewable energy source (RES) electricity production is 7.88 TWh/yr,

Average annual power from wind is 35 MW and the highest production is in December, January and February month.

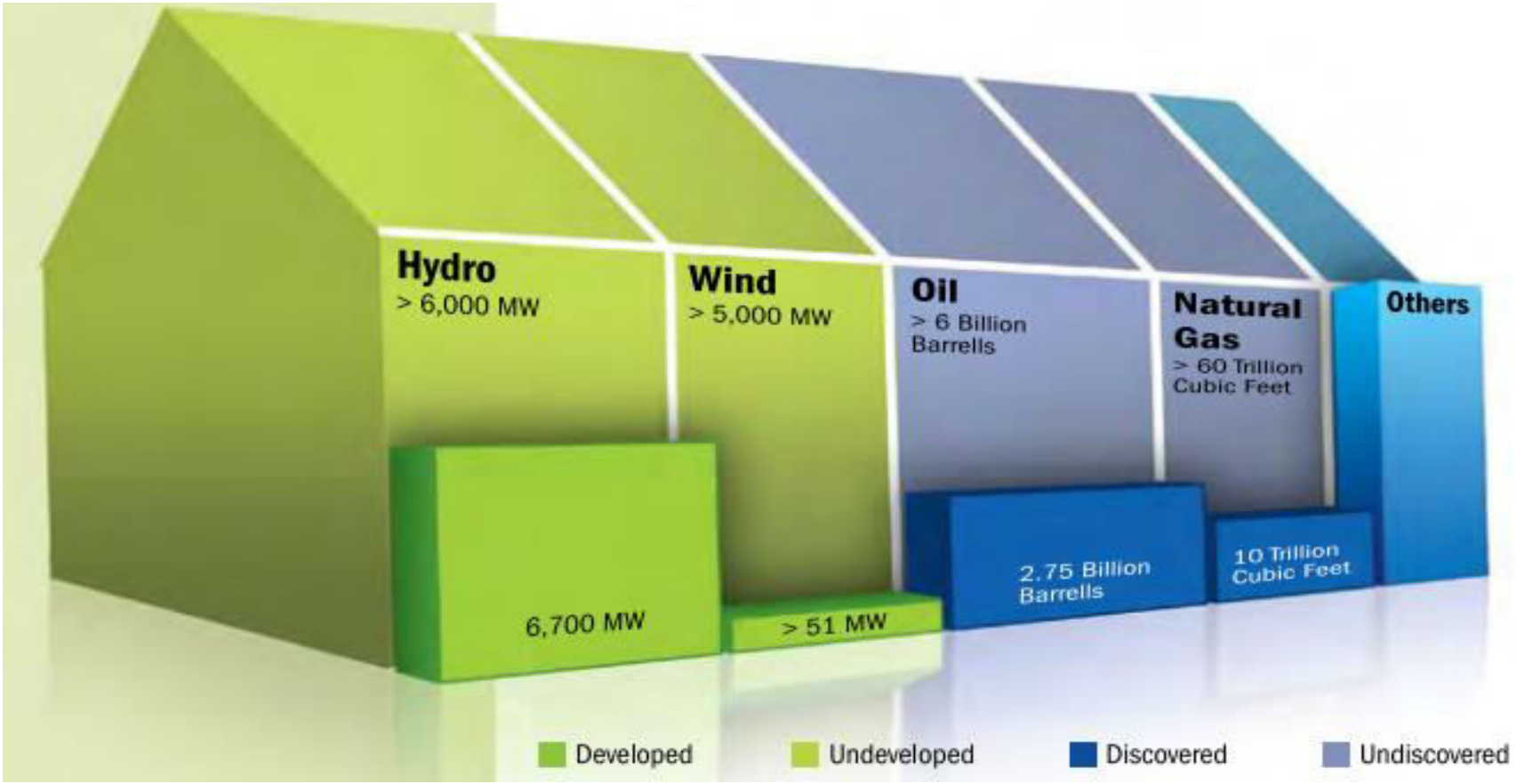
For hydro the annual average is 862 MW with highest production in December

EnergyPLAN Outputs -Existing scenario



Electricity production (yellow) meets with the demand (blue) for year 2013

NL Energy Resources (from NL Government Energy Plan)

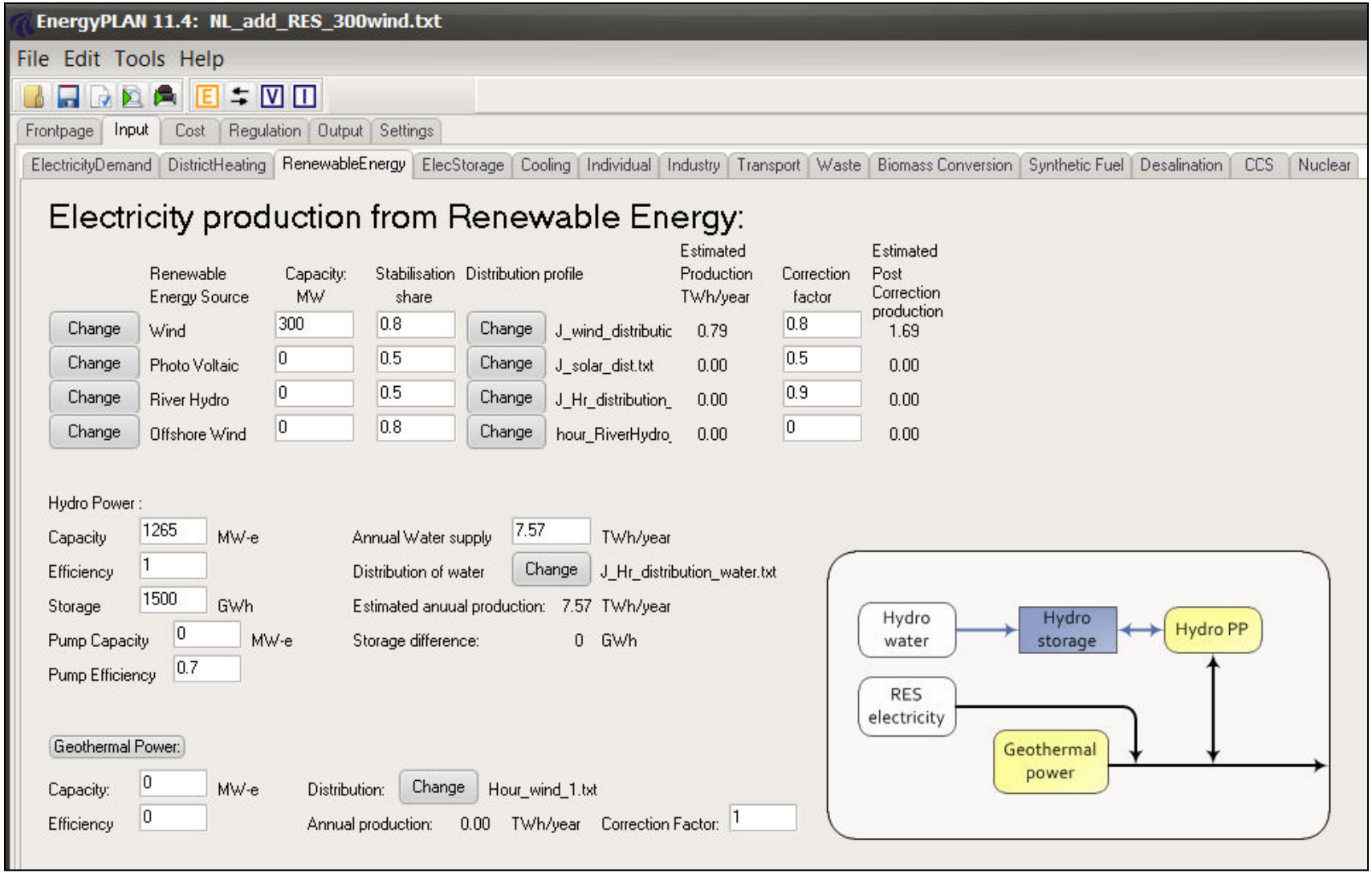


All new developments are focused on Large Hydro and Oil.

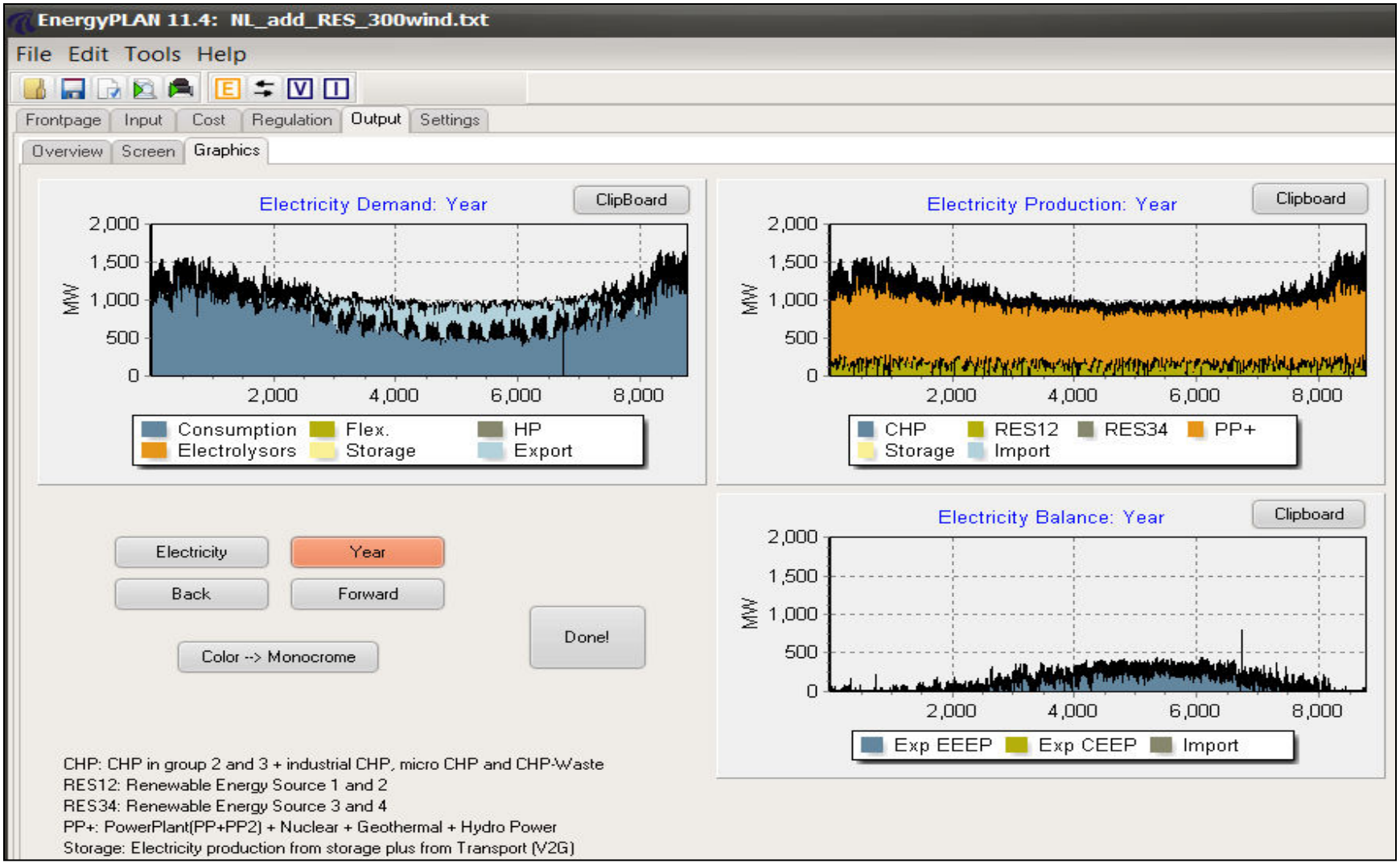
Why wind energy?

- Environmentally-friendly, pollution-free and endless source of energy.
- A wind turbine has a typical life span of 20 to 25 years.
- Modern wind turbines can withstand 180km/h winds and temperatures as low as - 40°C
- Reduce fossil-fired generation at Hydro's thermal generating station in Holyrood.
- In 2010, Hydro purchased 183,252 MWh of clean energy from the island's two wind projects. That's enough green energy to power over 12,300 homes, equivalent to burning 290,000 barrels of oil at the Holyrood plant.
- Greatest benefit is seen during winter months when both wind speed and energy demands are higher.

EnergyPLAN Input-300 MW wind



EnergyPLAN Output with 300MW wind (future scenario)



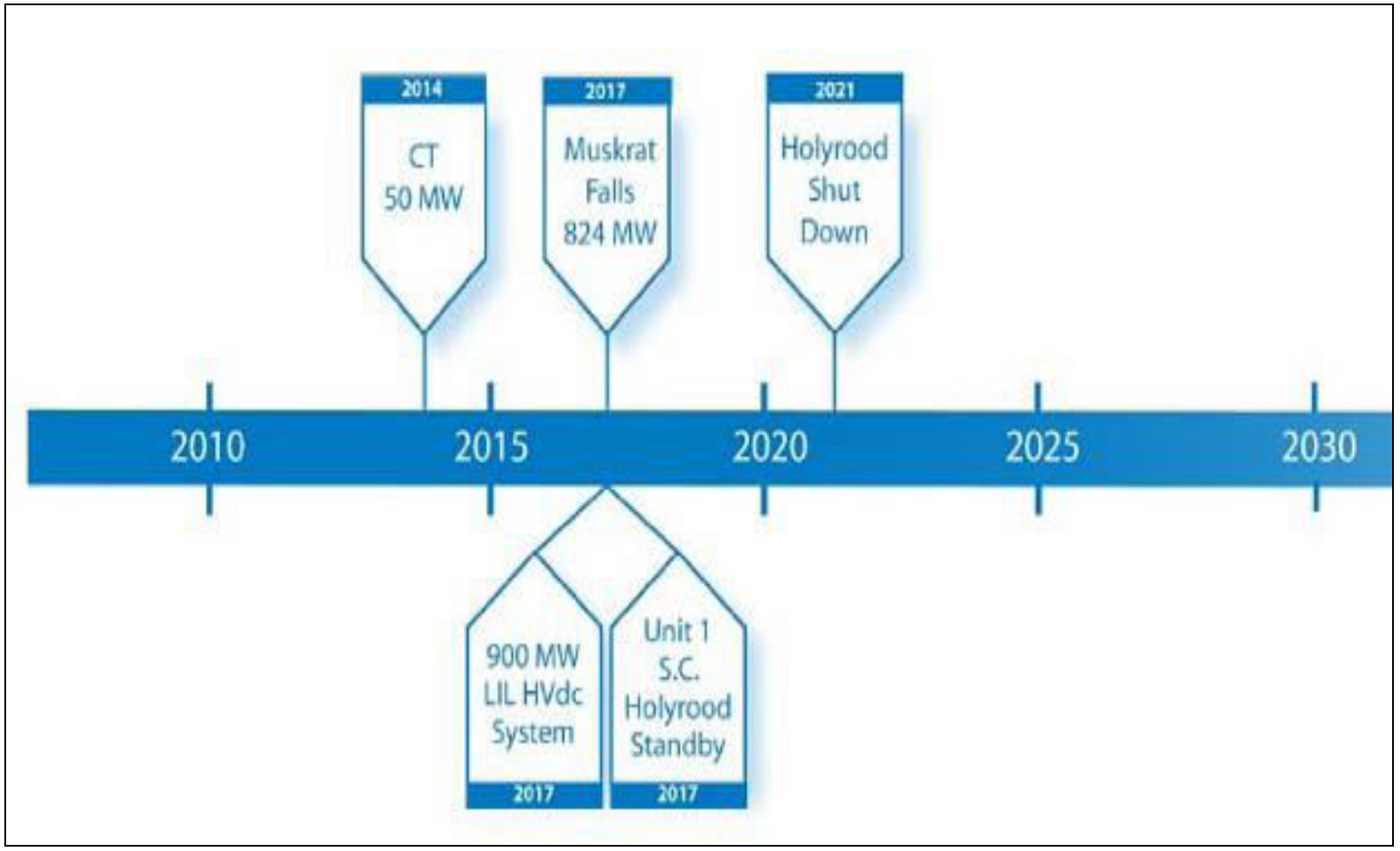
EnergyPLAN Output-Future scenario

	elec. demand	wind power	PV	River hydro	Offshore wind	Hydro power	Hydro pump	Hydro storage	Hydro Wat-Sup	Hydro Wat-Loss	pp elec.	pp2 elec.	CEEP	EEEP
TOTAL FOR ONE YEAR (TWh/year):														
Annual:	8.16	1.69	0.00	0.00	0.00	7.57	0.00	0.00	7.57	0.00	0.02	0.00	0.00	1.12
MONTHLY AVERAGE VALUES (MW):														
January	1271	206	0	0	0	1066	0	449381	361	0	7	0	0	7
February	1227	211	0	0	0	1021	0	88678	816	0	3	0	0	8
March	1093	198	0	0	0	918	0	438394	1984	0	0	0	0	23
April	975	186	0	0	0	854	0	1116604	1659	0	0	0	0	64
May	805	192	0	0	0	781	0	1369229	669	0	0	0	0	168
June	728	187	0	0	0	757	0	1126590	215	0	0	0	0	216
July	632	179	0	0	0	728	0	747730	228	0	0	0	0	275
August	634	193	0	0	0	724	0	579457	773	0	0	0	0	283
September	663	187	0	0	0	736	0	759483	1051	0	0	0	0	259
October	816	186	0	0	0	787	0	788255	764	0	0	0	0	157
November	1008	184	0	0	0	883	0	898305	1049	0	0	0	0	59
December	1303	203	0	0	0	1091	0	828713	787	0	19	0	0	10
Average	929	192	0	0	0	862	0	767314	862	0	2	0	0	128
Maximum	1652	300	0	0	0	1265	0	1409623	15341	0	312	0	0	805
Minimum	1	0	0	0	0	579	0	1177	51	0	0	0	0	0

Exportable Excess Electricity Production=1.12 Twh/yr

CO_2 emission reduces to 12.392 Mt

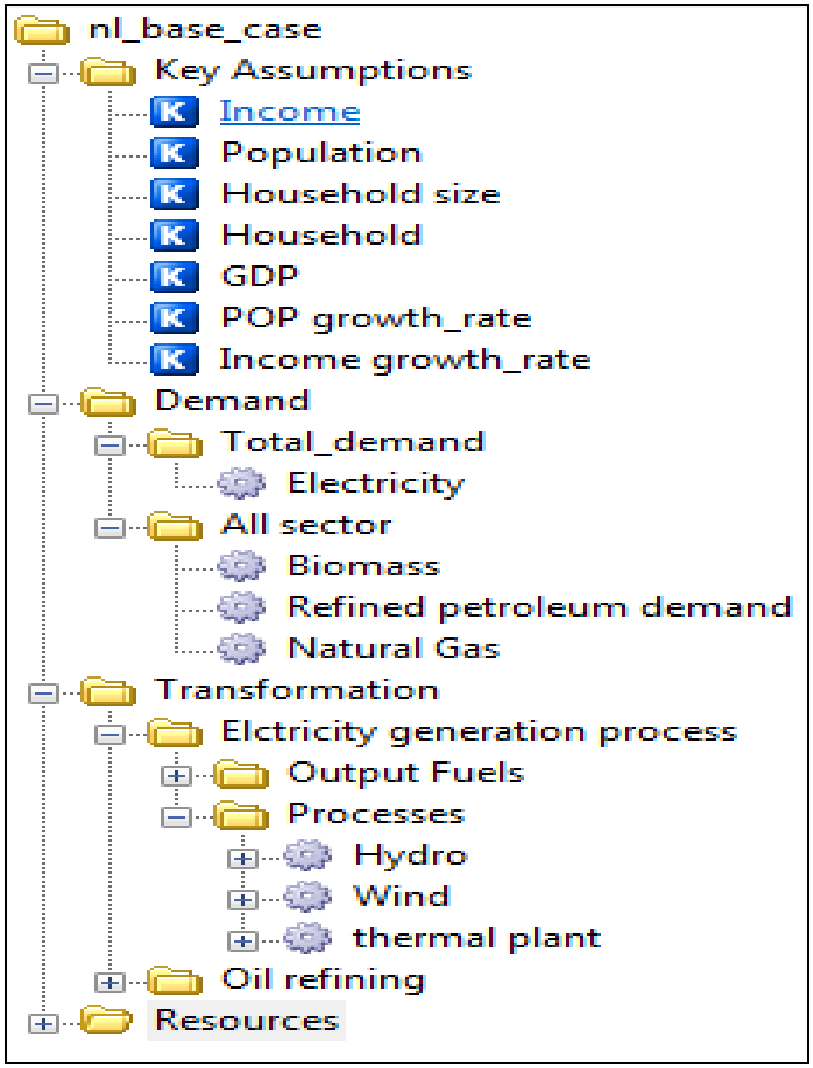
NL energy plan up to year 2030



Modeling in LEAP Software

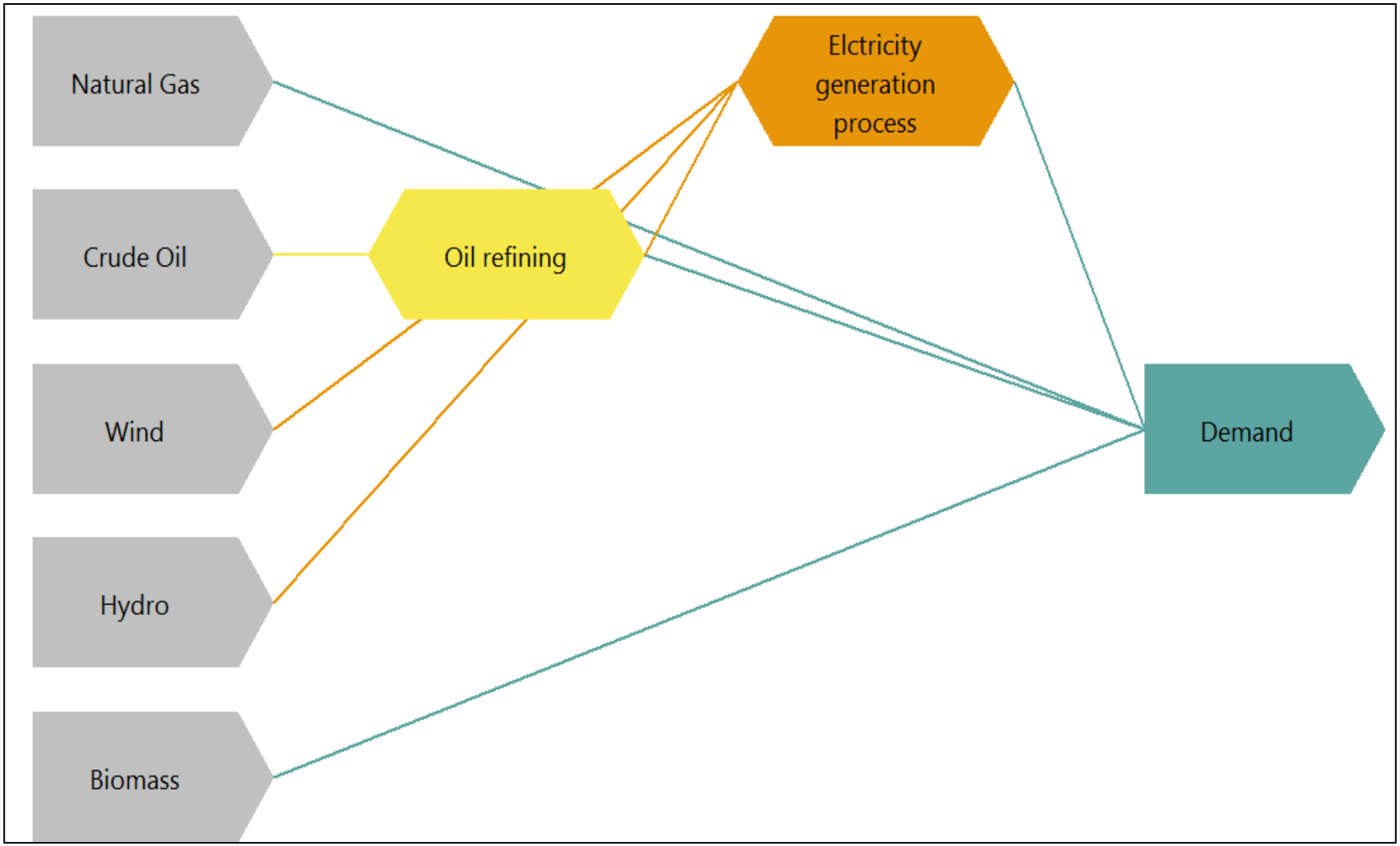
- Developed at the Stockholm Environment Institute.
- It can model electric sector generation and plan future capacity expansion of a region or country for an unlimited number of years.
- Input and output can be shown in four sectors. Analysis view, Diagram View, Result view & Energy balance.
- Calculation is done on an annual time step and time frame can be set to the desired number of years.
- Besides resource planning it can also be used to analyze green house gas emission, optimization for least cost model etc.

Analysis view & Input data



- Population growth rate= -8.74%
- Income growth rate= 3.4% per year
- GDP growth= 1.6 per%/year
- Electricity demand =1.4% /year
- Decrease in petroleum production=0.6% /year
- NL's offshore energy reserves contain 2.9 billion barrels of oil, 479 million barrels of natural gas liquids, and 10.9 trillion cubic feet of natural gas

Energy supply system of NL island system



Transformation output &Energy balance(base case)

Energy Balance for nl_base_case

Scenario: NL_future, Units: Million Megawatt-Hour

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Production	33.7	32.8	32.8	32.9	33.0	33.1	33.1	33.2	29.3	29.3	29.3	29.4	29.4	29.4	29.5	29.5	29.6	29.6
Imports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Exports	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Primary Supply	33.6	32.8	32.8	32.9	33.0	33.1	33.1	33.2	29.3	29.3	29.3	29.4	29.4	29.4	29.5	29.5	29.6	29.6
Oil refining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elctricity generation process	-5.4	-4.6	-4.7	-4.7	-4.8	-4.9	-4.9	-5.0	-1.0	-1.0	-1.0	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
Total Transformation	-5.4	-4.6	-4.7	-4.7	-4.8	-4.9	-4.9	-5.0	-1.0	-1.0	-1.0	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
Total_demand	8.2	8.3	8.4	8.5	8.6	8.7	8.9	9.0	9.1	9.2	9.4	9.5	9.6	9.8	9.9	10.0	10.2	10.3
Electricity	8.2	8.3	8.4	8.5	8.6	8.7	8.9	9.0	9.1	9.2	9.4	9.5	9.6	9.8	9.9	10.0	10.2	10.3
All sector	20.0	19.9	19.8	19.7	19.6	19.5	19.4	19.2	19.1	19.0	18.9	18.8	18.7	18.6	18.5	18.4	18.3	18.2
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Refined petroleum demand	19.4	19.3	19.2	19.1	19.0	18.9	18.7	18.6	18.5	18.4	18.3	18.2	18.1	18.0	17.9	17.8	17.6	17.5
Natural Gas	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total Demand	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.3	28.3	28.3	28.3	28.3	28.4	28.4	28.4	28.5

The total demand in year 2030 is 28.5 TWh and no import is required.

Future scenarios

Scenario 2

- Total (gasoline) energy used by Motor vehicle was 871100 m^3 or 9314672300 kWh.

20% Motor energy= 9.3*0.2=1.86 TWh

Remaining vehicles, 9.3-1.86=7.44 TWh

- With 2% growth rate the electricity demand reaches to 11.4 TWh from 8.13 TWh
- petroleum demand decreases to 20.7 TWh with negative 0.6% rate.
- By year 2030 electricity demand will be 18.84 TWh and petroleum demand would decrease to 13.26 TWh

Scenario 3

- Heating oil=Light fuel oil+ Stove oil+ propane

  = (199.5+301.5+30.5)* 1000 m^3

  =531.5*1000*10693 kWh

  =5.65 TWh
- By 2030 with 2% growth rate and addition of heating energy, electricity demand will be 17.05 TWh. And Petroleum demand will decrease to 15.05 TWh.

Scenario1:Higher growth rate

Scenario: NL_future, Year: 2030, Units: Million Megawatt-Hour

	Electricity	Natural Gas	Oil	Crude Oil	Wind	Hydro	Biomass	Total
Production	-	0.6	-	17.5	0.7	12.3	0.0	31.1
Imports	0.1	-	-	-	0.1	-	-	0.2
Exports	-	-	-	-	-	-	-	-
Total Primary Supply	0.1	0.6	-	17.5	0.8	12.3	0.0	31.3
Oil refining	-	-	17.5	-17.5	-	-	-	-
Elctricity generation process	11.3	-	-	-	-0.8	-12.3	-	-1.7
Total Transformation	11.3	-	17.5	-17.5	-0.8	-12.3	-	-1.7
Total_demand	11.4	-	-	-	-	-	-	11.4
Electricity	11.4	-	-	-	-	-	-	11.4
All sector	-	0.6	17.5	-	-	-	0.0	18.2
Biomass	-	-	-	-	-	-	0.0	0.0
Refined petroleum demand	-	-	17.5	-	-	-	-	17.5
Natural Gas	-	0.6	-	-	-	-	-	0.6
Total Demand	11.4	0.6	17.5	-	-	-	0.0	29.6

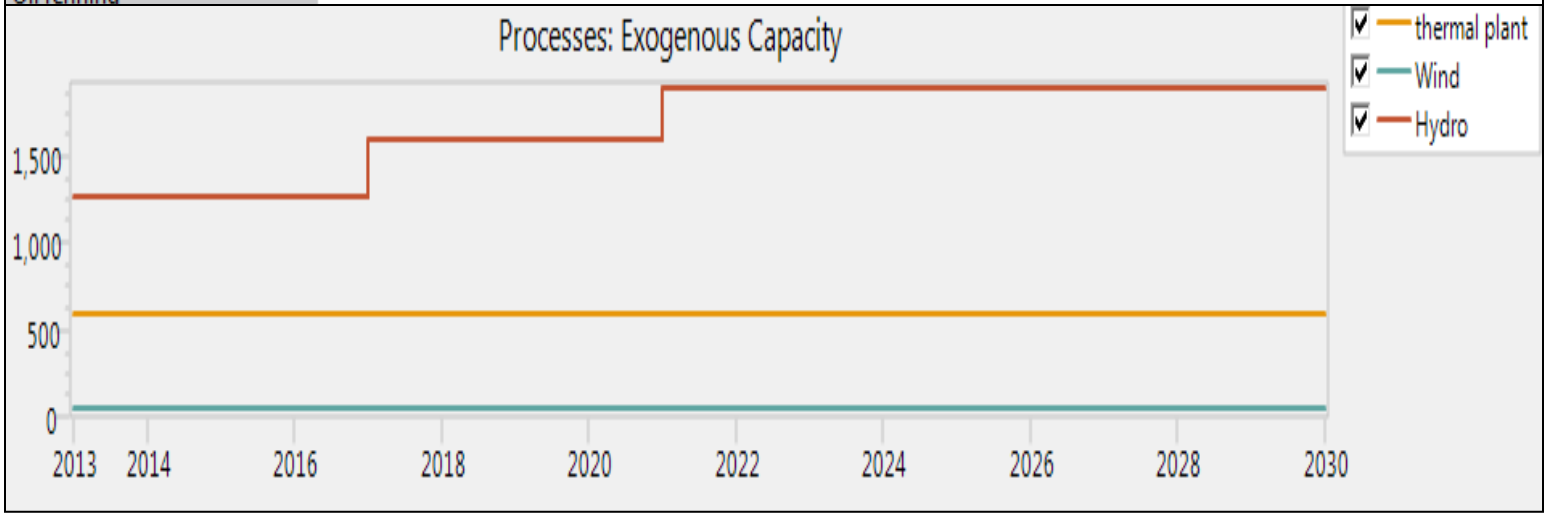
200000 MWh energy needs to be imported

Scenario-2: Encourage and use electric vehicle

Energy Balance for nl_scenario2

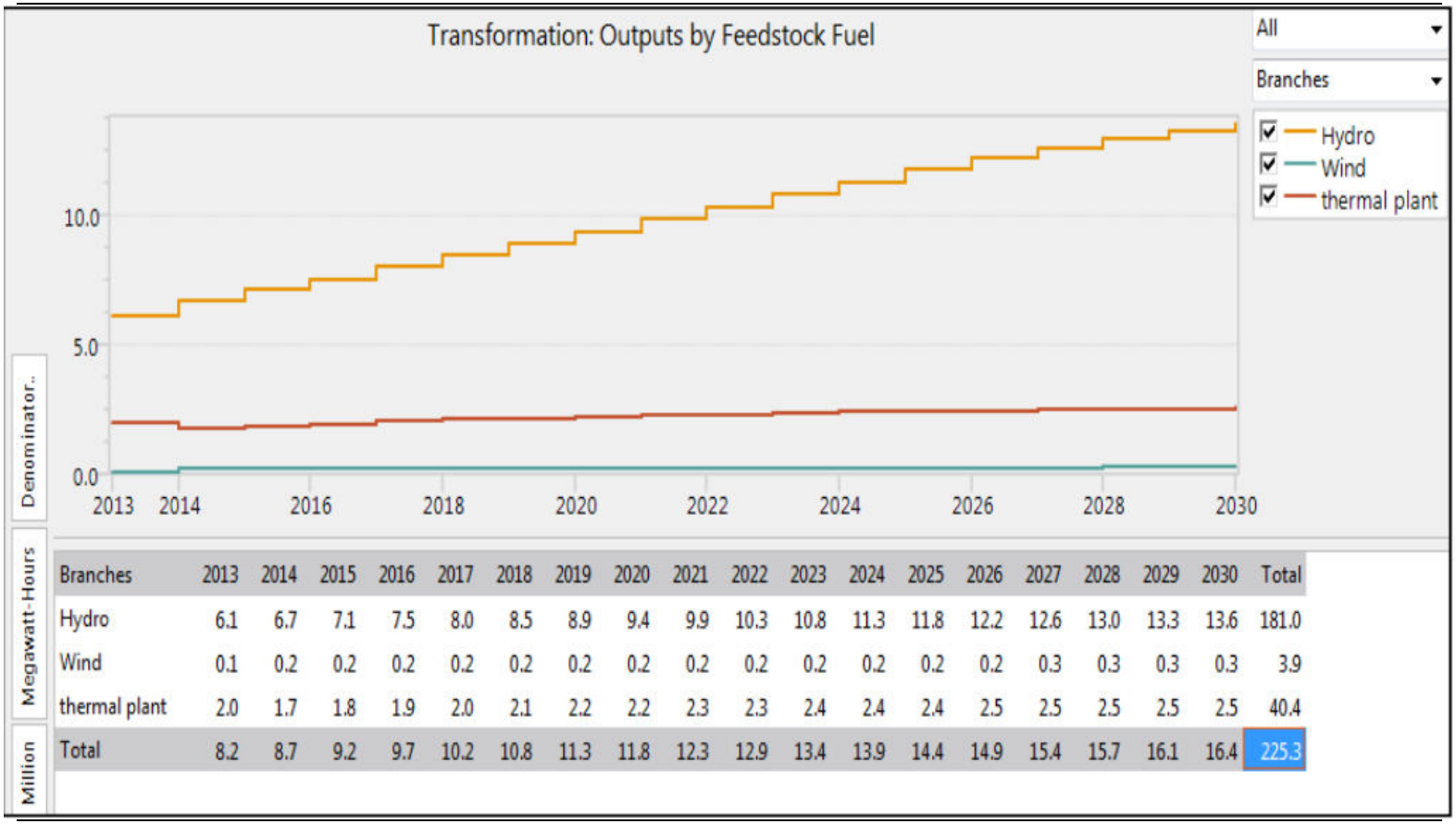
Scenario: NL_future, Units: Terawatt-hour

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Production	33.7	33.2	33.7	34.1	34.6	35.0	35.3	35.6	36.0	36.3	36.6	36.8	37.0	37.0	37.0	37.0	36.9	36.7
Imports	-	0.4	0.4	0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.5	0.6	0.7	0.9	1.2	1.5	1.8	2.2
Exports	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Primary Supply	33.6	33.6	34.1	34.6	35.0	35.4	35.8	36.2	36.4	36.8	37.1	37.4	37.7	38.0	38.2	38.4	38.6	38.9
Oil refining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



Hydro capacity increases from 1265 to 1595MW in 2017 and again to 1894 MW in year 2021.

Scenario-3: Switch to electric heating



Branches	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Hydro	6.1	6.7	7.1	7.5	8.0	8.5	8.9	9.4	9.9	10.3	10.8	11.3	11.8	12.2	12.6	13.0	13.3	13.6	181.0
Wind	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	3.9
thermal plant	2.0	1.7	1.8	1.9	2.0	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	40.4
Total	8.2	8.7	9.2	9.7	10.2	10.8	11.3	11.8	12.3	12.9	13.4	13.9	14.4	14.9	15.4	15.7	16.1	16.4	225.3

Conclusion

- Energy consumption in year 2011 by the people of Newfoundland was calculated 185.34 kWh/person/day compared to the published estimation of 168.93 kwh/person/day.
- The designed data logger can measure and store inside & outside temperature and current consumption of a house accurately.
- A detailed house energy analysis and modeling is done. Thermal simulation in Beopt showed the simulated output values matches with the measured yearly consumption value of the houses.
- EnergyPLAN considered wind energy integration in the NL energy system.
- LEAP forecast concluded if 80% of the motor vehicle use electricity or all the heating demand is replaced by electricity, NL excess electricity has the capacity to fulfill the increased demand.

Future work

- Adding more sensors in the data logger design
- Multiple SD cards or an SD card with more space
- Two houses simulation in BEopt with cost analysis
- Design of a renewable energy system for a house
- Study human behaviour and energy usage
- House-1 power consumption analysis for recent years
- In LEAP, design of a 100% renewable energy system with no thermal units. Analysis of green house gas emission and find the optimized least cost model.

Publications

- 'Thermal simulation and energy consumption analysis of two houses in St. John's, Newfoundland ,' BSME International Conference on Thermal Engineering, 2014, Dhaka, Bangladesh.
- 'Data logging and energy consumption analysis of two houses in St. John's, Newfoundland,'International Conference on Electrical and Computer Engineering 2014, Dhaka, Bangladesh.
- 'Newfoundland Energy System Modeling and Analysis,' Newfoundland Electrical and Computer Engineering conference 2014, St. John's, Newfoundland and Labrador, Canada.
- 'Design of a 3-bed passive house for St. John's using BEOPT software,' Newfoundland Electrical and Computer Engineering conference 2013, St. John's, Newfoundland and Labrador, Canada

Questions?

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