

# TIME STUDY

System Type: MaxSpan™ FastBuild Pile Driven System 6.1047MW  
 EPC/Installer: Horne Brothers (HBC)  
 Modules: 315 watt aluminum framed modules  
 Location: North Carolina  
 Site Conditions: Relatively level

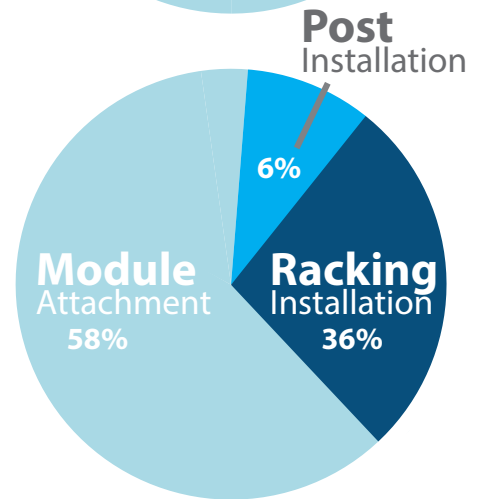
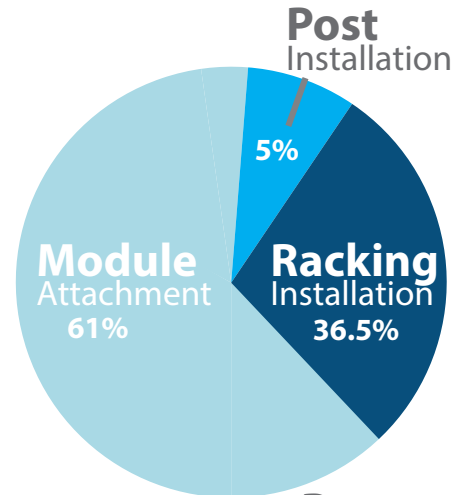
Time frame: August 2015  
 Weather Conditions: Relatively dry North Carolina weather  
 Installer familiarity with System: HBC has previously installed several GameChange MaxSpan™ systems totaling approximately 60MW  
 Module Mounting Hardware: Bolts, serrated flange nuts and star washers

### Not including moving materials from staging area:

	Man Hours Per Module Equivalent (%)	Man Hours Per MW (315W modules)	Man Hours Per Module Equivalent (Hours)
Module Attachment	61%	272	0.0857
Post Installation	5%	231	0.0072
Racking Installation	36.5%	149	0.0470

### Including moving materials from staging area:

	Man Hours Per Module Equivalent (%)	Man Hours Per MW (315W modules)	Man Hours Per Module Equivalent (Hours)
Module Attachment	58%	317	0.1000
Post Installation	6%	34	0.0107
Racking Installation	36%	194	0.0611



## STUDY RESULTS

The study concludes that the installation rate for the installation period studied for a 6.8 actual hour workday was:

Not including moving materials from staging area:

**.1399 man hours per module equivalent**  
**20 men system installation rate per week: 1.532MW**

Including moving materials from staging area:

**.1718 man hours per module equivalent**  
**20 men system installation rate per week: 1.247MW** (including staging)

## ABOUT THE STUDY

Study Focus: Task 1: Movement from staging area and installation of piles. Task 2: Movement from staging area and installation of beams, braces, purlins, roll ties, purlin straps and purlin angles. Task 3: Movement from staging area and installation area of PV modules with rivets and star washers or with bolts, serrated flange nuts and star washers (one per module).

Please note that installation rate may vary from site to site and installer to installer. It is advisable to receive training from GameChange personnel for first time installers of GameChange systems.

The following time study project was conducted to develop a valid assessment of the work content of the labor related to installation tasks in terms of hours spent on each task and total hours spent per module equivalent for installation of the completed system.

The study was primarily conducted by interviewing site supervisors regarding workplace production on hourly and daily basis with employees assigned to perform specific tasks. Hours noted were actual hours worked and were not adjusted for the typical 20% loss factor related to hours actually performing tasks versus recorded hours for payroll timesheets. For example the 6.8 hours worked shows a typical work day, but worker pay would be based on an 8 hour work day.

The study analyzes each operation in terms of completed units, each unit being one installed module equivalent.

## STUDY DETAILS

The employee work hours were studied relating to three principal installation tasks.

### Task 1: Movement of Piles from Staging Area and Installation of Piles

This task consists of driving posts at marked locations on the site. One team of three men: one driving skid steer moving piles, second man operating a pile driver and third man helping to handle piles for pile driver for a total install of 150 posts per day.

Each row had an average of 40 posts resulting in one extra post for each of the 40 posts, or a 2.5% loss on a module equivalent basis.

Man hours per module equivalent for posts, which supports 13 modules less row ends.

**= (3 men x 6.8 hours) / (150 posts x 13 modules per post x 97.5% reduction for row ends) = 0.0107 man hours for installation only, not including staging, installation rate = 2/3 x .0107 = .0072 man hours**

### Task 2: Movement from Staging Area and Installation of Beams, Braces, Purlins, Roll Ties and Purlin Straps

A twenty six man crew completed this task in 6.7 days.

Four men moved parts from staging area while several crews of three men each installed beams and braces. Crews of four men each followed behind to install purlins, Roll Ties and purlin straps finger tight. The last crew of two to three men did final alignment, squaring, torque to specification and torque marking.

### Task 2 (continued):

Man hours per module equivalent for movement from staging area and installation of beams, braces, purlins, roll ties and purlin straps:

**= (26 men x 6.8 hours x 6.7 days) / (19,380 modules) = 0.0611 man hours**

**For installation only, not including staging, installation rate estimated 20 men = 20/26 x .0611 = .0470 man hours**

### Task 3: Mounting of PV Modules

This task consists of mounting modules onto purlins from below. This included inserting bolt from below purlin through the module frame, and then placing star washer on bolt. Next, install flange nut onto bolt, then torque bolt to specification at one location, and install only a bolt and flange nut at other three locations per module and torque bolts to specification.

A thirty five man crew completed the installation of the 19,380 modules in 8.14 days, working 6.8 hours per day actual work rate.

**Man hours per module equivalent for Mounting of PV Modules = (35 men x 6.8 hours x 8.14 days) / (19,380) = 0.100 man hours**