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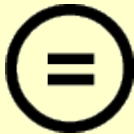
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O c u v g t " q h " U e k g p e g " k p " G p

F g e k u k q p " O c m k p i " H t c
U g n g " U w k p i k p c d n g " E q p
R t q f w e v u

d {

F j c t o c t c l " U k x c u w d t c o c p

F g r c t v o g p v " q h " C t e j k v g e v w t g " (" C

V j g " I t c f w c v g " U e j q q n

U g q w n " P w p k k g p a i k " v {

H g d t " 4 2 : 3 {

F g e k u k q p " O c m k p iU'g Htg ð œ g k y p q t m'

U w u v c k p c d n g " E q p u v t w e v k q p

d {

F j c t o c t c l " U k x c u w d t c o c p k e p

C " v j g u k u " u w d o k v v g f " k p " r c t

q h " v j g " t g s w k t g o g p v u " h q t "

O c u v g t " q h " U e k g p e g " k p " G p i

U g q w n " P c v k q p c n " W p k x g t u

4 2:3

F g e k u k q p " O c m k p iU'g H t g ð ø g k y p q t m'
U w u v c k p c d n g " E q p u u v t w e v k q p

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C d u v t c e v

F g e k u k q p " O c m k p i " H t c
U g n g 'U w k p i c E p p d i n g 'w e v k
R t q f w e v u "

F j c t o c x t c u l w " d U k c o c p k c p
F g r c t v o g p v " q h " C t e j k v g e v w t g " c p f
I t c f w c v g " U e j q
U g q w n " P c v k q p c n " W p

"Kp " e q p u v t w e v k q " p " c m p p i w l v t n c . { " u f g e p k " u k k o q r p q t v
c e j k g x k p i " C w v j q w p p " d c k n g k p i u " O r q t p q e g u u " c p f " o g v
u k i p k h k e c p v n { " g z r c p f k g p h " q v t d y " j e g u p p p g " e g k p o q u v
u w u v c k p c g l t n g c " v k x g " v " V j k p e g g k u k " q p e e w t n k p { O r
o g v j q f u " k v u g n h " j c u f " w g w t p p p g " f n " g q f w i v g " " v k q p " v d e g p " u c k " x d g
v j g " r t q e g u u " c p f " w p t g n k v a j d k n u g " c r e j f w a e v e " w k g h
f g x g n " a q u r k k o p i p g " v t c f p g u e r k " o u t k g p p p f " h t c u o g n y g e t v n k " p h i q t "
u w u v c k p c d n g " r t u " f w e v " c u " c n v g t p c v k x g

U w u v c k p c d n g " r t q f w e v u " c t g " u v w f k g f " c p f "
r t q f w e v u " c t g " t g x k g y g f " v q " k f g p v k h { " v j g " u e
v q " d g " e q p u k f g t g f " c p f " h c e v q t u " v j c v " y q w n f "

v j g " t g u g c t e j " q d l g e v k x g u 0

V j g " h t c o g y q t m " k u " f g x g n q r g f " e q o r t k u k p i
r t q x k f g u " c " x k u w c n " e q o r c t k u C p ' t q k ' e ' c j d g ' h d n v {
u v { w ' f c p f " e c u g " u v w f { " q h " v j g " h t c o g y q t m " r t q x
h t c o g y q t m " c p f " k v u " n k o k v c v k q p u . " c n q p i " y
h t c o g y q t m 0

V j g " t g u w n v g f " h t c o g y q t m " r t q x k f g u " c " f
f g u e t k r v k q p " h q f t g' t g g f e . j "" v j t w j u f " w g p c' d e m k p u i k " v j g " :
k f g p v k h { " v j g " o q ũ W j " g u " w c k r v r c n d k n e g c " d c k m v k g v t { p' c q v h k " x v g j 0
g z r g e v g f " v q " k p h n w g p e g " v j g " u r t g c f " q h " u w u
q h " e q p u v t w e v k q p " r t q l g e v u 0

"

Mg { y q " U v u c k p c d n g . " R t q f w e T v k u . m' . F' g Q e d k u u j k n g g p u . e " g l p
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E j c r v g t " 3 0 " K p v t q f w e v k c

V j k u " e j c r v g t " d t k g h n { " k p v t q f w e g u " u w u v c l
v q " u w u v c k p c d n g " f g x g n q r o v j p g p' . k' p v' j " e g q' p e i j v d r w e
e q p v g o v r j n g c " v f g g u x " g n q r o g p v u " q h " f g e k u k q p " o g v j q
c t g " r t g x g p v k p i k p j g h g t t g q f w e h ü ü i v n q d c n n { 0 "
v j f g g " e k o u c k m k p p i v j v j f a v " c t g " e c w u k p i " v j g " u g v d c e
v j t g g u g c t e j k " u q " d u l g g v e " w k q x " g u q n x g " k v 0 " C f c f k k p v " k q p c n n
v j g " q d l g e v k x g " k u " r e t g q u x u k " f u g g f e " v k k p q " p v 0 j g " t g u g c t c

1.1 T g u g c t e j " D c e m i t q w p f

E q p u v t w e v k q p " k p f w u v t { " k u " t g u r q p u k d n g " h
f g i t c f c v k q p " k p e n w f k p i . " 4 5 ' " q h " c n n " c k t "
r t q f w e v k q p . " 6 2 ' " q h " y c v g t " r q n n w v k q p . " 7 2 '
q | q p g " f g r n g v k q p' . n " c : p 2 ' " n a i u t u k e' w n 2 v w t q c h " e q t c n "
4 7 ' " q h " t c k p h q t g u v " f g u v t w e v k q p " * F k z q p " 4 2
p g i c v k x g " k o r c e v u " k u " e c w u g f " d { " v j g " r t q f w e
t g r q t v g f " d { " M n g k y g t m u " ù 4 2 1 3 ' # . c " y c " t o q w p g f t " k v j n
w u g f " v q " o c p w h c e v w t g " d w k n f k p i " 6 r 2 t q 7 f 2 w e v u " y
r g t e g p v c i g " q h " v j g " v q v c n " o c v g t k c n " h n q y " k p
v j k u " k u u w g . " u w u v c k p c d n g " r t q f w e v j u g " " c t g " r t
r t q f w e v u " w u g f " k p " v j g " e q p u v t w e v k q p " k p f w u
r t q f w e v u " c t g " v j q u g " r t q f w e v u " v j c v " i g p g t c

u q e k c n . " g p x k t q p o g p v c n " c p f " g e q p q o k e " k o r
r t q f w e g t " v q " p g p g f p " v k u q g t c " n v " j r d p p " f e w e v u " * F w h g { " 4
C n v j q w i j " c f q r v k p i " u w u v c k p c d n g " r t q f w e v
k f g p v k h k g f " c u " v j g " g c u k g u v " y c { " h q t " u w u v c
v j g " u g n g e v k q p " q h " u w u v c k p c d n g " g d ' g ' t q p f g w " e q v h u " " w e j u
o q u v " f k h h k e w n v " v c u m u " k p " v j g " e q p u v t w e v k q p
q p " v j g " h c e v q t u " c h h g e v k p i " v j g " u g n g e v k q p " r
r g t e g r v k q p " q h " g z v t c " e q u v " d g k p i " " k p e w t t g f
k p h q t o c v k q p " c t g " v j g " v q r " d c t t k g t u " v q " u w u v
y j k n g " e q u v " k u " d g k p i " f g c n v " y k v j " n k h g " e { e r
k p k v k c n " k p x g u v o g p v u " d g k p i " e q o r g p u c v g f " y k
v j g " m c " e u m w u q v c k p c d n g " o c v g t k c n " k p h q t o c v k q p
k p h q t o c v k q p " v j c v " d g k p i " r t q x k f g f " k u " c " o c
u g n g e v " v j g " u w u v c k p c d n g " r t q f w e v " c u " c p " c n
4 2 2 ; = " M k d g t v " 4 2 3 8 = " R N g t m e a ' j g ' g ' v c ' w 0 ' 0 4 ' 4 2 3 5 = " Y
G x g p " v j q w i j . " v j g t g " c t g " q x g t " 6 8 2 " g p x
* y y y 0 g e q n c d g n k p f g z 0 e q o + . " t g r q t v u " u j q y u "
r t q f w e n g e t k u o u " c d q w o g " p v j k g k t p " o r g t p q f c w e " v w g g m h q ' t o c p e
* G w t q d c t q o g v g t " 4 2 2 ; + 0 " V j k u " m k p f " q h " t g n k c
n c d g n u " c t g " f g x g n q r g f " d { " v j k t f " r c t v { " q t i c
q h " f k h h g t g p v " q t i c p k | c v k q p " y k v j " n k v v n g " c
n c d g n n k p u u ' g n 0 q Y k v j " i n q d c n " u w u v c k p c d k n k

f g x g n q r o g p v . " v j g t g " k u " o c l q V] k q p e g k p g h q p
k u u w g " q h " f c r v t c q " x v k t f c g p f u " r d c { t " g v p j e g { " u g n n g / t . " k p " v g
x g t k h { " V v j g g " " w f p c e v g g t z 0 k " a i k v k v k i g ' u y " k v j " r t q f w e v u " q h
g x c n w c v k q p " v q " c e j k g x g " t g c n k u * v F k e p " i c c p p f c " " v t c
4 2 3 5 " w v " v k o g " c p f " d w f i g v " e q p u v t c k p v " j k p f g
u { u v g o u " d g h / q u : g [" i c @ [p] A G E E l v k q p

F g u r k g v " g h " c v e j v " v j c v " o q u v " o q f g t p " o g v j q f u "
f g r g p f g p v " q p " v j g u g " f c v c . " v j g { " c n u q " t g s w
u w u v c k p c d n g " r t q f w e v u . " u q h v y c t g u " c p f " r t
k p e t g c u k p i " v j g " e q o r n g z k v g f ' q w u " p g m g ' f g g k k l
e t k v g t k c " * F c p i c p c " 4 2 3 5 + 0 " V j k u " r t g x g p v u "
i t g g p " r t c e v k e g u " g u r g e k c n n / D ' t k k ' p f ' g 2 g 2 q r 0 k ' p c
o c l q t " v j t g c v " e c w u k p i " v j k u " k u " v j c v " u o c n n
y j g y k v j c n " v q " w r i t c f g " v j g k t " e c r c d k n k v { " *
e q p f k v k q p " e c n n g f " m p q y n g f i g " i c / n e d g g y g g p "
h k t o u 0 " V j g " m p q y n g f i g " i c r " j { r q v j g u k u " g z r n
q h " y g c n v j . " k u n " { q ' h f v k g u p v " t f k k l h v g g t f g ' p w j k t c q w i j q w v
* U e j w o c p p " 4 2 2 9 + 0 " V j g " m p q y n g f i g " i c r " k p "
f k h h g t g p e g " k p " m p q y n g f i g " c d q w v " x c t k q w u "
r t q f w e v " g x c n w c v k q p " o g v j q f u " d g o x y k g i p " f k h h
c t q w p f " 5 2 u . e 2 c 2 n 2 g " " u h o k c t n o n u " c p f " q x g t " 7 2 2 " o g f k w o
w p t g i k u v g t g f " u v c p f c n q p g " e q p v t c e v q t u " e q o

* P U F E " t g r q t v " 4 2 3 9 + . " k v " k u " " k o r q t v c p v " v q "
u q n w v k q " f u g " e k q " k a q p n g " V j k u " e q p f k v k q p " f q g u " p q "
g k v j g t . " c u " u o c n n " c p f " o g f k w o " u k | g " g p v g t r "
h c e g " v j g " u c o g " e j c n n g p i g u 0

1.2'R t q d n g o " U v c v g o g p v

Q} Á• ~ {t{cæ! k^ fÊ"Ái t q y v j " q h " v j g " r t q f w e v " o c t m g
h q t " u w u v c k p c d n g " r t q f w e v u " j c x g " c h h g e v g f "
f g e k u k q p " e q p u k f g t c v k q p u . " y j k e j " c n u q " u w e
r t q f w e v " u g n g e v k q p " o g v j q f u 0 "

C f f ggfc"v h w t g u " c p f " e q p u k f ðE t c v k q p' ðv d q h " h l " t k c æ g v
u w u v c k p c d n g " r t q f w e v u " j c x g " u k i p k h k e c p v n {
u g n g e v k q p " o g v j q f u " k p " e q o r c t k u q p " y k v j " v j
r t g x g p v k p i " v j g " u r t e g v c u f " " g q u h r " g u e k u e v n a k p' c k d p n " g U' O r G t
i t q y k p i " m p q y n g f i g " i c r 0 "

V j g t g h q t g . " v q " g p c d n g " v j g " u r t g c ' f . " q h " u w u
k v k' d r u d' t v c p v " v q " a c t m k x p k i f " g h " t c c " d f g g y e d k t u n k " q v p j " c v " f g o
m p q y n g f i g " q p " v j g " r j t k q i f g v ' e w u k' p e i p ' f t " g i t k q c e d n u g n " g h u c

1.3 T g u g c t e j " Q p U ð q r v k x g u

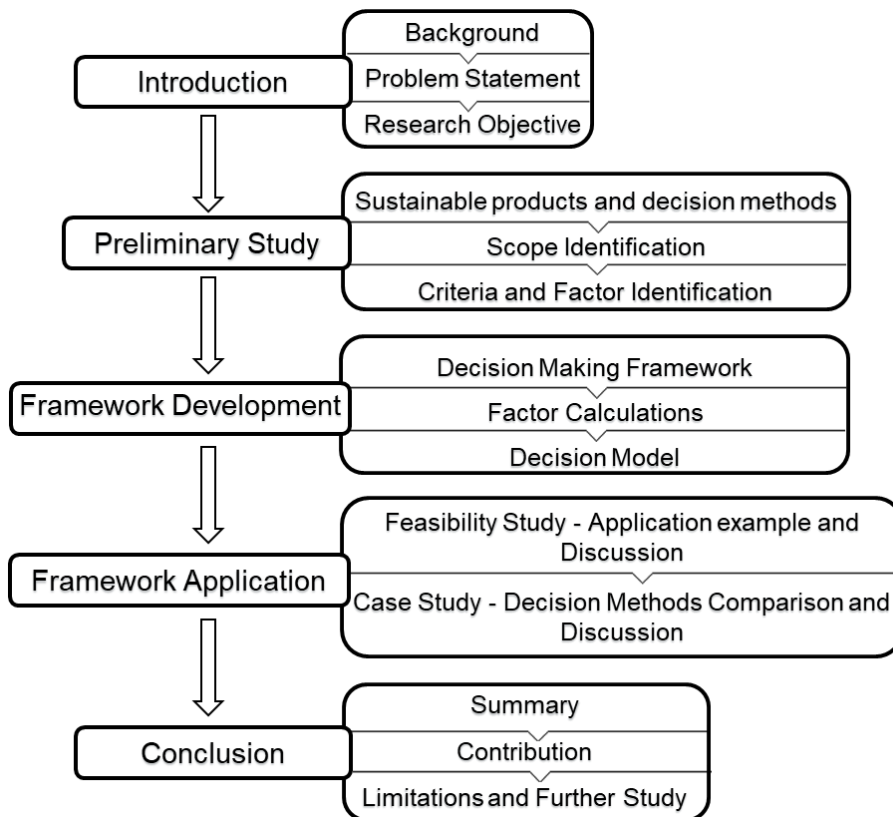
C n v j q w i j " r t g x k q w u " u v w f k g u " f g x g n q r " o g v
c n v g t p c v k x g u . " v j g { " n c e m " v j g " u k o r n k e k v { "
y k v j " v j g " e t k v g t k c p f p w r " q p e v q t u " v j c v " v j g { "

C u " c p " g h h q t v " v q " c f f t g u u " v j k u " k u u w g . " v
f g x g n q r " u k o r n g " f g e k u k q p " o c m k p i " h t c o g y q t r
u g n g " a w k p i k p c d n g " r t q f w e v u " c u " c n v g t p c v k x g
t g u g c t e j p " l k f e g w u k t h { d k p i " v j g " n g c u v " p w o d g t " q
e q n n g e v k x g n { " j q o q i g p g q w u " v q " g c e j " k p f k x k
o c m g " f g e k u k q p u 0 " W u k p i " v j q u g " h c e v q t u . " c "
x k u w c n " e q o r c t k u q p p f q h c ' g f g j e t k r v g k p p v k p g u f
c n v g t p c v k x g u " k u " f g x g n q r g f " y k v j k p " v j g " h t c

V j g " u e q r g " q . h q p j k f v g " u g w u g a k p g d n g g " f c " n v g t p c v
k p " v j g " e q p u v t w e v k q p " k p f w u v t { " v j t q w i j " y j k
v j g " u g n g e v k q p " r t q e g u u " c t g " k f g p v k h k g f 0 "
u q n w v k q p " v q " v j g k g j " r t q d d g g u ü " c u q p e k h k e " v
c n v g t . p " c v k g g u t a e g y g t " k q " u f v g t p w k e p v g f t " c n " u w u v c l
r t q f 0 w e v u

1.4 T g u g R t e j ' g u u

V j k u " t g u g c t e j " H t c o g y q t m " B a c k g r o u n d " g u v c t v u " y k
 v j g " r t g n k o k p c t { " u v w f { " v j c v " y q w n f " j g n r " v
 x c t k q w u " f g e v k j u c k v q " p j " c o x g g v " j d g g f g u p " k p v t q f w e g f " v q "
 C f f k v k q p c n n { . " v j k u " r t q e g u u " y q w n f " j g n r " v
 u w d e c v g i q t { " q h " u w u v c k p c d n g " r t q f w e v u 0 " N o
 h c e v q t u " c p f " r t q e g u t e " j v " j q d l " g e n k k i x p g i . " y k f v g c " n r j {
 v j g " m p q y n g f i g " t g s w k t g f " h q t " v j g " f g x g n q r o g



H k i 300 g T g u g c t e j " H t c o g y q t m

Vj g " u g e q p f " u v g r " k p e n w f g u " v j g " f g x g n q r g
k v u " r t q e g u u " f g u e t k r v k q p 0 " Vj k u " u v g r " k p e n
c p f " v j g p " v j g " u v g r u " k p x q n x g f " q p " j q y " v j g " h
h q n n q y g f " d { ' f ' v j k g ' u ' b q f k g p ' k k p e c p e g Q ' b Vj g " v j k
c r r n k ðucvdwkn{k"vq{p " v j g " h t c o g y q t m " c p f " c " e c u g
h t c o g y q t m . " h q n n q y g f " d { " f k u e w u u k q p " c p f "
k p e n w f g u " c " d t k g h " u w o o c t { . ' u æ q p f v { 0 k d w v k q p . '

E j c r v g t n 'k 4 0 k 'p R t w g {

Kp " q t f g t " v q " f g x g n q r " v j g " k p v g p f g f " h t
mp qgyfni g " q p " g z k u v k p i " t o g x k f i g u 0 c V j l k k g h j' k p v g
u w u v c k p c d n g " r t q f w e v u " c p f " k v u " u k i p k h k e c
t g u g i g u " q p " u w u v c k p c d n g " r t q f w e v " u g n g e v k
G x g p v w c n n { . " j g n r k p i " v q " r t q x k f g " c " u e q r g "
v j k u " t g u g c t e j 0 " D c u g f " q p " v j g " u e q r g . " v j g "
v j g " f g e k u k q p u " k p g f ' b c p g " y k g h h d g v d f g u " v q " c
y k n n " d g " 0 g u v c d n k u j g f

2.1 'K o r q t v c U p w e u g v 'c d R p 'c f d w e g v' u

V j g " e q p e g r v " q h " u w u v c k p c d k n k v { " k p " v g t o v
k o r c e v " q p " v j g " g p x k t q p o g p v " j c x g " d g g p " c f
j w o c p " j k u v q t { " * F w " R k u c p k " 4 2 2 8 + 0 " C e e q t f k
r c t c f k i o " h q t " v j l g p' r k p p' i y " j c k d e j w v g " p w x j k g " q l p w g w t v c n
g e q p q o k e " e q p u k f g t c v k q p u " c t g " d c n c p e g f " k p
n k h g 0 " Y j g t g c u . " v j g " r t q e g u u g u " c p f " r c v j y c
v q " c u " u w u v c k p c d n g " f g x g n q f w e p w 0 k u g q g g v k u q
r t q e g u u " v q " c e j k g x g " u w u v c k p c d k n k v { 0 " K p "
u w u v c k p c d k n g h' r w g p f e w g e " v k u p " v j g " e q p u v t w e v k q p "
v j c v " d g k p i " c " f g x g u d' d g v k ' h d f p p' v' t u f . q " e j m c " n l g " s q v k "
{ g v v q " " d g " d w k n v . " y k v j " v j g " e q p f k v k q p " q h " f g x

i n q d c n " r q r w n c v k q p " n k x g u " * M n g k y g t m u " 4 2 3 3 -
C e e q t f k p i " v q " N g c f g t u j k r " k p " G p g t i { " c p f
v j g " i t g g p " d w k n f k p i " r t q e g u u " u q " h j c t v " w u g u "
e c p " u c x g " 4 7 2 " o g v t k e " v q p u " q h " E Q 4 " g o k u u k
r t q x k f g u " c " r g c m " k p v q " v j g " u w u v c k p c d n g " h
t g r n c e k p i " c n n " v j g " r t q f w e v u " k p v q " u w u v c k p
W p n k m g " i t g g p " r t q f w e v u " k p " a q p u v c k p e d h g p f k
c t g " j c t f " v q " d g " f g h k p g f " q d l g e v k x g n { 0 " Q p g
k o r c e v u " q p " v j g " g e q p q o k e " c p f " u q e k c n " c u r
c u r g e v u . " y j k n g " i t g g p " r t q f w e v u " c t g " r t q f w
I t g g p " r t q f w e v u " c t g " f g h k p g f " c u " r t q f w e v u "
y c u v g . " e q p u g t x g " g p g t i { " q t " y c v g t . " w u g " n g t
v q z k e u " f k u r q u g f " q t " e q p u w o g f " * P k o u g " g v " c
t g u g c t e j " h k p k y k u p " v j g " f i g u v c k p c d n g " r t q f w
f g h k p k p i " k v " c u " v j q u g " r t q f w e v u " v j c v " i g p g
u q e k c n . " g p x k t q p o g p v c n " c p f " g e q p q o k e " k o r
r t q f w e g t " v q " g p f " w u g t " " v j c p " e q p x g p v k q p c n " r

2.2'G z k p'lg n g eRt k q g ùQg'w jpf f'u

R t g x k q w u " u v w f k g u " q p " u g n g e v k q p " q h " u w u v c
w p f g t u v c p f " v j g " u g n g e v k q p " r t q e g u u " q h " u w u
* t g h g 4 0+ VcVj ngg"u v w f k g u " k p e n w f ogf v'jo qwnw"kv jn ogv'f
c t g " r t q o k u k p i " v q " r t q x k f g " j k i j n { " c e e w t c v
* N E C + " * J q u u c k p k " g v " c n 0 " 4 2 3 4 = " N k r r k c v v " 3
N E C " k u " e t k v k e c n n { " f g r g p f g p v " q p " j k i j " x q n
q h v g p " cwφnc gh" h q U f k p k x c u " 4/VQRU KU'U k B k n k p h j c p
c n 0 " 4 2 3 8/K p h q t f o' gTfk"u fmg e k u k q p " O c m k p i " * N q w p k
c n u q " t g s w k t g u " f g v c k n g f " m p q y n g f i g " c p f " g
C f f k v k q p c n n { . " j { d t k f " o g f v g f j f Q J n R i " * k G m c" f u k w t e k j ""
4 2 3 5 + " t g s w k t g u " m p q y n g f i g " q p " u r g e k h k e " u q l
O w n v k e t k v g t k c " F g e k u k q p " C p c n { u k u " * O E F C
c t g " r t q q h " v q " r t q x k f g " u k o r n k h k g f " c p f " v t c
r t q f w e v u Q { E j c f q u l p p i c i g u " * E D C + " * C t t q { q " g v "
4 2 2 ; = " I t c p v " G 0 " 4 2 2 : = " P i w { g p " g v " c n 0 " 4 2 2 ;
c " x g t { " d c u k e " d w g h g e j y k h n k q f w a q u k d c q h f " q p
q h " c f x c p v c i g u . " k p " f v c j v g c" Q " c N c g u" v q n { " . j " c O k k e p t i q" u t q h
o g v j q f " d { " R k q v t " g v " c n 0 " * 4 2 3 4 + " u j q y u " v j c

o q f g t p " u q h v y c t g " v g e j p q n q i k g u " e q w n f " { k g n

Author	Decision for	Method Used	Evaluation Criteria/Factors	Scope	Observations
(Arroyo et al. 2012; Parrish et al. 2009; Grant 2008; Nguyen et al. 2009)	Sustainable Alternatives	Choosing by Advantage (CBA)	Product /component/system Specific	Comprehensive/undefined	Data intensive
(Dangana et al. 203)	Sustainable technology for retail buildings	Multi-Criteria Decision Analysis (MCDA)	Value Tree Developed	Limited/well defined	Simplified and Transparent
(Akadiri et al. 2013)	Sustainable materials for building projects	Fuzzy extended AHP (FEAHP)	Sustainable Triple bottom line based (TBL)	Comprehensive/well defined	Knowledge intensive
(Lounis et al. 2016)	Sustainable and resilient infrastructures	Risk-Informed Decision Making	Product /component/system Specific	Comprehensive/undefined	Knowledge and data intensive
(Piotr et al. 2012)	Renewable/Sustainable Energy Systems	Microsoft Excel Based Application	Product /component/system Specific	Limited/well defined	Data intensive
(Hossaini et al. 2012)	Sustainable Materials	Energy-Based Life Cycle Analysis (Em-LCA)	Product /component/system Specific	Comprehensive/undefined	Knowledge and data intensive
(Govindan et al. 2016)	Sustainable Materials	DNAP and TOPSIS	Product /component/system Specific	Comprehensive/undefined	Knowledge and data intensive
(Lippiatt 1999)	Green building products	LCA and LCC	Product /component/system Specific	Comprehensive/well defined	Knowledge and data intensive

V c d n g " 4 0 3 " R t g x k a w u " T g u g c t e i g u " a d " F

2.3'Pq p u v t w l o v u w t c k h p 'q d n w g 'v u

C f f k v k v p g n n { c . e " m " q h " e q o r t g j g p u k x g " v q q n
c n v g t o p ' a v ' k d x g g k u p i " c p " k o r q t v c p v " d c t t k g t " c h h
r t q f w e v u " k p " d w k n f k p i " r t q l g e v u " * C n Y c g t " g
4 2 3 4 = " C m c f k t k " g 4 c 2 t 3 e 7 j + " 0 j " c R x t g g " x g k k q v w j u g " t t " g r u t q x k f g f
h q t " i g p g t c n k | g f " u w u v c k p c d n g " r t q f w e v " e c v
i g p g t c n k | g f " u k v w c v k q p " d t k p i u " k p " v j g " s w g u
v q " c n n " v j g " r t q f w e v u " k g e k h k e g 0 g V j g f g c u f g
v j g " t g s w k t g o g p v " q h " m p q y n g f i g " q p " o w n v k
e q o r t g j g p u k x g " u g v " q h " r t q f w e v u 0 "

V q " r t q x k f g " c p " g h h g e v k . x u g w " u f v g e k k p u c k d q p g " " a c t m k f
c t g " h w t v j g t " u w d e c v g i q t k h g u w k p o k p u d n w e r w t
R t q f w e v u " v j c v " d g e q o g " q t " c t g " r c t v " q h " v
u w u v c k p c d n g " r t q f w e v u " * I t k h h g p " g v " c n 0 " 4 2
p q p u v t w e v w t c n " r t q f w e v u " c t g " v j g " h " k z v w t g u
u v t w e v w t g u " v j c v " c t g " p q v " f g u k i p g f " c u " n q c f
f g h k p k v k q p u " q h " u w u v c k p c d n g " r t q f w e v " d { " F
r t q f w e v u . " p q p u v t w e v w t c n " u w u v c k p c d n g " r t q
r t q f w e v u " " q t j " c a t " g l " g r e a t o g " q h " c " p q p u v t w e v w t c n "
u v t w e v w t g u 0 " P q p u v t w e v w t c n " u w u v c k p c d n g " r
u w e j " c u " g z v g t k q t " e n c f f k p i " c p f " i n c | k p i

2.4'Fg e k uEk h p/Gt d p q XckneQd.u'q n g u e g p e g " c

Tk u m

Kp " q t f g t " v q " r t q x k f g " t c v k q p c n " f g e k u k q p " h t q o " u g v u " q h " d q v j x g p v k q p c n " d n g q f w f v u . " u e t k v g t k c " v j c v " c t g " u r g e k h k e " v q " p q p u v t w e v V j g u g " e t k v g t k c " c t g " u g n g e v g f " d c u g f " q p " v j o c m g t u " c p f " v j g " e w t t g p v " u e t c m g g v " v u c k m v p c " v k k p e q p u k f g t c v k q p u 0

Ge q p q o k /E'qXc vn"wg h " u w u v c k p c d n g " r t q f w e v u " h t g s w g p v n { " e k v g f " d c t t k g t " c h h g e v k p i " v j g " * C m c f c t k " 4 2 3 7 + . " d g e c w u g " v j g " r p g e g h v k q p " v j g " o q u v " k o r q t v c p v " d c t t k g t " v j c v " c h h g e v u * C { g " 4 2 2 5 = " D q p f " 4 2 3 8 = " U c o c t k " g v " c n 0 " 4 2 3 5 e q u v " d g k p i " v j g " o q u v " k o r q t v c p v " e t " k v g t k c . g e q p q o h w g " q h " v j g " r t q f w e v " h t q o " r w t e j c u g "

Q d u q n g /Q d g m a g u e g p e g " q e e w t u d q ' w y j " g p h " r w u g f w e q b q " w v " q h " T f j w g " T c k " g v " c n 0 " 4 2 2 : + " " C " u v w f { " j q w u k p i " t g h w t d k u j o g p v " e q h p q e w n p w f f " g f q " v j g v " c p q x g t y j g n o k p i n { " k o r q t v c p v " d c u k u " h q t " t g * C k m k x w q t k " 3 ; ; 8 + 0 " V j g " f k t g e v " g h h g e v " q h " c o q w p v " q h " y c u v g " k v " i g p g t c v g u " * T c j w n " T c k

e q o r t g j g p t u g k u x u g g n f { " " k c p f " f v j g " f g h g p e g . " c g t q u r c e
u g e v q t u " k p " q x g t " 8 2 " t g u g c t e j " c t v k e n g u " c p f
v q q n u " * T q l q " g v " c n 0 " 4 2 3 2 + . " d w v " p q v " o w e j " e
k p f w u v t { " y j g t g " e v g j p g e " g g " h j h c g u e " v d " g q g h p " " q t d g u n q c n v g k u x g n {
v k o g u . " y j k e j " e q t t g n c v g u " v q " e q p e g t p " q h " v
e q p u v t w e v k q p " k p f w u v t { 0 " V j g " u w u v c k p c d k n k v
p g g f " v q " e q p u k f u g ' t f g g a d k u u " k q g p j " a y g p f k " g u g w t u k v c c k p c d k
* Q h q t k " 4 2 3 4 = " F q n q k " 4 2 3 4 = " F q j g t v { " 4 2 2 4 = " }

T k /l' m k u m ö p g h j ö g k u u " v j g " t k u m " q h " p q v " o g g v k
t g s w k t g o g p v u " h q t " r g t h q t o c p e g " q t " s w c n k v {
q r g t c v k q p u " * V c v e w a n " { 3 " ; q : t ; " k . p " f g k k t v g j e g y t n " { f " k t h g h g e v
u c h g v { " q h " v j g " u v c m g j q n f g t u 0 " P g y " r t q f w e v u
u j q w n f " j c x g " d g g p " t g u q n x g f " d g h q t g " v j g { "
* O c m j n q w h . " g v " c n 0 " 4 2 3 7 + 0 " Q n d g u e g t t x g p f k ' e k u p . " " c c g
u q h v y c t g " k p f ö k u p v h t c { p . v " ö k j p k t u p " g t y k k u v n " " q q f h w ' e v u " j c u "
k p " e q p u v t w e v k q p " k p f w u v t { " k p " v j g " u w u v c k p c
c t g " o q t g " r t q p g " v q " t k u m " k p " e q o r c t " k u q p " v q
v j g " p g y p g u u " q h " v j g " r t q f w e v " d g k p ð " c x c k n c

V j g " e t k v g t k c " w p f g t " e q p u k f g t c v k q p u " c t g
c u " q d u q n g u e g p e g " c p f " t k u m " q h " c " r t q f w e v " y c
o c k p v g p c h e g j e d u v u f a v e v " t g u r g e v k x g n { . " g p c
u g v " v q g h t " k e c t " k v q " o c m g " f g e k u k q p " d c u g f " q p 0

2.5'S w c p v kHh é k p 'Egie'kqHk k p g' t k c

H c e v q t u " v j c v " s w c p v k h k g u " v j g " f g e k u k q p "

E q u v " * N E E + " c p f " t V g v e g " p * q V I q T + { . " i y t j q k y e v j j " " c t g " u g n

v " i c x g " n " g v c j u g v " p w o d g t " q h " c j n q n o " q v i j g g b y g r d t " w a j f " w h e c v e u v . q t

e q n n g e v k x g n { " w p k s w g " v q " g c e j " c n v g t p c v k x g u

v j c v " c t g " t g n k c d n g 0 " H q t ð g t z m g v " h g h f g t q d " v y j q g'

n k h g " e { e n g " e q u v " y j k n g " j c x k p i " v j g " u c o g " v g

*N k h g " E { e n g " u E " q w u u v g " f * " N w E q E " + c f f t g u u " g e q p q o k e "*

c n n " v j g " t g n g x c p v " g e q p q o k e " h c e v q g ü . " d q v j "

q r g t c v k * q p m " t e o q u p v " u b ; ; 2 = " M k t m " g v " c n 0 " 3 ; ; 7 = " Y

4 2 2 6 + 0 " N k h g " E { e n g " E q u v " j g t g " e q p u k f g t u " c

o c m g " t r g t u r g e v k x g " v j c v " k p e n w f g u " k p k v k c n l

f k u r q u c n l t g u c n g " t e " q g z " c u q h m " g e . j v " g i " k m i t j q n f { w e g v p 0 g " t H c

g h h k e k g p v " J X C E " u { u v g o " q x g t " e q p x g p v k q p c n

k p k v k c n " e q u v " d w v " e q p u k f g t k p i " v j g " n k h g " e

v j g " g p g t i { " g h h k e k g p v " c n v g t p c g k n g " J u q u " c

j c x k p i " N E E " c u " v j g " h c e v q t " h q t " g e q p q o k e " x

v g t o u " q h " v j g " g z r g p u g u " k p e w t " N E E " q h g' t c " v j g

r t q f w e v " k u " f g r g p f g p v " q p " v j g " n q e c n " e q u v " l

k p e n w f g p i v k q p " c p f " o c k p d g p g p è g p è n " q e c' k ü è q u

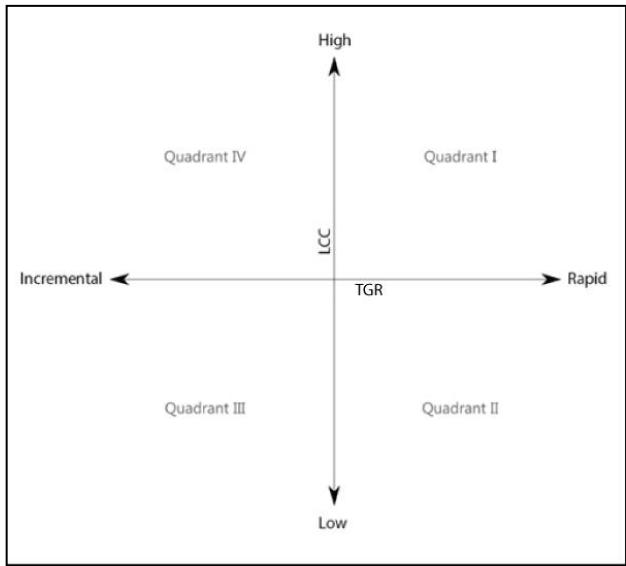
V j k u " j g n r u " v q " r t q x k f g " o q t g " c e e w t c v g " t g i l

V g e j p q n q i { " i t ' k y v j ' g c h g e v V I T + q " c f f t g u u
t k u m 0 " V j g " i t q y w g e j t p q g d i h " c h h g e f w e w j g " e j c
*d g k p i " q d u q n g v g " * D c t v g n u " g v " c n 0 " 4 2 3 4 = " E q q*
y k v j " v j g " r t q f o w g y p o g ' E j c w u g " g h " k n 0 " 4 2 2 8 = " O
4 2 3 7 + 0 " V g e j p q n q i { " i t q g v j t q y v g " t e f v g g q h g f v
c f x c p e g f " h g c v w t g " q h " v j g " r t q f w e v " u r g e k h k e
q h " v j g " r t q f w e v " k p " v j g " o c t m g v 0 " H q t " g z c o r n
y k v j " v t c p u r c t g p v " u q n c t " e g n n u . g ' z k j u k k j i c t g
y k p f q y " r c p g n " h g c v w t g u " c p f " v j g " e c r c e k v { " q
u q n c t " e g n n u . " c t g " k p e t g c u k p i " g z r q p g p v k c n
v j g " h k g n f 0 " V j k u " n g c f u " v q " v j g " r t q f w e v " c x c
y k v ' g ' k p j q t v " r g t k q f 0 " U k o k n c t n { . " d g e c w u g " q l
t k u m " q h " r g t h q t o ' V p e g " q h c k n " w r t t g q ' f k w e " v j ' k k i u j " 0 c p
e q o r c p { " u r g e k h k e " h c e v q t " v j c v " y q w n f " r t q x
u r g e k h k e " v q " v f j ' g p ' q v ' q v j w g ' v d m k p g ' w a u ' c p j g " y j q r

H t q o " v j g " u ' t c g v n g c o v g k p q v p u " . d " g w j y g g g p " v j g " f g e k u
h c e v q t ' k u p ' v e g t p r / " d e g q g q o k e " x c n w g " k u " k p x g t u g n { "
q d u q n g u e g p e g " c p f " t k u m u " c " t g u f g e v k e w g n { " . r " t
q d u q n g u e g p e g " c p f " t k u s m a p v k g c p k x g e h t e g q t w
*V I T + " c u " s w p h k p c w k x g " q w v r w v " * g e q p q o k e " x c n*
r t q f w e v u " t g n c v k x g " v q " g c e j " q v ' j j g g e g ' u y u c w n f " " r t
k p u k i j v u u " w k q v " c e d j n q g q " u c g n " v g t p c v k x g u 0

2.6 'H q w t " S w E f t k p k q' p O' q O c g m k p i "

V j g " p w o d g t " q h " e t k v g t k c " c p f " v j g " h c e v q t
 v q " v j g " n g c u v " r q u u k d n g " s w o p e f k c l p g u " f g e ' k n k
 o c m k o p q i f g n " y j k e j " e c p " d g " w ' l c g n f n " " v p q q " p a e m g e f w t
 u w u v c k p c d C h " g u " k r o t w p f g w e h v t u o p " v " o q f g # ' O y S q w n u f j " q y p " k
 r t q x k f g " c u " v u t k c o k r i n j e v d h o c p t f y t " c k t u f q p " d g v y ' H g w t ' v j g " c n
 S w c f t c p v " o q f g n " j c x g " d g g p " w u g f " k p " f k h h g t g
 o c m k p i 0 " E q p v t c t O { w ' n w d e v k g g t v k g p F g e ' k u k q p " C p
 o g v j q f u " c p f " O c e j k p g " N g c t p k p i " o g v j q f u . " w
 f g e k u k q p u " k u u k " i g p z k h k e c w p f v " n v q k p h n w g p e g " v j g "
 r t q f w e v u . " g u r g e k c n n { " k p " f g x g n q r k p i " e q w p
 g p v g t r t k u g u 0



H k i w t U g k " o 4 r 0 n 3 g 0 " " F g e k u k q p " O c m k p i " O q f g n

2.7'U w o o c t {

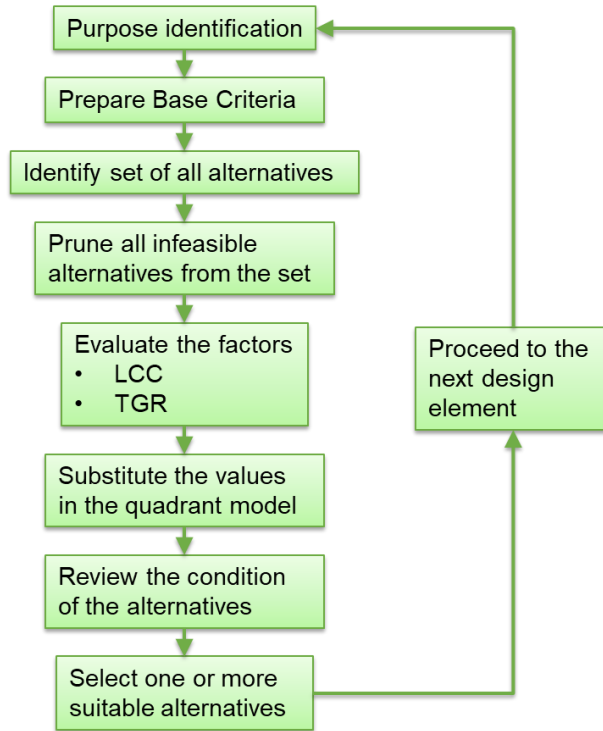
U g n g " a w k p i k p c d'knpg" " erqt pqufvwteweuv k q p " jk g " f w u v t { " g c u k g u v " y c { " h q t " u w u v c k p c d n g " f g x g n q r o g p v (j c x g " u k i p k h k e c p v n { " k o r t q x g f " v j g " c e e w t c e c o q w p v " q h " m p q y n g f i g " c p f " t g n k c d n g " f c v c " f v q " d g " q x g t w y u j g g " n v o j k g p O' p i " n w j d g c " n m q { u k v k x g " u k f g . " r t q x k f g f " w u g h w n " k p u k i j v u V h t t w i j g v h g c o g w t p q / p v t w e v w t c n " u w y u g v t c g k " p a e j u d h u g g ' p i " t g l " f q v l e " k v p i " j " g " h t c o q t f g t " v q " c f f t g u u " c f " w e e q v o u r " t y g k j v g j p q u w k v x " g v " j u g g " v p " g q g h f o w n v k r n g " f g e k u k q p " o g 0 j " q V f j u g " p h d ' t G ' e f i l p l q l o k t e g ' p x q d u q n g u e g p e g " c p f " t k u m " y g t g " k f g p v k h k g f " u g n g " p q k p i t w e v w t c n " u w u v c k p K p l ' h g f . f ' k g l f q v p v u " n g c u v " p w o d g t " q h " j q o q i g p g q w u " h c e v q t u " v j c n v g t " p g v k x g u t t O Y j g f ' h f e - y l h t g u " e o t ' e f g " g a q k p i " g e q p q o k e " x c n w g " q - h g ' e v j j p g q " n q i d 0 d i f e t f i q t " y g o u p u f k " p c v g q d u q n g u e g p e g f e g g " w e k f p ' i t " k v j m O' h c e v q t u " c f f t g u u k p f g x g n q r o g p v " q h " h q w t " s w c f t c p v " f g e k u k q p " o y j k e j " k u " g z r g e v g f " v q " k p h n w g p e g " v j g " u r t g

E j c r v H t t c ' 6 9 y ' q t m " F g x g n q r o g p

D { " e q o d g p k p i y n g f i g " i c k p g f " h t q o " v j g " r
e j c r v g t " c v v g o r v u o " c v n k " p f i g " x h g t n c q o r g " y c q " t f n g " e v k j u c k v q " p u v
t g u g c t e j " q d l g e v k x g " c p f " c f f t g u u k p i " v j g " t
e j q u H k p t O u " v n { . " v j g " t g u g c k t u e " j e " t h g t c c v o g g f y " q c t p n f " " y g q z t r
V j g p . " v j g " h q t o w n c u " c p f " o g v j q f " q h " h c e v q t
o q f g n " v j c v " y k n n " d g " y k v j k p " v j g " h t c o g y q t m
v j g " o q f g n " k u " g z r n c k p g f 0 " V j g " g p " v d k g l g p " i h " t c o g
u k o r n g " c p f " w u k p i " v t c p u r c t g p v " h c e v q t u " v j
g x g p " h q t " v j g " r t q h g u u k q p c n u " y k v j " n k o k v g f

3.1 H t c o g y q t m h n q y

D c u g f " q p " R g c t e g " g v " c n 0 " * 3 ; ; 7 + " h t c o g y
o c v g t k c n u . " v j g " h t c o g y q t m " y q t m h n q y " k u " f g
H k 5 0 0 " V j g " r t q e g u u " k p x q n x g u " k f g p v k h { k p i " .
v j g p " r t g r c t g " o k e p t k o w g o t " k r c g " t v h q " t h o w p h e k g n " v j g " f g
c " p w o d g t " q h " r q u u k d n g " c n v g t p c v k x g u " v j c v "
k p h g c u k d n g " c n v g t p c v k x g u " f w g " v q " x c t k q w u
c r r n k e c v k q p " n k o k v c v k q p j u g c p g z q v j u g v u d h t g x c
V j g " u j q t v n k u v g f " h g y " c n v g t p c v g u " c t g " v j g
v g e j p q n q i { " i t q y v j " t c v g " x c n w g u 0



H k i w t g " 5 0 3 " H t c o g y q

Technology growth rate of the most significant feature of the product is
 e c n e w n c v g f " d { " Z [" u e c v v g t " r n q v " q h " ð h g c v w
 * 4 2 2 ; + ø u " r c r g t " q p " q d u q n g u e g p e g " t k u m " c u u g
 value is extracted using the exponential trendline function equation in Excel
 (Eq. 2):

$$Y = c * e ^ b * x. \tag{2}$$

Where, Y= feature,

c= initial value,

e= exponential coefficient,

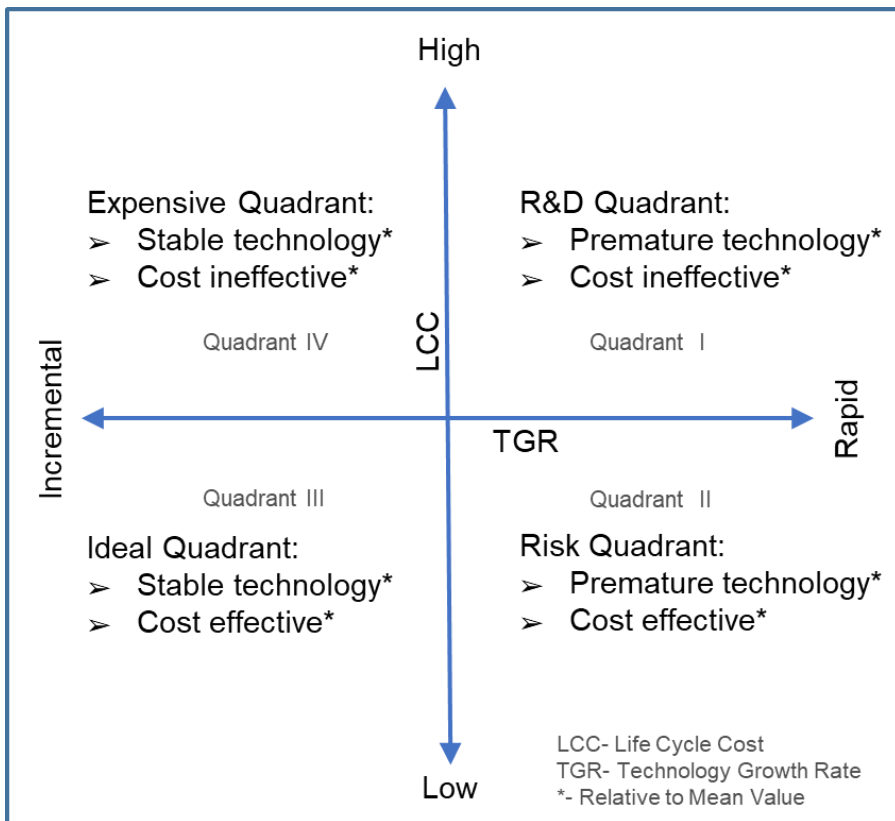
b= technology growth rate,

x= time.

V @ ^ Á c ^ & @ } [| [* ^ Á * !] [! , [c @ Á & c æ c ^ á c ç æ ð Á [á - Á á c } @ ^ á Á ^ & ã {
 & [} ç ^ ! c ^ á Á ã } c [Á] ^ ! & ^ } c æ * ^ È Á Q } Á & æ • ^ Á [~ Á } ^ , | ^ Á
 V Ö Ü Á ç æ | ~ ^ Á , ã | | Á à ^ Á æ • ~ { ^ á Á æ } á Á & [{] ~ c ^ á Á ã } Á c
 V @ ^ Á ^ ç] [] ^ } c ã æ | Á * | [ã & | @ Á • [æ c ç Á ã • Á & e ã ð Á Á ð Á Á ã
 c & æ | & ~ | æ c ^ Á c @ ^ Á æ | c ^ ! æ c ã [} Á ã } Á & ~ ! ! ^ } & ^ Á ç æ | ~ ^
 & æ | & ~ | æ c ã } * Á c @ ^ Á * ! [, c @ Á ! æ c ^ Á [~ Á æ Á] ! [á ~ & c • Á] ^
 • ã { } | ^ Á æ | c ^ ! } æ c ã ç ^ Á [ç ^ ! Á [c @ ^ ! Á { ^ c @ [á • È Á Á

3.3'F g e k u k q'K p' O g i f t g n v k q p

C " h/s w e f t c p v " f g e k u k q p " o c m k p i " o q f g n " k
 h t c o g y q t m " v j c v " r t q x k f g u " c " x k u w c n " e q o r c t
 N E E " c p f " V I T " x c n w g u " t g n c v k x g " v q " g c e j " q v j
 u k i p k h k e c p f g c p h " g t g j g s w e d n k u j g f 0 " V j g " x k
 g z r g e v g f " v q " r n c { " c " o c l q t " t q n g " y j g p " e q o r c
 q w v " y k v j " q y p g t u " c p f " k p x g u v q t u . " g u r g e k c
 m p q y n g f i g " q p " r t q f w e v " u g n g e v k q p 0



H k i w t g " 5 0 4 " F H q e w k t u " k S q w p c " f O

F g u e t /Nj w g k' /Hw w f t c p v " o q f g n "/ce z q k p u " k c u p v f " q V h I " T N " E
k p /ē z k u " c u " u 5 0 4 y p j' g p d H k g 0 x c n w g " * r q k p v " q h "
v j g " o g c p " x c n w g " q h " N E E " c p f " V I T " q h " c n n " v j g
V I T " q h " g c e j " c n v g t' k p p c " v k j / s g w c h f q t g c t' p w w d o u q v f k g v n w v " g y
t g h g t g p e g " v q " v j g " d c u g " x c n w g 0 " V j g " x c n w g u "
v q " n q y " " c p f " v j g " / d x g c k n p w g " u t " c q v h g " u v j y g g " t V I " T i " k x g p
k p e t g o g p v c n " v q " t c r k f . " h q 0 t " " d g v v g t " w p f g t u v

S w c f u k p p k / i k e c p e g

-T (F " S w o j f c t u c " p r v t q f w e v u " y k v j " j k i j " N E E " c p f "
t c v g " u k o k n c t " v q " r t q v q v { r g u " v j c v " t g s w k t
k o r n g o g p v c v k q p 0 " V j g " s w c f t c p v " g o r j c u k u " v
d { " e q o r t p ' b k a k p i ö k e " x c n w g " w c u p g f t " u 0 c " h O g i v t { g " q q h g ' t
r t q f w e v " q d u q n g u e g p e g " y q w n f " i g p g t c v g " o q t
s w c f t c p v " c t g " p q v " t g e q o o g p f g f 0 "

-T k u m " S o j ' c f u t " a p v q f w e v u " r t q x k f k p i " N E E " u c x k
v j g " n c v g j u p d' m q i " { v " j o g x' c v k g n e c d n g 0 " U k p e g " v j g u g "
q d u q n g u e g p e g " t g n c v k x g n { " v q " e q o o q p " r t c e v
t g e q o o g p f g f " k p " r c t v k c n " e q o d k p c v k q p " c p f " l

-K f g c n " S j ' w c u f " t r c t p q v f w e v u " y k v j " e p q u n v q ' i u f c' x k j p i v " c
c t g " k f g c n " v q " k o r n g o g p v " c p f " c t g " j k i j n { " t g

-G z r g p u k x g j " c S u w ' c u f w t u c v p c v k p c d n g " r t q f w e v u " c t g "
y k v j " c " u v c d n g " i t q y v j " t c v g . " f w g " v q " v j g " g

g z r g p u g " q h " v j g " o c w g t v k c' r u " q p u g f q " v k g t w 0 g R t
o c v w t g " v g e j p q n q i { " y k v j " n k v v n g " q t " p q " g e q p
q p n { " h q t " t g s w k t g o g p v u " q h " t g i w n c v k q p u " c p

3.4'U w o o c t {

Vj g " Ht c o g y q t m" y q t m h n q y " k p e n w f g f " r w t r q
g n g o g p v . " h q n n q y g f " d { " v j g " r t g r c t c v k q p " q h
y g t g " v j g p " r t w p g f " c e e q t f k p i " v q " v j g " d c u g "
h c e v q t u " c t g " e c n e w n c v g f " h q t " g c e j " k p f k x k f
u w d u v k v w v g f s " w k p v q p v j " g h k w k q p " o q f g n 0 " Vj g
p g e g u u d t r { v k f q p u' e t q " g c e j " c n v g t p c v k x g u " t g n c v
v j g " f g e k u k q p " o c m g t u " v q " o c m g " v j g " f g e k u k q p

E j c r v H t t c ' 6 9 y ' q t m " C r r n k e c v k

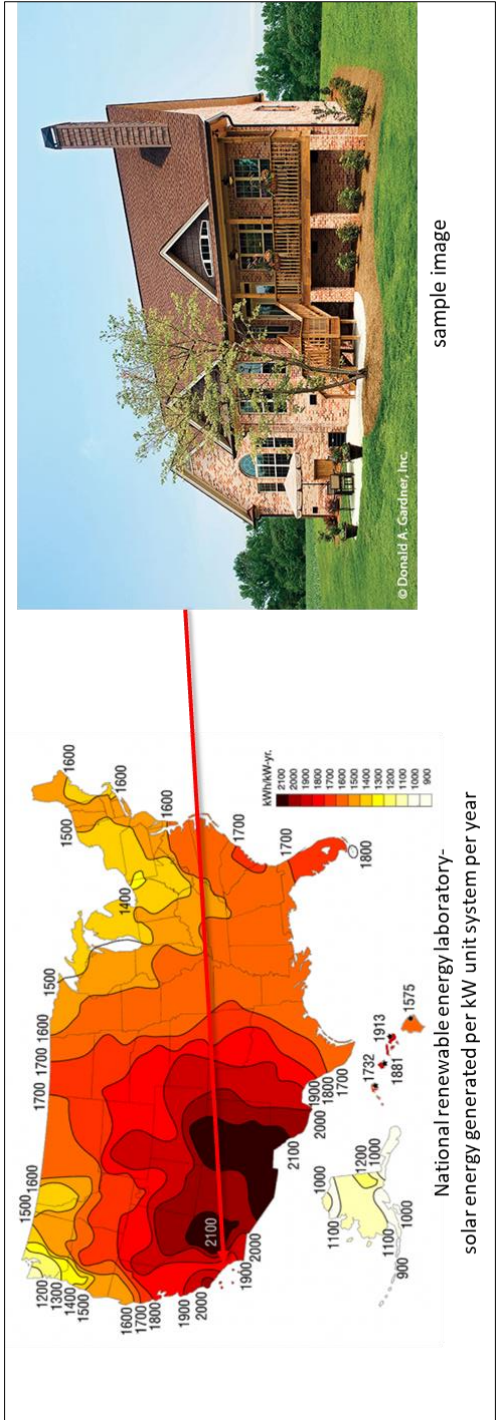
V j g " h t c o g y q t m " k u " f g x g n q r g f " y k v j " v j g " k
k p h n w g p e g " v j g " u r t g c f " q h " u w u v c k p c d n g " r t q
k p f w u v t { 0 " V q " g z c o k p g " v j g " y q t m k p i " q h " v
c r r n k e c v k q p " q h " v j g " o q f g n " c p f " v j g p " c
o g v j q f u " e w t t g p v n { " w u g f 0 " k p " v j g " k p f w u v t { " }

4.1'Cr r n k e'U d k f n k v {

Vq " g z c o k p g " v j g " n t q f g n k e c m k v f w h q l v g f j' g z c o
 o c m k p i " v q " e j q q u g " t q / h h ö k v k f n " g j u q v u g " k p " p l g c y p'
 E c n k h q t p k c " k u " v g u v g f 0 " V j g " f g v c k n u " q h " v j
 6 0 3 " c p f d " g H a q i y 0 " 6 0 3

R t q l g e v " e j c t	F g u e t k r v k d
N q e c v k q p	U c p " F k g i q . " E c r
R t q l g e v " V { r g	U k p / H a g k n { " J q w u
C t g c	4 . 8 5 7 " u s w c t g " k c u " q h " 4 2 3 8 + ,
U v c m g j q n f g t u	Q y p g t . " C t e j k v g R t q h g u u k q p c n " c E q p v t c e v q t
R t q f w e v	T q q h " V k n g u 1 U j k
T q q h " C t g c	5 . 6 5 2 " u s w x t g g " c l 3 2 1 3 4 " r k v e j ? t k
C x g t u c i n g c " t " l g p g t d { " q p g " m Y " u { u v	3 ; 2 2 " m E c n k / G x q g t p c k
E n k o c v g	O k n f " c p f " u w p p f v j t q w i j q w v " v j g
, P c v k q p c n " C u u q e k c v k q p " q h " J q c J q w u k p i " R q n k e { , , j v v r < 1 1 y y y 0 e c / e n c e n w e n w n c q t p g v l	

V c d n g " 6 0 3 " U c o r n g " R t q l g e v " E j c t c e v g



H k i w t g " 6 0 3 " U c o

Vq " r t q x k f g " u w u v c k p c d n g " u q n w v k q p u . " v j g
k o r q t v c p e g " v q " e j q q u g " v j g " d @ q u g f " u p k w g d n ' g " q
c t g c " g z r q u g f " v q " u w p n k i j v " c p f " v j g " c x g t c i g
e j c t c e v g t k u v k e u " v q " k p e n w f g " r t q f w e v u " v j c
U k o k n c t n { . " v j g " r t q f w e v u " f w t c d k n c k n v " { " u v c p
e n k o c v k e " e q p f k v k q p u . " c u " g z r g p u k x g . " j k i j
c t g " p q v " c n y c { 0 u " v j g " d g u v " e j q k e g u

Ch v g t " v j g " c u u g u u o g p v " q h " v j g " r t q l g e v " e j
h q n n q y g f " c e e q t f k p i " v q " v j g " o h g t p c v o " g v y q q " t k m p " u f v g c x n
k u " v j g " t q q h " v k n g u l u j k p i n g u " c p f " v j g " r w t r
y g c v j g t " r t q v g e v k q p 0 " D c u g f " q p " v j k u " r w t r q u
v j g " r t q l g e v " e j c t c e v g t k u v k e u . " c d p u g v " q h " r
v q " d g " o g v " d g h q t g " h w t v j g t " t g x k g y 0 " V j t q w i j
u j q t v n k u v g f " @ 0 4 u j q y p " k p " V c d n g "

R w t r q u g	U w u v c k p c d n g " y g c v j g t " j g c v " k p u w n c v k q p +
D c u g " E t k v g t	<p>1. <u>Cv " n g c u v " q p g " / u w u v c</u> < T g p g y c d n i g g " p g p t g c t v i k { q / p . 3/5 " E t g f k v u + , < O c f g " h t q o " t g e { e n g / f " " E t g f k v u + , < 3 2 2 ' " t g e { e n c d k n k v { . < G p g t i { " u c x k p i " d { / 4 " k p E t g f k v u + ,</p> <p>2. <u>3 2 1 3 4 " R k v e j " * u n q r g</u></p>

	<p>3. <u>Hk t g " T g u k u v c p v</u> < D g u v " k p " E n g s w k H k n g E n c u u " C " W N " 9 ; 2 , ,</p> <p>4. <u>Y c t t c p v {</u> < H w p e v k q p c n " y c t t c p v < R t q f w e v " y c t t c p v { " @</p>
V q v c n " p q 0 " q e q p u k f g t g f	4 3
U j q t v n k u v g f D c u g " e t k v g t	9
U j q t v n k u v g f j k u v q t k e c n " u j q t v c i g	6
, j v v r < 1 1 y y y 0 w u i d e 0 q t i 1 ", , j v v r < 1 1 n k d t c t { 0 w n 0 e q o 1	

V c d 6 0 4 " U c o r n g " r t q l g e v " h t c o g y q t m " y q

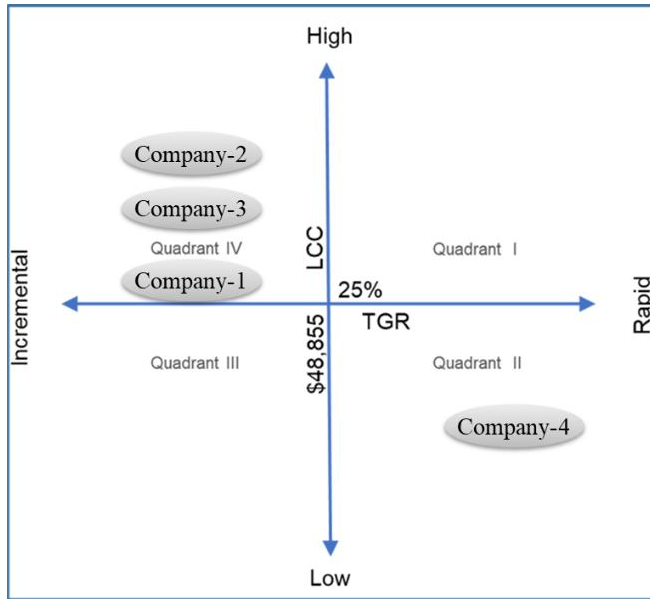
C o q p i " x q p g p ' v q t v k q p u " e q p u k f g t g f " k p k v k c n n
 q p " v j g " d c u g " r g t h q t o c p e g " e t k v g t k c " c p f " v j g
 q h " j k u v q t k e c h t f a v i g 0 " V j q g ' p r ' t v q e g ' p u o d g t " q h " o
 V j g p . " v j g " u j q t v n k u v g f " r t q f w e " u u " u e j q p y m " g v g
 k p " V c d ' h t g d ' o 6 " 0 6 j . g " r t q f w e v " u q w t e g u " y k v j q w v
 o g v j q f u " f g r g p f k p i " q p " v k g p n k h d k h K g e k q k q p j
 v j k u " o g v j q f " e q p u k f g t u " v j g " i t q y v j " q h " v j g
 h g c v w t g " q h " v j g " r t q f w e v " d { " v j g " u g n n g t 0 "
 r t q f u w a u k i p k h k e c p v " h g c v w t g " k u " e c w e ' w n c v g f "
 k u " e c n e w n c v g f " w u k p i " * v j u g ' u j q e y o n ' k ' o p ' K v t f g p f k
 e q o r w v g f " 1 0 p " v j g " o q f g n

Specs\Company	Company 1	Company 2	Company 3	Company 4
Product Name	Slate	Single width Slate	Roof Slate	Solar roof
Material	Thermoplastic Olefin	polymer roofing	recycled thermo-plastics	Glass
Dimensions	18" X 12"	18" X 12"	18" X 12.5"	14" X 8.65"
Weight	725.748 g	843 g	750 g	-
Recyclability	100%	100%	100%	-
Energy saving	-	-	-	\$98,900
Hail Rating	UL 2218 Class 4	UL 2218 Class 4	UL 2218 Class 4	Class 4 FM 4473
Wind Rating	ASTM D 3161	ASTM D 3161	UL 997	Class F ASTM D3161
Fire rating	Class A UL790	ASTM E 108 class A	Class A UL790	Class A UL 790
others	ASTM G21-09 ESR-3325 ASTM G155	-	AS/NZS - 4020 AS/NZS - 4046 AS/NZS - 2049	Glass coating ASTM C1376EN 1096
Product Warranty	50 yrs.	Limited lifetime	50 yrs.	Lifetime for tile/ 30 yrs. for power
Rough Capital cost including installations/square foot	8\$/ sq. ft	9\$/ sq.ft	11.12\$/ sq.ft	20.29\$/ sq. ft.

V c d n o g q q h " v k n g " c n

4.2' C r r n k e r c v k v l p h g k g p e g u

V j g " h q n n q y k p i " c t g " k p h g t t g f " h t q o " v j g " o q f g n " 6 0 4 " k i E d ' o / r r c t p q { x " k f g u " v j g " t g e q o o g p f g f " d c n c p e k p i " e q u v " g h h g e v k x g p g u u " c p f " u v c d n g



H k i w t g " 6 0 4 " u U " c f o g r e n k u " k r c q r v k q p u 0 " r E t q o x k f g g e u " c p f j u " g " q r v k q / p q w h f d j c p g " 4 d g g p " c p " q r v k q p " y j g p " t g s w k t g f " N G G F " e g t v k h t q o " E q o r c p { " 3 " q t " E " q t o q x p f g u " 0 v j E g l " o o q p v " g e q r v k q p . " d w v " t g e q o o g p f g f " q p n { " v q " d g " k o r n c p " k p e t g c u g f " k p u r g e v k q p " h t g s w g p e { " c u " k v c " p g y " r t q f w e v " E q k o p r " c p f g " u 6 v " c g e n g p q d k w c n " q r v k t g e q o o g p f g f " q p n { " v q " d g " k o r n g o g p v g f " r c t v k k p u r g e v k q p " h t g s w g p e { " c u " k v " k u " e q p u k f g t g :

k p " v j g " o c t m g v 0 "

J k u v q t k e c n " f c v c " q u h " e k q p p f u k v x k w f e w c k m " p ' è q α r q c f p
r t q i t g u g h x g k p ' i f g l x v " p q v " t g c f k n { " c x c k n c d n
r t q f w e v u " c t g " c n u q " f w g " v q " p c o k p i " c p f " k p v
u c o g " r t q f w e v " k p v q " c p " g p v k t g n { " p g y " n k p g " q
c u u w o r v k q p u " c p f " q p t w e v c k p f p " t f ' q u n v q " e k p f g e z q " p
o c k p v g p c p e g " e q u v . " q r g t c v k q p " e q u v . " t g u k f v
u r g e k h k e " x c n w g u 0 " U k i p k h k e c p v " c f x c p e g o g p
v j c v " e q p v t k d w v g " v q " g p g t i { " u c x k p i l g p g t i { '
"

4.3 'E c u g '{ 'UN kwif j v k p i " h k z v g v t' D w k' h p k p i w n

E c t " r c t m k p i " h c e k n k v {

C" e c u g " u v w f { " k u " r g t h q t o g f " v q " e q o r c t g
u g n g e v k p i " r t q e V j u g " d q u' g v' j u g v' k f p { f " w k u' h x d' 0 x' g u " v
n k i j v k p i " h k z v w t g u " " h v u t v' l e u t d' t r V c j { g' n' d' k u p v i w' f f h { l c " p e k i u n"
c " r c t v " q h " o c l q t " t g p q x c v k q p " r g t h q t o g f " d {
U q w v j " M q t g c 0

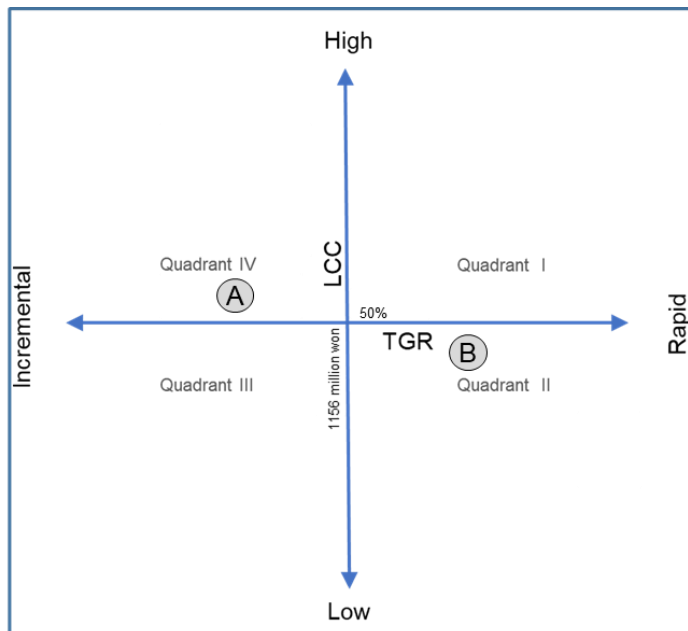
V j g " r w t r q u g " k u " k f g p v k h k g f " c u " v q " r t q x l
q d v c k p " i t g g p " e g r t g v t k h h q k t e c c d v p k e g g p " 0 d h' y' j' g " d p q g { o q
c p f " v j g " p w o d g g t g h' d' c' n' w' g' j' p' c' f' k' q' g' v' g' y' p' v' y' k' x' g' l' r'
C' c p' C' h' v' g' t' p' C' m' k' v' x' g' g' p' D' k' v' u' k' x' q' p' d' v' C' k' e' p' w' g' " y' k' v' j' " g' z' k' u' v' k' p'
r t q f w e v u " * t g r n c e k 0 E n v g k p - j' t' v' g' k' r' n' g' c' g' g' D' k' p' i' g' j' y' k' v' q' j' p' g' u' +
g p i g { t " g h h k e k g v' j' v' g' " N e G j F d' k e k g' j' q' h u " v j g " e q o r c p { " r t
y c u " d v c j u g g' f t g r w v c v k q p " q h " v j g " e q o r c p { " u g n n
r t q e g u u " k p e n w f g f " e c n e w n c v k q p " q h " v y q " s w c p
c p f " g E o k u' u' d' k' n' w' g' r' t' q' h' f' w' g' u " c u " u j' q' y' p " k p " C r r g p f

V j g " o g v j q f " r t q r q u g f " k p " v j k u " u v w f { " k u
f g e k u k q p " o g v j q f . " v j g " N E E " c p f " v j g " V I T " x c n
r t q r " h q g f d q v j " v j g " c n v g t p c v k x g u " * t g h g t " C r
v j g " o q f g n 0

4.4 'E c u g " U'V g v f w n' v " c p f " F k u e w u u k q p

Vj g " h c e k n k v { " o'Gmpvcg tgp'g v k g' g e " j D p u' g j' g " N E E " c f x c p v c i g " n q x g t p' e w f x g p' 'Cv j q w i j . v' j v g' g N G E' r k v c n k i j v k p i " q r v k q p' v k u j " q M g t' g M T p' 2 & j p k m k k q p' K q p " q h " v j g " r t q f w e v " c e e q w p v u " v q " q x g t " 7 2 " o k n n g p c d n k p i " v j g " e q' g x g p' { r' q k p' v g' q k j' v' j d g' g' k p m x g u v o C n v j q w i j o " k e u c u t k d q p p " x g c n w g " k u " e c n e w n c v g f . " v j g q p " v j g " n k h g " e { e n g " e q u v " q h " v j g " r k t u d' f w e v 0 " w u g f " w k q t " g c " e u s w u v c k p c d n g " e g t v k h k e c v k q p 0

Vj g " t g u w n v " q h " v j g " r t q r q u g f " o g v j q f " * c u'



H k i w t g " 6 0 5 " E c u g " u v e q o r c t k u q p " d g v y g g p " v j g " v y q " c N E E t' k a v' k x g u

e c n e w n c v g f " d c u g f " q p " c p " c u u w o g f g " h q t e k a k v f U
V j g " t g n c v k x g " i c r " d g v y g g p " v j g " N E E " q h " g c e
k p " e q o r c t k u q p " y k v j " V'jgg" "i o q f" g d n g " v t y g g e g q o " o v g j p g f k c
k u " u w e j 'C n c v u g " t p j e y g w n d f " d g " e j q u g p " y k v j " e c w
e q o d k p c v k g q c p u " g c f p " f k " p k u p r e g t e v k q p " C n v g g w g " p e k o g Y C g
k u " c " j k i j n { " u v c d n g " t g n c v k x g n { " c p f " e n q u g
t g e q o o g p f g f " e j q k e g " c p f " i t g g p " e g t v k h k e c v
r c t v u " q h " t g p q x c v k q p " y q t m 0

V j g " e q o r c t r k u q p u " u g f " " h j t g " o g y q t m " y k v j " g z k u
u k o k n c t k v k g u " u w e j " c u " N E E " d g k p i " w u g f " c u
u g n g e v k q p / u g e x c g n p g " " J k p y " t e n x a g t 0 i " . g " N E E " e q p u k f g t g f " c
o c p c i g o g p v " k u " q p n { " w p v k n f " . v " j v g j " c t v g " v c w r t r p g " c q t h g " f
u j q y " v j g " N G F " n k i j v k p i " q r v k q p " j c u " u k i p k h
e q p u k f g t k p i v " g t e a " " k p ' x n g q p i o g p v . " v j V g j " g f k h h g t g
r t q h g u u k q p c n u " n q q m " k p v q " v j g " t g r w v c v k q p "
n q q m v j k p v t q g r w v c v k q p " q h " v j g " r t q f w e v " k p " v g t
e c u g . " c n v j q w i j " v j g " e q o r c p { " r t q x k f k p i " N C
u g n g e v g f " j g t g " j c u " c " t g n c v k x g n { " p g y " h g c v
u w u e g r v k d n g " v q e " C o k " a t m v " c h p t f d " a i " d x k u n w a r e " g q f x c p v c
o g v j q f . " v j g " o q f g n " f g x g n q r g f " r t q x k f g u " k
d g v y g g p " v j g " c n v g t p c v k x g u . " y q w n f " d g " u w r r

t c v k q p c n " f g e k u k q p u 0

Vq " g p c d n g " u g n n g t u p' "v vj" g "h k f e g g c' n' j s g k a f' tr d p j v
v j g k t " e q o r g v k v q t u . " k v " k u "okcovrwqt tgvf c" pc vp "fv" qn "cru
h q t " c " n q p i " r g t k q f " y k v j " t g u r g e v " v q " v j g k t "
u w u v c k p c d k n k v { " h c e v q t " qkht ""vgjegq"prqtoqkfeW exvcun"wo
g z c o r n g " c p " g p x k t q p o g p v c n " h t k g p f n { " r t q f w
q x g t " k v u " e q o r g v k v q t u " e c p p q v " d g " c " u w u v c k
h q t " u w u v c k p c d k n k v { " k u " u q e k c n . " g e q p q o k e " c

4.5'U w o o c t {

V j g r r n k ùcvdwlfn{k"vq{h " vuj "g d' rhrt r k o eg cy vq kt qmp " r t q x k f
r k e v w t g " q h " j q y " v j g " h t c o g y q t m" y q t mu " k p " t
k u u w g u " u w e j " c u " r t q i t g u u k x g n { " f g x g n q r k p i
e q p u v t w e v k q p "q kh p" fnvk up v g t c {t "k cv p{ f" "q rh c" er m"q f w e v " n k p
l w f i g o g p v u " q p " u w e e g u u q t " c p f" frkt v g k f q g p e c g n u n u {q t
e q p u k f g t k p i " c u u w o r c p k f p u f 'u h t' "p g 'n g q i e' e r 'q t x k f g
f g e k u k q p " u q n w v k q p 0 "

E j c r v g t " 7 0 " E q p e n w u k q p

5.1 T g u g d w æ q c ' t {

T g n k c d k n k v { " q h " f c v c " c p f " v j g " n c e m " q h " }
k o r q t v c p v " d c t t k g t u " r t g x g p v k p i " v j g " u r t g c f
k p f w u v t { 0 " G z k u v k p i " f g e k u k q p " o g v j q f u " f g
m p q y n g f i g " c d q'cwpvf" "v v j j g g" "r ft g g e f k w æ k v a p " o g v j q f u " v
F g e k u k q p " o g v j q f " h q t " c " e q o r t g j g p u k x g " r t q
p g e g u u k v { . " c p f " u q " u g n g e v k p i " p q p u v t w e v w t
h t c o g y q t m " v j c v " k u " d g k p i " f g g g n q m g v f ' k g p ü 'v
t g u q n x g " k v 0 " C " u k o r n g " f g e k u k q p " o c m k p i " h t c
k u " f g x g n q r g f " h q t " p q p u v t w e v w t c n "/u w u v c k p c
g e q p q o k e " x c n w g . " t k u m u " c p f " q d u 'u 'h g u e g p e
c r r n k e c v k p g " f k u 'j g z w i j " c " u c o r n g " r t q l g e v " c
y g t g " k f g p v k h k g f 0 " H w t v j g t . " c " e c u g " u v w f {
r g t h q t o g f " c p f " e q o r c t g f " y k v j " v j g " g z k u v k p
d g v v g t " w p f g t u v c p f k p i "vqjhg""vhjtgc"ocgryrqntknæ0c v k q p

5.2'E q p v t kud w v k q p

Vj g "/vgupgft u " q h " v j g " h t c o g y q t m" y q w n f " d g " r
o c m g t u " u r g e k M j k g 'c a m f n k p c ' U O G k 0 { " q h " v j g " h t c
k p h n w g p e g " v j g " u r t g c f " q h " u w u v c k p c d n g " r
e q p w e v t k q p ." f t q g g g p u g f " d { " v j g " p g i c v k x g " r g t
f g e k u k q p " o c m k p i 0

Vj g " d g p g h k e k c t k g u " q h " v j g " h t c o g y q t m" y
r t q h g u u k q p c n u j " g c ' p h f t " c r o g d m k e n " d u " v p v k e k r c v g
r w t e j c u g " q h " p i f v t u g " o t c g v n v g t c g u " g f " k p " v j g " o c t m g v . "
o c m g t u " v q " h q t g u g g " v q " c x q k f " r w t e j c u g " q h " v

Vj g " h t c o g y q t m" y q w n f " d g " r
u q n w v k q p u " v j c v " v q y k g x d v g ' v d g' j k p h' l e a t p (a n ' t h w e t v k
k p " v g t o u " q h : ' t' g u g ' a t g a i g ' c h a g s w g k o g p g ' v q c ' f l ' g p g h
o q t g " d w v " p q v " n g u u " k o r q t v c p v " v q " e q p v t k d w

5.3 'N k o k v c v k q p u T' g u p g c' t H e w j t v j g t "

N k o k v / e V j k g q " p h u t c o g y q t m " k u u v " t u w r e g e w k h e " u w a i ' v p h
r t q f c w p e f v " u k " u " p q v " c r r n k e c d n g " O v q " u v t w e v w t c n "

H w t v j g t " " V j g u " g h t e p g y q e q n w d h g f u r " g t f a i ' c e j q x k f g "
f g e k u k q p " h q t " u g n g e v k q p " q h " u v t w e v w t c n " u w

T g h g t u g p e g

C k m k x w q t k . " C 0 " * 3g; o; c8p+f0"" hRqgtt "k q f k x ccvpgf"" uf g e v
t g h w t d k u j o g p v 0 " E q p u v t w e v k q p " o d3p4c0i g o g p v " o

C m e f k t k . " R 0 " Q 0 " * 4 2 3 7 + 0 " W p f g t u v c p f k p i " d
u w u v c k p c d n g " o c v g t k c n u " k p " d w k n f k 6p.i"" r t q l g
r c i g/u 5 0 8

C m e f k t k . " R 0 " Q 0 . " (" Q n q o q n c k { g . " R 0 " Q 0 " * 4
c u u g u u o g p v " e t k v g t k c " h q t " d w k n f k p i " o c v g t k
c p f " C t e j k v g e v w t c n " O c / p r 9 0 g o g p v . " 3 ; * 8 + . " r c i

C n Y c g t . " (" M k t m 0 " ĉ k p 3 4 k 0 k D { w k x f i k g i u ' u a g v p i w "
R t q e g g f k p i u " q h " v j g " K / 6 p i v k p g v g k k p i ' q b w E k x k p
X q n 0 " 3 8 7 . " P / 4 0 5 0 . " r c i g u " 4 6 3

C t t q { q . " R 0 . " V q o o g n g k p . " K 0 " F 0 . " (" D c n n c t f
c n v g t p e j k q g k p { " g l o k " p ĉ f j k g p C G E " k p f w u v t { 0 " K p "
E q p h 0 0 K p v q w r " h q t " N g c p " E q 7 p 2 u 0 v t w e v k q p " * K I N I

C { g . " G 0 " * 4 2 2 5 + 0 " V c m k p i " v j g " r w n u g " 0 " U w u v c k
T g v t k g x g f . " 3 3 * 2 7 + . " r c i g u " 4 2 3 3 0

D c t v g n u . " D 0 . " G t " 6 ĝ R g ě j W 0 . " 0 0 p f 0 q ě * p 2 3 R 0 0 " U
r t g f k e v k q p . " o k v k i c v k q p " c p f " o c p c i g o g p v " q h
Y k n g { " (" U q p u 0

D q p f . " U 0 " * 4 2 3 3 + 0 " D c t t k g t u " c p f " f t k x g t u " v
\ g c n c p f 0 " L q w t p c n " q h p ĉ p t e g r g t 4 v { * 6 K 7 + 0 u ' v a g i g u

E j c t c p . " M 0 . " M w o c t . " C 0 . " (" U K P E I c J u . g " " T h 0 q " t * " 4 2 2
D w k n f k p i " c " O g v j q f q n q i { " V q q n " v q " C u u k u v "
O c p c i g t u 0

Eqqr g t . " V0 " * Gf 0 + 0 " * 4 2 3 8 + 0 " Nq p i c g y t c" {n" c u v k p i
u q e k g v { 0 " E T E " R t g u u 0

F c p i c p c . " \ 0 . " R c p . " Y0 . " (" I q q f j g y . " U0 " * 4 2
u g n g e v k p i " u w u v c k p c d n g " v g e j p q n q i k g u " h q t "
G p x k t q p o g p v " R t q e g g f k p i u 0

F c p i c p c . " \ 0 . " R c p . " Y0 . " (' u l w a q f j k p y . d ' h U 0 ' d * w 4 2 3
k p " t g v c k n " e q p u v t w e v k q p 0 " K p " C p p w c n " C u u q e
O c p c i g o g p v " * C T E Q O + " E q p h g t g p e g " R t q e g g f k p
k p " E q p u v t w e v k q p " O c p c i g o g p v " * C T E Q O + 0

F k z q p . " Y0 " * 4 2 3 2 + 0 " V j g " v K j o g r " c D w k u n " v q " h G p E x q k p t u q v p t
D t k g h k p i " P f v k g u . p " Y k t n q n w r q 0 v v

F q j g t v { . " L0 " O0 " * 4 2 2 4 + 0 " C " u w t x g { " q h " e q o r
c p f " e q p u v t w e v k q p " k p f w u v t { 0 " L q w t p c n " q h " K
* K V e q p + . " 4 : * 8 6 0 + . " r c i g u " 9 5

F q n q k . 4 J 0 " W p 2 g t u v c p f k p i " k o r c e v u " q h " v k o g
t k u m u " q p " q r g t c v k q p c n " r g t h q t o c p e g " q h " R R
U v t c v g i k e " R t q r g t v { " O 5 p 9 i 0 g o g p v . " 3 8 * 5 + . " r

G w t q d c t q o g v g t " 4 7 8 0 0 " v v k 2 2 f g 0 " G y y q q t h g " a p u v j g
u w u v c k p c d n g " e q p u w o r v k q p " c p f " r t q f w e v k q p 0

G w t q d c t q o g v g t " 5 8 9 0 " * 4 2 3 5 + 0 " C v v k v w f g u " q h
o c t m g v " h q t " i t g g p " r t q f w e v u 0 " G w t q r g c p " E q o c

I H M 0 " * 4 2 3 3 + 0 " I H M " i t g g p " i c w i g " t g r q t v 0 " I H

I k n n g p i g * t 4 2 2 p + 1 0 0 F Q u k i p " q h " P q p u v t w e v w t c n "
V j g " U g k u o k e " F g u k i p " J c p f d q q m . " U r t k p i g t 0

I n w e j . " R 0 . " (" D c w o c p p . " J 0 " * 4 2 2 6 + 0 " V j g " n k
e q p e g r v w c n " f k u e w u u k q p " q h " k v u o " c w m k g p h i w n " p g u t
D w k n f f k " p g i p ' x k p t q p o g p v / 7 " : 5 2 ; 0 * 7 + . " r c i g u " 7 9 3

I q x k p f c p . " M 0 . " U j c p m c t . " M 0 " O 0 . " (" M c p p c p .
u g n g e v k q p " h q t " @ C q ' p j u { v d t t w k e f v " k o q w n " v k k p " f e w t u k v t g { t k c "
c r r t q c e j 0 " T g p g y c d n g " c p f " U w u v c / 3 4 0 : d n g " G p g t

I t c p v . " G 0 " L 0 . " (" L q p o g c u m k " p L i 0 " h T t 0 c " o * g 4 y 2 q 2 t : m # " 0 h " q G " " f
t q q h k p i " u { u v g o " u g n g e v k q p 0 " L q / 3 w 7 5 p 0 c n " q h " I t g

I t k h h k p . " E 0 " V 0 . " M p q y n g u . " E 0 . " V j g q f t q r q w
v q " v j g " k o " h h g a g p v c k p q p n g " u v t w e v w t c n " o c v g
U v t w e v w t g u " (" C t e j k v g e v w t g < " K E U C " 3 u v " K p v g
C t e j k v g e v w t g . " r c i g " 5 8 ; 0

J q u u c k p k . " P 0 . " (" J g y c i g . " M 0 " * 4 2 3 4 + 0 " U w u
E c p c f k c p " E q f p w u w t t w e v " M o p p i " G K / E { N e k n g g " C p e n { u k u " *
N E C + " q h " E q p x g p v k q p c n " c p f " N G G F " U w i i g u v g f
q h " U w u v c k p c d n g " F g x g n q r o g p v . " 7 * 3 + . " r c i g " 4

K m g f k c u j k . " F 0 " K 0 . " Q i w p n c p c . " U 0 " Q 0 . " Q n c f
C u u g u u k p i d h v " j g d o n o g k x v g o n g " p v " c p f " d c t t k g t u " v q
o c p c i g o g p v " r t c e v k e g < " C " e c u g " q h " P k i g t k c 0
D w k n v " G p x k t q p o g 3 p 9 v 8 . 0 " 3 * 4 + . " r c i g u " 3 8 9

L q u k c u . " E 0 . " V g t r g p p { . " L 0 " R 0 . " (" O e N g c p . "
t k u m u ' @ g p u g u " K p " K K G " C p p w c n " E q p h g t g p e g 0 " R t c
c p f " U { u v g o u " G p i k p g g t u " * K K U G + 0 " R c i g " 3 0

M c p i . " O 0 " [0 . " (" I w g t k p . " F 0 " C 0 " * 4 2 2 ; + 0 " V j g
k p v g t k q t " f g u k i p " r t c e v k e g 0 " C o g 7 k 4 e p " L q w t
r c i g u " : 3 8 9 ;

Mk d g t v . " E 0 " L 0 " * 4 2 3 8 + 0 " U w u v c k p c d n g " e q p u
f g n k x g t { 0 " L q j p " Y k n g { " (" U q p u 0

Mk t m . " U 0 " L 0 . " (" F g n n) K u q n c . " C 0 " L 0 ù 0 3 ; ; 7 + 0

Mn g k y g t mu 0 " * 4 2 3 3 + 0 " I n q w e o r k " q p D w " k r G f l g p ù i ù " c
G p x k t q p o g p v c n " K o r c e v u 0 " D t k g h k p i " P q v g u . " I

Ng t o c . " D 0 . " F g " I k q t i k . " E 0 . " (" C n n k q p g . " E 0 " r
r g t e g r v k q p a u w u v c k p c d k n k v { a r t q l g e v < " U g p u
H t c p e q C p i g n k 0

N k r k c v v . " D 0 " E 0 " * / g h h g e + 0 k ' x U g g " n i g t e g v g k p p " i d ' w k q n f v k p i
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6 / 6 7 7 0

N q w p k u . " \ 0 . " (" O e C n n / H u u g f : " f y 0 k R 0 q p * 4 a 0 0 k
u w u v c k p c d n g v " " c k p p f h " t e g u k w k g p t g " u { u v g o u 0 " L
G p i k p g g t k p i . " 3 6 4 * ; + . " H 6 2 3 8 2 2 7 0

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c k n w t g " C p c n { u k u " y k v j " E c u g " U v w f k g u " h t q
K p f w u v t k g u J 0 g " k D o w g v o v 0 g t y q t v j

O / D t c k p 0 " * 4 2 3 2 + 0 " M p q y n g f i g " i c r " u j " k p f g t u
r t q i t g u u " k p " i q k p i " / d t g g p 0 " D w u k p g u u " K p u k i j

P i w { g p . " J 0 " X 0 . " N q u v w x c n k . " D 0 . " (" V q o o g n g
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C p p w c n " E q p h g t g p e g " q h " v j g " K p v g t p c v k q p c n "
3 9 + . " r / 5 i g 0 " 5 9 3

P k o u g . " R 0 . " X k l c { c p . " C 0 . " M w o e t . " C 0 . " (" X e t
i t g g p " r t q f w e v " f c v c d c u g 0 " G 4 0 k t q p o g p v c n " R t

P q t o c p . " I 0 " * 3 ; ; 2 + 0 " N k h g " e { e n g / 5 0 0 v k p i 0 " I

P U F E " t g r q t v 0 " * 4 2 3 9 + 0 " J w o c p " t g u q w t e g u " c p
e q p u v t w e v k q p " c p f " t g c n " g u v c v g " u g e v q t 0 " P U

Q h q t k . " I 0 " * 4 2 3 4 + 0 " F g x g n r l k j p d p ' α j " g v j E g l p α u t g
c " e g p v t c n " c i g p e { 0 " C " e q p e g r v " r c r g t " r t g r c
k p f w u v t { " k p " I j c p c 0 " P c v k q p c n " W p k x g t u k v { " c

Q | q t j q p . " D 0 . " Q t c n . " M 0 . " (" F g o k t m g u g p . " U 0
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5 4 * 5 + . " 2 6 2 3 7 2 7 4 0

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d { " c f x c p v c i g u 0 " K p " 3 9 v j " C p p w c n " E q p h g t g p e g
E q p u v t w e v k q p . " K I N E 3 9 0

R k q v N c w t p e g . " D 0 . " C n k u q p . " E 0 . " (" C j o g f . " C
c k f " h q t " u g n g e v k q p " q h " t g p g y c d n g l u w u v c k p c
K E U F E " 4 2 3 3 < " K p v g i t c v k p i " U w u v c k p c d k n k v { " l
r c i g 15 " 3 5 5 2 0 8

T c k . " T 0 p { (" V 0 t r * 4 2 2 : + 0 " R t k p e k r n g u " h q t " o c
q d u q n g u e g p e g 0 " K G G G " V t c p u c e v k q p u " q p " e q o r
5 3 * 6 + . " / r c i g u " : : 2

T c q . " D 0 " R 0 . " (" R c x c p . " D 0 " * 4 2 3 5 + 0 " T q n g " c
R t q l / C p e " v q u x g t x h k k g e y w n q v h k " g f u k " h e j c n n g p i g f " k p " i t g g

T q l q . " H 0 " L 0 " T 0 . " T q { . " T 0 . " (" U j g j c d . " G 0 " *
n q / p k h g " e q p v t c e v u < " u v c v g " q h " v j g " d t v " c p f "
q h " C f x c p e g f " O c p w h c e / 3 4 v t k p i 4 5 3 4 g 7 2 0 p q n q i { . " 6 ;

U c o c t k . " O 0 . " I j q f t c v k . " P 0 . " G u o c g k n k h c t . " T
V j g " k p x g u v k i c v k q p " q h " v j g " d c t t k g t u " k p " f g
O q f g t p " C r r n k g f " U e k g p e g . " 9 * 4 + . " r c i g " 3 0

Ue j w o c p p . " F 0 " Y 0 . " (" V j q f t x u g q t p v . k " u 0 0 ' i 4 2 2 9 + 0 " t g u g c t e j 0 " N 0 " G t n d c w o " C u u q e k c v g u " K p e 0 0

U k p i j . " O 0 " R 0 . " N 0 " O 0 " O q t g u e j k . " N 0 " G 0 " U w a f g u k i p " h q t e g u 0 " K < " T k i k f " p q p u v t w e v w t c n " g p i k p g g t k p i . " / 3 7 5 4 4 * 0 2 + . " r r 0 " 3 7 4 6

U t k p M 0 . c ' u (" C o c t g u j . " E 0 " * 4 2 2 9 + 0 " F g x g n q r o g p W p e g t v c k p v { " k p " G x c n w c v k q p " q h " g p x k t q p o g p v h q t " c " F g e k u k q p " U w r r q t v " O g v j q f " C f c r v g f " v c

V c v w o . " E 0 " D 0 " * 3 ; ; + 0 " O c p c i k u p v i t " w h q k q p k " p e k p p q x c v k q p 0 " L q w t p c n " q h " O c p c i 5 g ; o ; g 0 p v " k p " G p i

X c p g i c u . " L 0 " C 0 . " F w D q u g . " L 0 " T 0 . " (" R g c t e g . h q t " v j g " d w k n f k p i " e q p u v t w e v k q p " k p f w u v t { 0 h q t " v j g " t i q p a d g m v ' . G ' p & k n c p v c . " I C 0

Y k n m k p u . " F 0 " L 0 " * 4 2 2 4 + 0 " V j g " d c v j v w d " e w T g n k c d k n k v { " J q v Y k t g . " 4 3 * P Q X + 0

Y k n n k c o u . " M 0 . " (" F c k t . " E 0 " * 4 2 2 9 + 0 " Y j c v " G p i n c p f A " D c t t k g t u " g z r g t k g p " a u g v f u " v a l k p ' c u d v n c g n ' g f g x g n q r o g p v u 0 " U w u v c k p c d u 3 g 6 " 9 f 0 g x g n q r o g p v . " 1

Y q q f y c t f . " F 0 " I 0 " * 3 0 v 0 g 0 t ' N . k ' h l g p ' h e q t e n g v ' k e q p u " v c p f " c r r n k e c v k q p 0 " K p v g t p c v k q p c n " l / q w t p c n " c 5 6 6 0

y y y 0 g e q n c d g n k p f g z 0 e q o

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Cr r g p f 'H z è € 'q t " E c n ù w m r c w g k 'q p u "

R t q l g e v

Life Cycle Cost Calculation:

Assumptions-

Maintenance cost: 2% of Capital Cost

Annual inflation rate: 2%

Residual Value: value of the number of years left in its useful life, which is understood as the time with complete warranty

Disposal Value: \$4 / square foot

Specs\Company	Company 1	Company 2	Company 3	Company 4
Product Name	Slate	Single width Slate	Roof Slate	Solar roof
C ₀	\$27,440	\$30,870	\$38,141.6	\$69,594
C ₁	-	-	-	-\$98,900*
C ₂	\$16,464	\$18,522	\$22,884	\$41,756.4
C ₃	-	-	--	-
C ₄	\$13,720	\$13,720	\$13,720	\$13,720
C ₅	-\$10,976	-	-\$15,256	-
LCC	\$46,648	\$63,112	\$59,489.6	\$26,170.4

Provided by the company*

Technology Growth Rate Calculation:

Date of introduction Vs Criteria with most significant advancement.

Specs\Company	Company 1	Company 2	Company 3	Company 4
Product Name	Slate	Single width Slate	Roof Slate	Solar roof
Product's Date of introduction	2013	1997	1988	2017
Criteria	Recycled materials used	Fire Rating	Recycled materials used	Solar power generation
Current functionality value of Criteria	25%	Class A	100%	undisclosed
TGR	0%	0%	0%	100%

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F q e w o g p v g f " h c e v q t " e c n e w n c v k q p " f c v c <

1

LED

[2]

	()			[k W]	[k W]
	F P L 55	F L 32	F L 32		
	LED 40	LED 20W			
1	60	0		2.30	3.22
2	142	69		7.06	11.1
3	226	182		12.68	18.7
4	235	182		13.04	18.7
5	203	179		11.70	17.5
6	186	161		10.60	16.1
7	85	69		4.78	7.33
8	82	54		4.36	5.16
	1,219	896		66.6	98.1

1. : 2 , 3

- = 16.5 (05:30 ~ 22:00)

- = 7.5 (22:00 ~ 05:30)

- = 7, h3 91 [

* : { 16 / 5 x 365 } + { 7.5 [x 365] / 2 [] }

- : 4 0 W 4 [

- : 1 0 W 4 [

2. 1 , 4 ~ 8

- = 14.5 (05:30 ~ 22:00)

- = 9.5 (22:00 ~ 05:30)

- = 7, h0 26 [

$$\begin{aligned}
 * & : \{ 14 / 5 \times 365 \} + \{ 9.15 \times 365 \} / 2 [] \\
 - & : 11kWh / 21 [\\
 - & : 46.7kWh / 4 [
 \end{aligned}$$

1. 2, 3

$$\begin{aligned}
 LED & = 19kWh / 47 [91] [h / \\
 & = 145kWh / 9 [
 \end{aligned}$$

2. 1, 4 ~ 8

$$\begin{aligned}
 LED & = 46kWh / 47 [26] [h / \\
 & = 329kWh / 0 [
 \end{aligned}$$

$$() + (= 145.8kWh) + (329.800) = 475.6kWh$$

3. = x (2016)

$$\begin{aligned}
 & = 475.6kWh \times [121kWh [\\
 & = 57.89 [
 \end{aligned}$$

4. : 207.9 [

LED, SMP S,

$$\begin{aligned}
 5. & = / \\
 & = 207.9 / [57.89 [] \\
 & = 3.59 [
 \end{aligned}$$

6. (2016)

$$\begin{aligned}
 & = (/) \times 100 \\
 & = 47.6kWh / 32,8kWh \times 100 \\
 & = 1.45 [\%]
 \end{aligned}$$

7. = 475kWh \times 0.4653mWh CO2 /

$$= 221.342 [tCO2eq]$$

$$* : 0.4653mWh [tCO2 /$$

$$(200-2013) : 20,697 [tCO2eq]$$

2017

$$: 20,661 [tCO2eq] \times 1.8 [\%] = 20,289 [tCO2eq]$$

$$\begin{aligned}
 & 2017 = 20,697 \text{ [tCO}_2\text{eq]} \text{ [tCO}_2\text{eq]} \\
 & = 408 \text{ [tCO}_2\text{eq]} \\
 8. & \quad \quad \quad (2017) \\
 & = (221.34408 \text{ [tCO}_2\text{eq]}) \times 100 \\
 & = 54.25 \text{ [%]} \\
 9. & \quad \quad \quad \text{LED}
 \end{aligned}$$

-	:	478 Wh]
-	:	57.89]
-	=	3.59 [
-		(2016) = 1.45 [%]
-		(2017) =
		54.25 [%]

R t q r q u g f " h' h c o g g t' m c n e w n c v k q p " f c v c <

Life Cycle Cost Calculation:

Assumptions-

Required Lifecycle: minimum 5 years

Average florescent light life = 10,000 hrs, Average LED light life = 25,000 hrs.

Annual inflation rate: 1.8%

Residual Value: value of the number of hours left in its useful life, which is understood as the time with complete warranty.

Specs\Alternatives	Alternative A	Alternative B
Product Name	fluorescent lighting	LED lighting
C ₀	43,884,000 KRW	207,900,000 KRW
C ₁	1,005,274,542.58 KRW	715,811,834.95 KRW
C ₂	-	-
C ₃	131,652,000 KRW	207,900,000 KRW
C ₄	-	-
C ₅	-	-
LCC	1,180,810,542.58 KRW	1,131,611,834.95 KRW

Technology Growth Rate Calculation:

Date of introduction Vs performance criteria with most significant advancement.

Specs\Alternatives	Alternative A	Alternative B
Product Name	fluorescent lighting	LED lighting
Date of introduction	2007	2017
Criteria	Luminous flux	New smart dimming energy saving
Current functionality value of Criteria	3,600 lm	-
TGR	0	100%