

SPRU Working Paper Series

Energy Policy

Sustainable
Development

**Science and
Technology
Policy**

Innovation
and Project
Management

Economics of
Innovation

SPRU Working Paper Series (ISSN 2057-6668)

The SPRU Working Paper Series aims to accelerate the public availability of the research undertaken by SPRU-associated people, and other research that is of considerable interest within SPRU, providing access to early copies of SPRU research.

Guidelines

Papers should be submitted to swps@sussex.ac.uk as a PDF or Word file. The first page should include: title, abstract, keywords, and authors' names and affiliations. The paper will be considered for publication by an Associate Editor, who may ask two referees to provide a light review. We aim to send referee reports within three weeks from submission. Authors may be requested to submit a revised version of the paper with a reply to the referees' comments to swps@sussex.ac.uk. The Editors make the final decision on the inclusion of the paper in the series. When submitting, the authors should indicate

!"#\$%&'()*! +

#",+##%+##"##?+'\$+##'%#3,(:#*;>\$#'%#3(4**,\$4\$)43@.+&?"9\$&1\$/#4@\$3&""#3,#9"#"#\$)#,/#"\$
,-#0\$67&"(4*&'\$#,\$4*<\$JKEJ\$K8#\$\$#"&+0&?'\$3&,\$&1\$3*("(34*\$,\$+(4*\$'+#9?3#'\$,-#\$\$11&+,'\$&1\$T7>
/-(3-\$-4:##\$)###"\$*&&@#9\$,&\$4'\$,-#\$\$%+(04+;\$("\$:#,&+'("\$4",05&,(3\$@>\$T(0%@">\$4"9\$
7&"(4*&'\$ JKEO3\$ C-#\$19(##+##"3#'\$40&".\$,-#\$\$4%%+&:4*\$ \$%+&3#"'#\$ &1\$ 9(11#+##,\$ 3&?"+(##\$
("3+#4'#\$,-#\$\$3&,\$1&+\$4%%+&:("\$4\$"/\$4",)(&,(3\$("\$,-#4#)'3#\$\$&1\$-4+0&"(V#9\$4%%+&43-
6Y4"\$Z/4"##")#+.##,\$4\$KEE8<P?+,-#+0&+##>\$4'\$,-#;\$+##%+##"#\$,\$4\$+(:4*+8?#4/9\$#/\$
3&00&"\$ %&&\$# \$6P&,'#+\$ 4"9\$ [+?"904""\$ JKEO4++4",\$ #,\$ 4*\$8KEO4+@#,'\$ 1&+\$
4", (0(3+&)(4*\$4+##\$0&+##?"3#+,4("\$6)&,-#,\$#0%&+4**;\$4"9\$("\$4..+#.4,#8\$)#34?'#\$48\$'%+##49\$&
+##('4"3# \$04;\$3?+,4(*\$,-#(+?*,(\$4"9\$)8\$+##.?*4,(&""\$,&\$*(0,\$?'#\$04;\$3&""+,4("\$49&%,(&"\$);\$
,-# \$04+@#,\$4\$**\$-#*\$*(0,(#9\$?'#>\$("\$,##"04+@#3&0%#,(,(&"\$4"9\$*&/\$%+04#,\$'\$1&+\$
"#\$4",)(&,(3\$4*'\$&+##%+##"#\$,\$49:3&#\$(,(&""1&+\$('""&:4,(8&5-&+V#*'@(\$#,\$4*<\$ KEW8
C-#\$4)&:##\$)4++(#&,\$&"";\$#1*#3,\$,-# \$04+@#,\$14(*?)(\$".4",)(&,(3\$('""&:4,(&'>\$)?,\$4*'\$&
';,#0 '\$14(*?+##\$ 4"9\$ #:#"\$ 9(+##3,(&"4*(,;\$ 1907#)## \$ 4"9\$ 5&-+43-##+\$ JKEJ\$ T3-&,\$ 4"9\$
T,##("0?#**#+\$ JKEJ\$

,#3-"&*&.(#'\$(\$+#.4+9#9\$4'\$,-#\$0&',\$(0%&+,4", \$1&+0\$&1\$'?%%&+,>?)?,\$%?)*(3\$%&*(3;\$'-&?*9\$
34,4*;V#\$\$&+\$4?.0#", \$%+(:4,#\$'#3,&+\$(":#',0#",<\$
7 4VV?34,&\$ 1?+,-#+\$ 9#:#*&%#9\$,-\$ 1+40#/#&+@5E1\$#0(#9\$ ("&:4,(&"\$ %&*(3;\$ /(-,\$
'&%-(',(34,#9\$ /&+@\$ &"\$,-\$ 9(',+())?,&"\$ &1\$ %?)*(3f%+(:4,#\$ +('@'\$ 4"9\$ +#/4+9'\$ 4"9\$ 4\$ 9##%
3&'"(9#+4,(&"\$ &1\$,-\$ 9#04"9\$ '(9#\$,&\$ 49:&34,#\$,-\$ 1&+04,('8\$48\$1\$"#/\$04+@#,'\$
674VV?34,&\$ JKEO\ \$ 74VV?34,&\$ JKEL4\ \$ d4,,#*8479\$,&\$ JKEL4\ \$ B (".\$)#;&"9\$ %&*(3(#\$
U?',(1(#9\$);\$ ^04+@#,\$ 1(A("._\$ 6(<#<\$ %?)*(3\$ (":#',0#",\$("\$)#476\$ 5R\$,-\$ %%+(:4,#\$ 5R\$ \$
(":#',0#",,\$ -4,\$ ('\$ 4)'#", \$ 9?#\$,&\$ 04+@#,\$ 14(*?+#8>\$ /-(3-\$ 74VV?34,&\$ 4+?.?9\$ 9&\$ "&,\$ %%+&:(9#\$,-\$

\$

"

211
&

4"4*;'#\$9?#,\$&\$,-#\$*4".?4.#\$)4++(#+'>\$9(:#+'#\$ %?)*(34,(&"\$4"9\$&"\$,-#\$*43@\$&1\$
9(.,4*(V4,(&"\$4"9\$]#\$. \$JKEE&\$5#'#4+3-\$4+, (3*#\$ %?)*('-\$9\$ (" \$D-("#\$)\$&1\$
4"4*;'V#9\$)4'#9\$&"\$DMdG>\$,-#\$*4+.#,\$94,4)D#(\$1&\$1&\$&?+"4*<\$]#?#'#\$%&' \$
64", (0(3+&)(4*\$+##('4"3#8_ \$4'\$,-#\$?)U#3,\$,#+0\$'#4+3-\$',+("\$.\$&\$'#4+3-\$("\$DMdG\$/(-("\$,-#\$
+##'4+3-\$4+##4&\$1\$%-4+043;>\$4'\$,-##\$4+##\$&,-##\$+##'4+3-\$4+##'4,(\$975&6?3-\$
4'\$#":(+&"0#",>#\$3&"&0;\$4"9\$)(*&.;8<\$C-#\$,(0#%##+(&9\$?'#9\$+?"\$1+&0\$EFLF\$,&\$JKEF\$6?
S#3#0)#+&1\$JKEF\$<

C-#\$4"4*;'(\$&1\$X".*('-%?)*(34,(&"\$(\$4"9\$&"\$N?)7#9\$4"9\$]#)\$&1\$T3(#"3#<\$](-("\$N?)7#9>\$
'#4+3-("\$.\$);\$?'("\$.\$7XT=\$6#9(34*\$T?)U#3,\$9#4' 8\$,#+0\$ %+&:(9#\$4\$0&+##\$433?+4,#\$
3-4+43,##+'(4,(&"\$&1\$#43-\$%4%##+!\$1&3?'>\$4'\$,-##\$4+##\$';#04,(34**;\$34#?&\$4V#9\$
("\$,#"#\$ ("9#A("\$.\$%+&3#"\$);\$ #A40("#\$]#?#\$,-\$7XT=\$,#+0\$,1B43,##+(4*\$2.#','\$
nSJb<WKW<FWj<EJJ\$&1\$W4+3-("\$N?)7#9\$&"\$*;\$/(-("\$,-#\$+##'4+3-\$4+##4&\$1\$%-4+043;<\$
]#&),4("\$4\$*('\$&1\$N?)7#9\$GS\$6#7#GS\$(Q?#\$9#',(1(#+"?0)#+\$?'#9\$("\$N?)7#9\$&1\$4\$
%4%##+<\$]#,\$-#\$?'#\$,-("\$N7GS\$,&\$'#4+3-("\$]#)\$&1\$T3(\$2)\$4"9\$?+,-##\$("\$1&+04,(&"\$
&"\$,-##\$%4%##+>\$4**&/("\$.\$4"4*;'(\$&1\$%?)*(34,(&"\$("\$3*?9("\$.\$4?,-&1\$6#&4<(\$3&1+&0\$
D-("\$4\$&+\$cd\$<\$

D4#\$',?9(#'\$&"\$#',4)*('-\$9\$4"9\$#/#\$4",)(&,(3'\$("\$D-("\$4\$4+##\$4*'\$&\$?'#9\$,&\$499+##'\$,-#\$'#3&"9\$
Q?#',(&"\$;\$*&&@("\$.\$)#;&'9%?)*(34,(&"\$&/4+9'\$3&00#+3(4*('4,(&"<\$S&3?0#",4+;\$#:(9#"3#\$
4"9\$("\$(-,\$1+&0\$#*(,\$\$("\$,#+: (#'\$/(**\$)#9+4/"\$?%&"\$,\$&\$?"9#+',4"9\$%4,,#+""\$&1\$4",)(&,(3\$
(""&:4,(&"\$("\$D-("\$4\$4"9\$,-#\$',+?3,?+##\$4"9\$("\$3#",(:#\$4,\$%*4,<\$P&?+\$34'#\$',?9(#\$69#',4(*#9\$("\$
C4)*#\$J&\$#\$?'#9\$,&\$ (**?',+4,\$\$,-#\$,(0#1+40#\$4"9\$9;"40(3'\$&1\$9#:#*&%0#",&\$1\$9(11#+##',
("9(.#'&?*; B%+&9?3#9\$4", (0(3+&)(4*\$3&0%&?"9">\$'&0#&\$1\$/- (3-\$4+##\$^#/#,\$&\$/&+*9_<\$C-##\$
"#\$9+?.\$4+##\$#,4(#9\$("\$,-#\$D-("#'#\$+##%&+,\$&+\$&,-##\$0#9(4>\$

4"9\$&"\$N+#:#",(&"\$4"9\$D&"+&*\$&1\$74U&+\$G"1#3,(&?*\$S/(#4\$)/#+\$*4?"3-#9\$1+&0\$
JKKL\$\$
=&/#:#+>\$,-#7#9(?0\$,&\$&"C#+0\$N*4"\$1&+\$##*%&0#",\$&1\$T3(#"3#\$4"9\$C#3-"&*&,\$
/4"\$&,\$,-#1(+,\$"4,(&"4*\$%*4"\$1&+\$'3(#"3#\$4"9\$,#3-"&*&4,\$\$8D\$,,-#1(+,\$"4,(&"4*\$%*4"\$
0#",(&("\$("\$&:4,(&"\$("\$4",)(&,(3'<\$C-#&\$&"B#+0\$N*4"\$1&+\$,-#S#:#*&%0#",\$&1\$T3(#"
4"9\$C#3-"&*&,\$1&+\$E#WOb_1&+0?*4,#9\$("\$E#WOb_1&+0?*\$4,\$#D&?"3(*\$E#WOb_1&+0?*\$4,\$
1&+\$04U&+\$%+&U#3,'>\$("\$3*?9("\$?"3*#4\$&29&#&10\$)*#\$,#3-"&*&,\$4'3\$,4**(V#9\$
)&:("\$\$(?"*("\$]4".\$JKEO8\$!,-#+\$%+&U#3,\$'/#+\$*4,#+\$499#9\$,&,\$,-#%*4"\$("\$+#+%&""#\$,&\$&3(
4"9\$%&*,(34*\$"##9'>\$'3-\$4'\$,-#%+&U#3,\$&"\$4,##*(,(\$,#3-"&*&,\$6/-(-3-\$*9\$,&,\$,-#1(+,\$D-("
'4,##*(,\$&"\$.P4"\$.&".\$&"\$EFb\$>\$'9\$4"&,-#+\$%+&U#3,\$&"\$,-#3+#4,(&"\$&1\$"/\$9+?.\$,&\$3?+#\$
04*4+(4\$6/-(-3-\$+#+?*,#9\$("\$,-#9#:#*&%0#",\$&1\$,-#9+?.\$2+,#0('("\$0#",(&"#9\$4):#\$
Z-4"\$.R\$Z-4"\$.JKEF\$,##+,#("\$*;>\$,-('\$EJ\$;#4+\$6E#WOb8\$%*4"\$4*'\$&0#",(&"#9\$,-#3+#4,(&"\$
&1\$"/\$4",)(&,(3'\$4"9\$,-#(+4\$%*(34,(&"\$("\$,-#4.+(3?* ,?+>\$("\$9?',+(4*\$4"9\$1&&9\$'#3,&+<\$
("\$3*?'(&"\$/4'\$9?#\$\$%+(04+(*;\$,&\$,-#*\$43@\$&1\$34%4)(*,;\$("\$,-#D-("##\$%-4+043#?,(34*f\$9+
("\$9?',+;\$4"9\$,-#,-#4,\$&1\$04",("\$1#3,(&?'\$9('#4'#'\$4,\$,-4,\$D0/4\$T,4,\$#D&?"3(*\$E#WOb8
C-#'\$4+*;\$("\$&:4,(&"\$%&*(3(#'>\$/-(-3-\$/#+\$#)\$4#9\$&"\$4,(&"4*\$%*4"\$4"9\$0&)*(V#9\$+#+&?+3#'\$
,-&?.\$490("\$'+4,(:#\$0#4'?+#\$4"9\$3&004'9'>\$/#+\$#,-#&+("\$4*\$1&+0&1\$,-#\$/-&*#\$"4,(&"\$
';,#0> 0 \$"\$,\$,-#4)'#3#&0\$+@#4'9\$0#3-4"('0< \$
D-("4I\$+#+#4+3-\$%&*(3(#'\$4+##',(**\$1+40#9\$("\$,-#3&,"A,\$&1\$4,(&"4*\$%*4"">\$4"9\$494%,\$,
"#\$ '\$(?4,(&"\$ #:#+;\$ 1#/\$;#4+<\$1&+\$,-# \$ #0#+.#"3# \$ &1\$,-\$4,(&"4*\$ T3(#',(1(3\$ 4"9\$
C#3-

,-\$ 49:4",4.## \$ &1\$,-\$ \$ ' &3(4*('\$ \$ ' ;',#0\$ (" \$ 3&"3#",+4,("\$ \$ +#&?+3#\$4\$ ("3+#4'("\$ \$
4%%#+#3(4,(&"\$1&+&*#\$&1\$,-\$ \$ 04003,4'('0 >\$# \$M4,(&"4*\$7#9(?&n&"\$C#+0\$N*4"\$
6JKK5KJE88",(&"#9\$4)&:#\$-\$&'#\$EO\$#3(1(3\$4+4'\$/-(3-\$48\$+#+%'&"9#9\$,&\$04+@#,9#04"9\$
.#"#+4,#9\$);\$#3&"&0(3\$4"9\$'&3(4*\$9#:#*&%0#",4"9\$)8\$+#+%+##",#9\$04U&+\$)&,,*##3@'("\$
1?+, -#+\$9#:#*&%0#57JTC\$JKK08F&0\$JKKO\$,&\$JKEL>\$# ##\$&?,\$EVBKK\$4",)(&,\$\$
5RS\$+*4,#9\$+##4+3-\$%+&20#3&+,#9\$);\$,-#\$.&:#+0#",!\$04U&+8U#3,'>\$/(-,\$4\$,&4*\$
40&?",\$ &1\$ 1?"9("\$ &1\$ jKK\$ 0(**(&"\$ a?4"\$ \$ 674H(&"4*\$ =#4*,-\$&00("(&"\$
JKEb64%%+&A(04,*;\$cTS\$OK\$0(**(&"
C-#+#\$4+##\$&0#\$(0%&+,4",9(11#+#"3#)\$#,/###3##04U&+\$TRC\$+##4+3-\$%+&U#3,'\$4"9\$
,-\$04U&+\$%+&U#3,'("\$EFOK'<\$C-#)\$(..#',9(11#+#"3#+\$*4,#\$,&\$3-4".#("\$,-#("\$&:4,(&"\$;',#0
5#'#4+3-#+'\$/#+#\$4**\$#0%*	\$);\$,-#\$.&:#+0#",("\$,-#EFOK'\$4"9\$,-#,\$-49\$%#04"#,\$
%&'(&"<\$C-#+\$#4+3-\$,#40'\$/#+#\$&+.4"(V#9\$);\$,-#\$.&:#+0#",>\$/-(3-\$3&?V9\$
"4,(&"4*\$+##&?+3#'\$4"9\$+##4+3-#V\$+88"\$3+,(34*\$%+&)*#0'<\$C-#)\$(..#',+\$#4+9\$1&+\$
+##4+3-#+'\$/4'\$&,\$0&"#,\$)?,\$140#'\$4"9\$%+&.+##\$'/(-("\$,-#\$',;609-40\$#,\$4\$Efb\$
! "\$,-#\$3&"+4+;>\$%+##",("\$&:4,(&"\$;',#0'\$4+##\$04+@#,(V#9\$4"9\$&-\$TRC\$+##4+3-\$
%+&U#3,'\$4+##3&0%#,(:#*;\$1?"9#9<\$G",##*#3,?4*\$%+&%#+,;\$)#"#1('\$)+&?-,;\$)+##4+3-\$
)#3&0#\$4\$"#/\$9&0("4",0&,(;4,(&"\$1&+\$+##4+3-#+>\$'&\$,-#\$3&&+9("4,(&"\$4"9\$0&)*(V4,(&"\$
)#/,###"\$,-#\$',4,#\$4"9\$43+&"\$9(11#+#"3#,\$+##4+3-\$,#40'\$(\$023#\$9(11(3?*\$4"9\$,&\$&0#
#A,#,\$?" +4*'(,65(\$4"9\$T?\$JKF\$3&0%#,(:#\$4%%*(34,(&"\$%+&3#"1&+\$1?"9("\$3-4+43,#+('#'
,-\$&%#4,(&"\$&1\$,-\$74U&+\$TRC\$+##4+3-\$%+&U#3,\$4+&?"9\$"#/\$9+?.\$9('3&:#+;>\$4*,-&?..
1&3?'\$4"9\$9(+#3,(&"\$&1\$+##4+3-\$('\$9#3(\$9#'#4+3-#+'\$,-#0'#:##<\$C-('\$0#4"\$,-4\$,,-#\$

^(")*+,-&%&\$.%&+*/.-*0"%&!)*)'.1)-&#&2)*./345*!";67*8))&*#!*9::: *<&.*+*9;:=?*#W*
@#++)-*./#20"%&#*)!+#86)%!*")*035BB*!/.@*9::C?*#&7*%&*9)*035BB*-)1)#6)7*+"#+*
+)* \$-.86)@* ./345* D#!* !)-%.,!* #+* +"#+* +%@)P)*!4%&%!+-E* ./F)#6+"* +..G* @#&E*

"#.&,(4,(&"\$%+&3#" \$&1\$,-#\$ 175\$JKEF>\$04";\$ (" "&:4,(\$9+?.'\$/#+#\$*(

, -('\$4'"/#+\$4"9\$, &\$) #. (" \$, &\$499+ # "\$Q?#', (&\$J<
\$

O1 23C;4+3(+! .C! 75\$585+3%+ /! 233.9%5.3! :.;5(, ! 3-A53'P\$

\$

!"#\$%&'()*+,-./0123456789: ";&.-<&,- '=.0\$%3&>'
5--6>??@@@7&-6\$2)304)3,?
\$

!"#\$%&'8\$<2&%'089!: '#%+,

"

!\$"

94,4\$4*;'#9\$-#+#>\$(\$9&#\$4%%#4+\$,-4,\$-(-\$*#:#*\$&B50(('#9>\$B&9("4,#9\$5RS\$
1?"9("\$,\$-('\$4+#4\$/#+#\$&,\$&),4("#9\$("\$,-B86(9\$EF\$#C&\$%+&:(9B&4+('>\$,-#\$
cdB&00(,9\$4%%+&A(04,\$T,SiWK\$0(**(\$"+&?.\$4\$('.*#4",)(&,(3'\$+##4+\$1?"9\$\$
,-#P*#0("\$P?"9\$"\$JKEO\$6cd\$[&:#+"0#",\$JKEO8

\$

\$

P(.?+~~\$~~ ~~\$~~ MdG\$%4%#+'\$&"\$275\$4'\$4\$%#+3#" ,4.#\$&1\$,-&'#\$(",\$-#\$4+#4\$&1\$%-4+043;\$6,&,4*\$
MTPB?"9#9\$
\$

\$

P(.?+~~\$~~ ~~\$~~ M?0)#+\$&1

!&"

"

P(.?+~~00~~M?0)#+~~\$&1~~\$*(-\$*4".?4.#\$%4%#+'\$2", (B-H43,#+(4*\$2.#"\$1+&0\$4?,-&+'("\$
, -# \$d\$4"9\$D-("4\$4"9\$, -#(+ \$%+&%&+/(&"\$91\$)*(34,(&\$"\$,-#\$4+#4\$&1\$%-4+043;\$
6'&?+34\$N?)7#9>\$]!T\$
2\$9+404,(3\$("3+#\$'#

1+&0\$,-#\$+#.?*4,&+;\$9#%4+,0#,\$\$4+\$41,>#,- \$%-4'#\$\$\$'(34*\$,+41*+\$?%%#+\$
+##%(+4,&+;\$,+43,\$('1#3&0%*#,#9\$('\$JK\$F,\$('\$+#3#',\$;#4+'>\$,-('\$%+&U\$3\$('*,\$
1?"9#9\$);\$,-#\$^/\$9+?.\$9('3&:#+;\$04U&+\$%+&U#3,_\$

\$

G"\$'?'004+;>\$,-#\$-(',&+;\$&1\$,-##\$"/\$4",)(&,(3'\$%#-2;\$%?)*(3\$1?"9("\$-\$&".)\$##"\$
(0%&+,4",\$1&+,\$-#\$3+#4,(&"\$&1'\$)/&\$(3'>\$#'%#3(4**\$4\$)4'(3\$+##4+3-\$',4<\$4'\$&\$
+##4*\$ \$,-4,\$ %?)*(3\$ 1?"\$-4'\$)##"\$ ("&*:#9\$4*&".'(9#\$1&**&2%\$ (":#',0#",\$ 1+&0\$
#",+##%+##"##?>\$/(,-\$'&0#\$\$("1(34",\$'?'33#"\$<\$C\$&".B#+0\$,+4,##,;\$-4'\$)##" \$A%4"9("\$.\$
%+&U#3'\$"/\$4",)(&,(3'\$4,\$,-#\$)4'(3\$+##4\$4-# \$&\$("3+#4'##,-#\$%&"()*(,;\$&1\$9+?.\$
9#:#*&%0#",\$4"9\$?'%%&+,\$-#\$%+##3*("(34*\$4"9\$3*("(34*\$34"9\$41\$"/&\$(3'>\$/- (3-\$
4+#\$?"9#+,4@#"\$,--+&3&&%#4,(&"\$/(,-24 (#) 0.4 2 -0Tm -4+##%4+##"?+'<\$20.4 (+)35.1 (') -0.4 (24

!"#\$%&'&!(%&)**+,"-)+*&./+0%11&+2&3"4+/&+/)5)**\$&)**+,"-),%&"*-)#)+-)01&)*&/%0%*-&6%"/17

!"#\$ %	&'(#)(* %	+*,-,/")(*(% 0123,)0.,3(2\$ %	4\$-"0("#(2(*\$ %	8"/)360)* &
4."55%	!"#\$%&'()%*#+,-	./%0%1/#\$%'%\$,	2	

!" #

#

#

\$%#

!"#\$"%&" (

(

!"#\$%"&'(#)*#+,-./01/.2345546"576*48"98\$'&;+'4"5949)946"5'4""8"8*<=>89?88"/000#'\$/010@!'!A6BC#*#94D8'

#"#E=545'6F'GH4"#&'9H8'I"498\$'J4"<\$6B&#" '\$9H8'I"498\$'K958528"/L6E4AM1@'1NOP.

Q466".'/00N.'2GH4"#25'R""6D#94D8'+*)<'G8F94#B4\$4"8'L*6B6985'9H8'+8D8E6CB8"9'#"\$!CCE4A#946"652894

Q466".A6B.

Q6)"\$&'J.&'K#)"\$8*5&'S.&'T4E5\$6"&'U.';U.'!\$#B5'V/01W4"#25'#>56*C94D8'59#98@'*858#*AH&'4""6D#946""#"\$'9H8

C*65C8A95'F6*GH4"J'A6EE#>6*#946".'(6"\$6"@'[KS! ' '

G#6&'G6"<.'/01O.'2/W.'GH4"#28G/'5A48"A8"*8C6*9@'96?##\$5'/0W0P/TW&'L#*45@'I"498\$[#946"5'\\$)A#946"#E&'

KA48"94F4A#" '\$G)E9)*#E']*<#"45#946"

GH8"&'GH)#"H6"<&'#" '\$J#4^#4""GH8".'/01_SH8':6#'\$96'LH#*B#A8)94A#E'R""6D#946"@':8D48?'6F'10WQ4L*6`8A9'V

cdef ghi 10WQklmno Xvp4<H8*"\$)A#946""L*855'stuvw X@'Q84`4"<X.

GH8&'x#"9#4#" '\$!\$*4#"E=.'/011.Y p8#E9H'>4698AH"6E6<='4""6D#946""F6*56A4#E'539#4"6845C8A94D8'

F*6B'GH4"Z &'KS\LK'T6*z4"<'L#C8*MN&'Q*4<H96"&'KS\LK'G8"9*8&'

!%#

#

:858#*AH'G8"9*899#?#.'G#"\$X.
GH*4598E' 301_.' LH#*B' \^8A25' S6C' O0' G6BC#'"485' /01_LH#*B#(8)94A#E' \^8A)94D8.' W_VPX&'&U)01_.'
H99C@{{{???C.B8^8A.A6B{CH#*B78^8A596C007A6BC#"485/010'V!AA8558\$'U)"8'1M&'/01_X
1)&U)"=#"&'x4B84'p)#"<&'#\$',4#6`)'(=).' /01_.'2G*4545'6F#"94B4A*6>4#E'*85459#"A8'4'"GH4#"@"'6?'#"\$'9H8'F)9)*828
€*6"948*5'4'"B4A*6>46B610@'//M0.
:8"?4Az&'3#99H8?'U&}4A96*4#K'4B624'E4#5'36554#E65.'/01P.'2S#*<894"<'4'"6D#946""4'"#94>4694A\$*)<\$45A6D8*=
#"\$'\$8D8E6CB8"928#E9H'L6E4A='K8*485'6F'9H8'l)*6C8#""]>58*D#96*='6'"p8#E9H'K=598B5
:658">8*<['.1_P_.'Y SH8'+4*8A946""6F'S8AH"6E6<4A#E'GH#"<8@'R"\$)A8B8"9'38AH#"45B54#"S'6D4A85.'
IA6"6B4A'+8D8E6CB8"9#"('\$G)E9)*#E'GH#&'19V1&'L#*9'1Y&M1"
K#BC#9&'Q.'['/01/.'23455466*48'98\$>46B8\$4A#E'*858#*AH'#9'9H8'85624AH'L6E4AM1@'1MM1'.
KAH69&'U6H#"&'#\$'T.'\$?#*\$'K984'B)8EE8*.'/01•.'2SH*88'F*#B85'F6*4'"6D#946=@'::;+&'5=598B5'6F'4'"6D#946"
#"\$'9*#"5F6*B#94D8'AH#"<828#*AH'L6E4AMN@'17DM
K+!.'1_•_.' Y R"98*4B'B8#5)*85'F6*9H8'#\$B4"459*#946""6F'"8?*\$*)<'*858#*AH'F)"\$'C*8A958\$498\$>='K9#98'
+*)<!'\$B4"459*#946".Q84`4"<.
K94'E4"<&'!'"\$8?.'/00_2L#*94A4C#946"&'C*8A#)946""#"\$*8FE8^4D8<6D8*"#"A8'F6*5)59#4"#>E8'\$8D8E6CB8"92
4"!\$<8*&['.;'U6*\$#"&'!.'\5\$X'|6D8*"4"<'K)59#4"#>4E49=&'G#B>*G#B@4\$<8'l"4D8*549='L*855'1_W
//O '
S##*#"9&'G66EB#"&'!.'3.&'GH#9966*6?"&'&'U8"z4"5&+'.':.&'38H9#*#&'K.&'L8*8*#&['.#'\$'\.3.'J*6Az6?.'/01_.'
Y]C94B4-4"<' #94>4694A' C*85A*4>4"<@' A6EE8A94D8' #CC#6#AH85#9A6B6" 7C66E' *856)*A8Z
GE4"4A#E'34A*6>46E6<=#"\$'R'"8A946"@'1WOPW
IJ' |6D8*"B 8"9.' /01P.' |6D8*"B8"9' *85C6"58' 96' 9H8' :8D48?' 6"" !"94B4A*6>4#E' :85459#"A8&'
H99C5@{{{#55895.C)>E45H4"<6B'D446D8*"B8"9()CE6#\$5{5=598B}CE6#\$5{#99#AHB8"9°\$#9#{F4E8{OOWM
N1{|6D°*85C6"58°!3:°:8D48?.C\$F'V#AA855\$/0'U#"#*)*=/0/0X.

x4^4#"&'1).'/01_.'Y T#"<'=4<)>#'"<&'#C46"88*6F'9H8""8?'#"94>4694A'8*#&')58\$'<8"894A'8"<4"88*4"<'96'\$8D8E6C""8?'
\$*)<5.Z 'R""SH8'IA6"6B4A']>58*D8*[8?5C#C8*
...H#"<'U4)AH)"&'...H#"<'Q#4AH)".'/01_.'2LE#""4"<'KA48"A8#"S8AH"6E6<=@T6*z4"<6)9#"RBC8B8"947<'9H8'(6"<
98*B'L*6<*#B'F6*'+8D8E6C4"<'KA48"A85#"S8AH"6E6<='F*6B'1_OP'96Q_FGH4"858'A#\$8B='
6F'KA48"A85NM@7_1!
...H#"<&'4#4#"&'|)"#< 7|)6'x4"<&'GH#"<7|)4'L#"&'x6) 7KH8"<'(4)&'#"S'U4#'

#

FGPH0	/#('.,#)%%;-('.,%B)#,%(.%	*+,-('., %O% P%	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %
GU000	1.,(#',%;;('4'\$.C'#)% %	FO%SO%MC															
	8"?'(##,-"%LFGP%RGFGM																

FGPH0	I+()'. "%J%(6"%5"#)(6@%	*+,-('., %O% P% Q %															
PG0P%	16',##%FGSG%B)#,	H%															

FGPH0	B)#,%#,<%2+'<#,-"%J.\$%	*+,-('., % H%	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %	Q %
PG0P%	B6#\$4#,-"+(' -#)?%	PON0%T															
	<"3").E4", (%																

FGPR0	&6"%PS(6%R0"#\$\$%E)#,%	*+,-('., %O% P%	Q %													Q %	
GH0P%	J.\$%&1D%,-"%#,<%	H%															
	("-6,.).2@%' ,.3#('., %																

FGPR0 &6"%PS(6%R0"#\$\$%E)#,%
GH0P% J.\$%5@2"" , (") -11f [(J.) -2

!""#\$%&'()*(\$,#-.&#/#(0&1,

!

!

!"#\$%&'(\$(\$	*+, '#'+")	-.#(\$)+/)"#\$%&'\$(
0)	*%+/\$, +%)+/12'\$"2\$)."3)4\$25"+6+78)*+6'28	9;<=;:=;>)
?)	@/'2'.6)/%+A)BQ1D	9;<=;:=;E)
D)	@/'2'.6)/%+A)F"" ,#%8)+/12'\$"2\$)."3)4\$25"+6+7	9;<=;:=;E)
-)	@/'2'.6)/%+A)D5"").C++3)."3)-%G7)03A"" ,#%Q.#'-	9;<=;:=;>)
H)	@/'2'.6)/%+A) F"" ,#%8) +/!"3G, #%8) ."3) !"/+%A	9;<=;:=; ;)
Q	4\$25"+6+78 @/'26)/%+A)D5"").D+AA'##\$\$)+/)!\$.6#5=	9;<=;:=:J)

!

!

!

!" #

#

